Energy and Carbon Footprint of Ubiquitous Broadband

by

Sascha Suessspeck

ORCID identifier: 0000-0001-8031-2538

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Department of Electrical and Electronic Engineering

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Abstract

This thesis concerns ubiquitous broadband in Australia. We use a comparative-static computable general equilibrium model to analyse the economic effects, and to derive the environmental effects of the National Broadband Network (NBN) in the short term and long term. While investment is significantly increased due to NBN deployment in the short term, overall economic activity increases marginally. We find that national greenhouse gas (GHG) emissions are effectively unchanged by the construction of the NBN.

We run model long-run simulations to analyse the impact of new services and new ways of working that are enabled by the NBN. The simulation results are dependent on our estimates of the incremental impact of the NBN on service delivery. For this purpose, we map the coverage of broadband in Australian regions using an open-source geographical information system (GIS). We then define two sets of service requirements and determine service availability across regions with and without the NBN.

The results show that the NBN produces substantial benefit when services require higher bandwidths than today's offerings to the majority of end users. In this scenario, the economic effects of productivity improvements facilitated by electronic commerce, telework or telehealth practice made widely available through the NBN will be sufficient to achieve a net improvement to the Australian economy over and above the economic cost of deploying the NBN itself. If, on the other hand, the NBN has a significant effect only on the availability of entertainment services, then the net effect will not be sufficient to outweigh the cost of deployment. We find that national GHG emissions increase with service availability and are higher with the NBN.

We construct an NBN power consumption model to estimate the purchased electricity and GHG emissions of the NBN network in the long term post NBN deployment. We find that the NBN network increases energy demand and GHG emissions marginally.

The main contributions resulting from this thesis relate to the model simulations. Detailed analysis of the economic and environmental effects of the NBN on the Australian economy provides policymakers and researchers new insights based on a state-of-the-art methodology. Beyond the regional scope of this thesis, the results provide fresh evidence of the rebound effect and GHG emissions abatement potential of ubiquitous technologies such as broadband. While this thesis points at the possible trade-offs when evaluating economic policy faced by various individuals or groups, an efficient way to achieve a more sustainable outcome is to address externalities related to GHG emissions directly by way of implementing appropriate environmental policies.

Declaration Page

This thesis comprises only my original work towards the degree of Doctor of Philosophy except where indicated in the preface.

I have made due acknowledgement in the text to all other material used.

This thesis is fewer than the maximum word limit in length, exclusive of tables, maps, bibliographies and appendices.

Sascha Süßspeck

Sascha Süßspeck

Preface

This work is to the best of my knowledge original, except where acknowledgments and references are made to previous work. The computable general equilibrium model TERM ("The Enormous Regional Model") used in this thesis is a key element in the work towards this thesis and was exclusively developed by Glyn Wittwer, Mark Horridge and other staff members from the Centre of Policy Studies (CoPS) at Victoria University.

Part of this work has been presented in the following publication:

Süßspeck, S., Adams, P.D., Hinton, K., Walmsley, T. (2015), Economic, Energy and Carbon Footprint Impact of Australia's National Broadband Network, 18th Annual Conference on Global Economic Analysis, June 17-19, 2015, Melbourne, Australia.

Kerry Hinton and Terrie Walmsley have made minor editorial changes (<1%) and commented on the content of draft versions of the conference paper.

I was awarded a scholarship and living stipend from the Centre for Energy-Efficient Telecommunications (CEET) during my full-time enrolment as a PhD candidate at the University of Melbourne.

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I could not have hoped for better surrounding conditions and people to work with in Australia which makes it a very special place on earth. I am thankful for the opportunity to be able to experience and share those memorable moments with my family.

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Chapter 1 Introduction

1.1 The National Broadband Network (NBN) and ubiquitous broadband

On 7 April 2009, the Australian Government announced the National Broadband Network (NBN) with the objective to create a wholesale-only, open-access communications network. The aim of the NBN is to deliver high-speed broadband and telephony services nationwide. The NBN Corporate Plan released on 6 August 2012 set out peak funding of $AU 44 billion, providing 93 percent of premises with fibre-to-the-premises (FTTP) and the remaining 7 percent of premises with fixed wireless and satellite connections by 2021. Following the Australian federal election and a change of Government in 2013, an independent assessment was undertaken as part of a strategic review (NBN Company, 2013a). The independent assessment found that the existing NBN plan is forecast to miss its completion date by three years and would cost $AU 73 billion to complete, instead of the $AU 44 billion originally proposed. Consequently, the original model was considered unfeasible and an alternative model was proposed subject to other reviews, including an independent cost-benefit analysis and a review of regulation related to the availability of high-speed broadband in Australia. Among a number of scenarios, a potential technology mix was proposed which minimises peak funding. The so-called Multi-Technology-Mix (MTM) scenario plans to deliver to 90 percent of premises a service of at least 50 Megabits per second (Mbps) data rate for transferring data from the service providers' network to the end user (download) by 2019 (NBN Company, 2014a). The download data rate of 25 Mbps will be delivered to the remaining 10 percent of premises not served with a 50 Mbps download data rate by 2019 (NBN Company, 2014a). With a revised statement of expectations from April 2014, the Australian Government endorsed the building of a cost-effective NBN, utilising the access technology most appropriate in each area of Australia (Department of Communications and the Arts (2014b).

The NBN in Australia is an example of ubiquitous broadband in areas of inadequate access to broadband infrastructure, mostly in regional or remote areas, or in small pockets of poor service in metropolitan and outer metropolitan areas. Broadband access is considered as key to accelerating progress towards national and international development targets (Broadband Commission for Sustainable Development, 2016, page 1). Ubiquitous high-speed broadband impacts the way society functions, communicates, works, shops and recreates (IBISWorld, 2012). In an international context, results from studies by Greenstein and McDevitt (2011a, 2011b, 2012) and Grimes et al. (2009) have suggested that there is an economic benefit in broadband adoption, but there is little published evidence for greater benefits as higher broadband speeds are made available. Some evidence was provided by a non-peer reviewed study by Access Economics (2009), which has relied on a large-scale computable general equilibrium (CGE) model to measure the economic benefits of high-speed broadband, not the NBN, to the Australian economy for the period from 2009 to 2020.

The potential of the effective use of the NBN was described by the former Australian Government Department of Broadband, Communications and Digital Economy (2011). Nevertheless, there has been an ongoing debate in Australia on the question whether the NBN is providing value for money or not? Investigation by the Australian Government (Department of Communications and the Arts, 2014a) of the costs and benefits of the NBN using a partial equilibrium analysis has found a net cost relative to the scenario of an unsubsidised evolution of broadband. With the rare exception of Access Economics (2009) and the Department of Communications and the Arts (2014a), however, studies of the economic impact of broadband often fail to account for the evolution of broadband in the absence of the proposed initiative aimed at expanding the broadband infrastructure.

Since the adoption of the United Nations (UN) Sustainable Development Goals in September 2015, the UN Broadband Commission for Sustainable Development has promoted information and communication technology (ICT) and broadband-based technologies for sustainable development. The Broadband Commission has "affirm[ed] [its] sincere belief in the vital role of broadband for addressing climate change" (UN Broadband Commission for Sustainable Development, 2017), and that "[b]roadband and ICTs can help make economic growth more sustainable, while protecting the environment" (UN Broadband Commission for Sustainable Development, 2016, p. 1). Research from industry-led initiatives support this notion, suggesting that, if ICT is deployed with the intention to reduce carbon emissions, global carbon emissions could be reduced (Ericsson et al., 2013; Ericsson, 2015; The Climate Group and GeSI, 2008; GeSI and Accenture, 2012; GeSI and The Boston Consulting Group, 2015). The role of broadband in this context appears to be centred on its ability to "deliver vastly enhanced energy efficiency" (UN Broadband Commission for Sustainable Development, 2012, p. 4). However, no report to date has studied the overall energy and carbon impact of a nationwide broadband network on an economy.

While the introduction of ICT may help to reduce carbon emissions in some areas, it may also have other consequences. Lessons learned from history suggest that increased efficiency in the use of coal, for example, due to substantial improvements to the steam engine introduced by James Watt in the 19th century, would tend to increase the demand for coal (Jevons, 1866). This so-called efficiency paradox might come about because increased efficiency makes the use of the respective resource relatively cheaper. This in turn encourages increased use throughout the economy which may be reinforced by increased economic growth (Saunders, 1992).

Recognising the benefits of the CGE approach, we use broadly the same methodology as in the above-mentioned Access Economics study to measure the potential effects of the NBN, including its overall energy and carbon impact, on the local economy.

The remainder of this chapter briefly outlines the contributions of this thesis.

1.2 Aim and Contribution of Study

The aim of the present study is to explore and quantify the economic and environmental effects of expanding the coverage of high-speed broadband to the Australian economy. We focus on the NBN in particular and consider two scenarios: one in which services require higher bandwidths than today's offerings, and one in which services require only modest bandwidths. In addition to measuring the economic effects, we also measure the environmental effects of the NBN in the form of greenhouse gas emissions. These are derived from estimates of the use-phase electricity consumption of the NBN network, and results from the CGE model such as changes resulting from the NBN in consumption and output of economic sectors. The focus of the analysis is on the incremental impact of the NBN. That is, we acknowledge the evolution of broadband in the absence of the NBN and take into consideration areas of (in)sufficient broadband coverage and speeds under both scenarios.

In this study, we have taken the approach of considering the economic benefits arising from new services or new ways of working that are enabled by broadband and the NBN. Only services for which there is well-attested, published evidence of economic benefit in Australia and other countries have been included. The selection of services was informed by an international literature review and discussions with researchers from the University of Melbourne. The objective was to include services that studies had identified as providing the greatest benefits and those services that are considered of significant national interest. We have used the service benefits and our estimates of the NBN (incremental) impact on service delivery to derive the inputs for the simulations in the CGE model.

Most of our estimates are derived from public data available at the time of our analysis. New inventions and new broadband services are being deployed all the time. Some new service, as yet unenvisioned, may have substantial economic impact not accounted for in the present study.

The comparative-static CGE model we have adopted does not provide year-by-year forecasts. Such forecasts would involve modelling the rollout schedule of the NBN until completion, which was not publicly available. Therefore, issues such as labour market dislocation or adjustment costs are outside the scope of the present study. Rather, our results show the step change in the economy due to the construction of the NBN in a typical short-run year, and the presence of the NBN in a typical long-run year after it is fully deployed.

The present study contributes to research in providing evidence of the greater economic benefits and energy efficiency of broadband as higher broadband speeds are made available. It is the first such study to rely on a general equilibrium approach and a well-founded computable CGE model of the Australian economy to assess the effects of the NBN. The results are based on inputs derived from services and their benefits we have considered, the cost of deploying the NBN itself, and account for the unsubsidised evolution of broadband in the absence of the NBN.

The results show that the economy would be substantially better off after the NBN has been fully deployed when services require higher bandwidths than today's offerings. We also show that the expansion of the overall size of the economy with the NBN in the long term increases national greenhouse gas emissions. This seems to support the notion "that energy efficiency improvements that, on the broadest considerations, are economically justified at the microlevel lead to higher levels of energy consumption at the macrolevel than in the absence of such improvements" (Herring, 1998, p.5).

1.3 Structure of the Thesis

This thesis consists of eight further chapters within three main parts. In Part I (Chapters 2 and 3), I situate the current study relative to related literature and establish the background and research methodology. Chapter 2 includes a critical review of the publications and work to date on the impact of broadband. I undertook a cross-disciplinary approach drawing from areas such as economic growth and environmental economics. Chapter 2 argues for the need to investigate the greater benefits as higher broadband speeds are made available, and the energy efficiency of broadband. Based on the gaps identified in the literature, the research questions are posed accordingly. In addition, chapter 2 includes a review of the literature on broadband access network technologies and broadband-enabled services that are the subject of the analysis. This more general review provides an overview and necessary background for the analysis described in Part II and III. Chapter 3 describes the methodology and research questions. This provides the theoretical and procedural description of instruments used in the study to manipulate, present and analyse data.

In Part II (chapters 4, 5, 6, 7 and 8), I present the results of data analysis of the NBN impact on service delivery, and its impact in economic and environmental terms. PART III (chapter 9) contains the discussion, policy implications, and conclusions of the present study. Based on the discussion on the key findings in chapter 9, implications and recommendations are drawn to inform the policy of broadband-enabled service use and energy efficiency of broadband. Chapter 9 also contains the conclusions, a reflective evaluation of the study and suggestions for further research.

Chapter 2 Literature Review

2.1 Economic Impact of Broadband

Research dedicated to identifying the economic impact of broadband has a relatively short history and is growing. An extensive international literature review conducted on behalf of the European Commission found that: "In general, economic and employment benefits increase with broadband take-up rather than with the particular advantages of high-speed broadband" (Analysys Mason and Tech4i2, 2013, p.2). According to the International Telecommunication Union (ITU, 2012), the contribution of broadband technology to economic growth occurs on three levels. First, broadband facilitates the adoption of more efficient business processes improving productivity across business enterprises. Second, greater broadband diffusion eases the introduction of new innovative consumer applications and services. Third, broadband provides a more efficient way to overcome geographical boundaries by maximising the reach of enterprises to labour pools, access to raw materials, and consumers.

The areas of focus of the literature reviewed in this section can be summarised in five categories:

1. Contribution of broadband deployment to employment and Gross Domestic Product (GDP) growth;
2. Productivity improvements;
3. Improvement of businesses efficiencies;
4. Positive externalities and the contribution to employment and GDP growth; and
5. Increase of social welfare, in particular consumer surplus.

The study on the socio-economic impact of bandwidth by Analysys Mason and Tech4i2 (2013) on behalf of the European Commission relied on input-output analysis covering 27 European countries. For each country, three different coverage and take-up targets of broadband with 100 Mbps access speed by the end of the study period in 2020 were specified. The level of funding that may be required to achieve these targets was then calculated by industry sector. Coverage achieved in the 27 European countries under the "do nothing" scenario was estimated to be 50%, with service take-up of 36%. The coverage targets under the modest and major intervention scenarios are 61% and 82% with assumed take-up rates of 34% and 47%, respectively. Funding in the modest and major intervention scenarios was assumed to be used to deploy FTTP in those areas not already covered by a terrestrial fixed next-generation access network (e.g. fibre to the cabinet, FTTP and fixed-wireless access). The total benefits or return on investment spent on network deployment includes estimates of potential multiplier effects. That is, potential growth in the other sectors of the economy stimulated through the investment in one sector of the economy. Multipliers were calculated using input-output analysis on an annual basis from 2012 to 2020 for each member state for each of the three scenarios.

The calculated benefits ratios across the 27 European countries are 2.4 in the do nothing scenario (€ 181 billion from an investment of € 76 billion), 2.6 in the modest intervention scenario (€ 270 billion from an investment of € 103 billion) and 2.7 in the major intervention scenario (€ 569 billion from an investment of € 211 billion). The benefits calculated under each scenario were converted into full-time equivalent (FTE) jobs by dividing the output or benefit by turnover per person employed, using Eurostat data at the country level, resulting in 1.35 million ("do nothing" scenario), 1.98 million ("modest intervention" scenario) and 3.94 million ("major intervention" scenario) FTE jobs over the intervention period. One third of total jobs created are estimated to be directly involved in network deployment and businesses selling to those that are directly involved in network construction. The remaining jobs created by FTTP deployment are induced by household spending of the income earned from the direct or indirect effects. While Analysys Mason and Tech4i2 give an indication of the nature of jobs created due to network deployment, they acknowledge that it is impossible to determine how long the additional jobs may last beyond the study period, since this will be subject to prevailing economic conditions. In addition to the estimated benefits due to network deployment, Analysys Mason and Tech4i2 have estimated consumer surplus benefits arising from broadband deployment and adoption, which is further discussed in this section below.

Previous studies relying on input-output analysis for estimating the change in total employment throughout the economy resulting from the deployment of a broadband network were conducted by Crandall et al. (2003), Katz et al. (2008) and Atkinson et al. (2009). The estimated capital investment required to deploy a ubiquitous broadband service (Crandall et al., 2003) or as a broadband stimulus in the United States (Atkinson et al., 2009), and to build a national multi-fibre network for Switzerland (Katz et al., 2008) is used as an input to the input-output model for calculating the broadband construction effects on employment. Crandall et al. find that the effect of the cumulative investment of $US 53 billion in current broadband (e.g. DSL and cable) and $US 93 billion in more advanced access technologies (e.g. FTTP and very high-speed digital subscriber line) between 2003 and 2021 on U.S. employment in their "benchmark" subscriber growth model would be an estimated average of 140,000 sustained jobs per year and $US 414 billion in economic output or GDP. Under a more rapid broadband adoption scenario, Crandall et al. estimate that broadband providers will invest $US 165 billion between 2003 and 2013 resulting in a cumulative increase of $US 465 billion in GDP and an average of 271,000 additional jobs per year. According to Atkinson et al., the outcomes of a $US 10 billion broadband stimulus package applied in the United States are that 498,000 jobs will be created or retained for one year due to direct telecommunications jobs (49,820), direct capital equipment jobs (13,840), indirect and induced jobs (165,815) and additional jobs in upstream industries throughout the economy due to the network effect (286,480). The network effect occurs in the form of upstream investment in industries encouraged by broadband "creating new and innovative applications and services such as telemedicine, Internet search, e-commerce, online education (distance learning), and social networking" (Atkinson et al., 2009, p.7 and 8). Katz et al. use national input-output tables for a study on the impact of the deployment of a national open access fibre network in Switzerland at a cost of CHF 13 billion, relying on national input-output tables. The deployment of such a network was estimated to generate 114,000 jobs, broken down into 83,000 in direct jobs and 31,000 in indirect employment, not including estimates of induced employment.

The broadband effects on productivity were investigated by various studies relying on econometric analysis. Results from a study by Waverman (2009) for 15 OECD countries including the United States suggest that the level of impact of broadband on productivity is subject to the level of ICT penetration and adoption costs in the country of interest. The findings support the emerging view in the economics literature that, in order for ICT adoption to boost economic (GDP) growth and productivity, significant levels of complementary investment or capital are likely to be required. Similar studies were conducted by Czernich et al. (2009) for 25 OECD countries between 1996 and 2007, Koutroumpis (2009) for 22 OECD countries between 2002 and 2007, and Thompson and Garbacz (2008) for 46 states in the United States between 2001 and 2005. The study results from Czernich et al., Koutroumpis, and Thompson and Garbacz suggest that productivity-based broadband network externalities exist, resulting in a positive impact of broadband on employment growth in OECD countries. Thompson and Garbacz (2008) also found that the productivity impact of broadband alone can result in a net reduction in employment due to capital-labour substitution. However, Crandall et al. (2007) found no statistically significant results in terms of GDP growth for 48 states in the United States between 2003 and 2005.

Grimes et al. (2009) relied on an official economy-wide sample survey of New Zealand firms from 2006, including a wide range of questions in relation to the individual respondent firm regarding business operation, information and communications technology and employment practices, linked to financial data available from the Statistics New Zealand's prototype longitudinal business database (LBD). The LBD comprises tax- and survey-based financial data, merchandise and services trade data, a variety of sample surveys on business practices and outcomes, and government programme participation lists. The longitudinal nature of the data enabled Grimes et al. to determine the impact that different types of internet access have on firm productivity. The types of internet access considered were cable (fast) and other (slow), including DSL, cellular, wireless, satellite, and no broadband, including both dial-up and no internet access. Grimes et al. found that, although broadband adoption boosts productivity, no statistically significant productivity differences were found across different types (speeds) of internet connectivity.

In a bottom-up study about the impact of broadband on efficiency and effectiveness at the firm level, Fornefeld et al. (2008) combined micro- and macroeconomic data from two regional case studies. Fornefeld et al. identified the following three types of impact of broadband on employment:

- Introduction of new applications and services accelerate innovations;
- Adoption of more efficient business processes enabled by broadband improve productivity; and
- Attracting employment from other regions as a result of the ability to process information and provide services remotely (outsourcing effect).

In the short-term, the productivity effect on employment is negative, resulting in fewer personnel at constant output or sales. The outsourcing effect typically results in jobs created in the business service sector that are displaced from other sectors of the economy. After accounting for the effects of productivity improvement and outsourcing, Fornefeld et al. estimate that there was still a positive number of jobs created in the 27 European countries studied from 2000 to 2006 due to the creation of innovative business services. The results rest on three key assumptions. First, it is assumed that 100% of the innovative activity in the financial and insurance activities sector is directly or indirectly related to high-speed internet access. Second, the ratio of jobs created to jobs lost in the financial and insurance activities sector (112%) applies to activities in other economic sectors. Third, the net creation of jobs is mainly due to the development of new markets by creating innovative business services rather than a change in demand. Fornefeld et al. remark that in the rest of the economy “information-intensive activities are diffused in other kinds of activities” and therefore “[t]he impact of broadband-related innovation in the rest of the economy cannot be calculated directly” (Fornefeld et al., 2008, p.100). To estimate the impact of broadband on GDP, the estimated increases in employment were expressed in terms of value added. That is, employment growth was multiplied with labour productivity in the economic sectors under consideration. The total contribution of broadband-related effects to GDP growth in Europe was more than € 82 billion per year or 0.71% of the growth of the European GDP in the base year 2006 of approximately € 11,500 billion.

The study by Katz et al. (2010) relied on econometric modelling to investigate the impact of broadband on both GDP and employment. Based on data from Germany, results from Katz et al. suggest that the impact of broadband on both GDP and employment in areas with high broadband penetration is relatively high in the short term and then declines over time. Katz et al. suggest that the reason for this “supply shock” to occur is the ability of the economy to immediately utilise the newly deployed technology. Katz et al. note that the results showing employment and GDP to increase at the same rate indicate that the impact of broadband on innovation and business growth dominates any potential employment reduction resulting from productivity effects. In terms of regional differences, Katz et al. were able to show that the impact of broadband penetration on GDP in areas with low broadband penetration was smaller than in highly penetrated areas in the short term and increases to comparable levels over time. With regard to employment, the results from Katz et al. suggest that the increase in broadband penetration in poorly penetrated areas has a negative impact on employment in the initial years. However, employment growth in areas with low broadband penetration “catches up” with more developed areas within three years.

Katz et al. note that their findings in terms of the different broadband network effects across regions are consistent with results from previous research. For example, results from econometric modelling conducted by Gillett et al. (2006) based on data from the United States between 1998 and 2002 suggest that communities in which mass-market broadband was available by December 1999 experienced more rapid growth in employment, the overall number of businesses, and businesses in IT-intensive sectors. Gillett et al. note that further research is required to disentangle causality between infrastructure availability and economic development. Furthermore, the study findings from Gillett et al. could be refined with better data on how broadband is actually being used in areas where it is available and on the quality of broadband.

Shideler et al. (2007) used the same theoretical model used in Gillett et al. (2006) to estimate the impact of broadband on employment growth in Kentucky counties in the periods 2003-04 and 2004-05. Results from the study by Shideler et al. suggest that the broadband infrastructure’s contribution to employment growth was greater where Kentucky counties were neither sparse nor saturated in their deployment. According to Shideler et al., a critical amount of broadband infrastructure may be needed in order to increase employment significantly. Once a community is completely built out, however, additional broadband infrastructure might have no significant impact on employment growth.

In a study on broadband in relation to export performance in low and middle-income countries in Eastern Europe and Central Asia, results of the econometric analysis conducted by Clarke (2008) suggest that broadband technology is positively correlated to exports of manufacturing and service enterprises.

ACIL Tasman (2004) and Access Economics (2009) both relied on general equilibrium analysis to estimate the economic impact of broadband on the Victorian and Australian economy, respectively. ACIL Tasman derived direct productivity impacts of basic broadband (256Kbps) from studies on the productivity impacts of Information and Communication Technologies (ICT) and the internet in general. Access Economics considered an FTTN (VDSL) network upgrade to 90% of the Australian population and mapped various coverage scenarios using a GIS. The evaluation of the net benefits was based on estimates of the direct capital costs of the infrastructure investment and the impact of productivity improvements on economic growth. The direct effects of VDSL on productivity in each sector of the economy relied on modified assumptions of the direct effects of basic broadband derived earlier by ACIL Tasman (2004). Access Economics assumed the economy-wide multifactor productivity levels in an Australian economy with VDSL available everywhere relative to an Australian economy without VDSL after ten years. The positive net present values (NPVs) calculated by Access Economics for different rollout scenarios suggest that the expansion of coverage of VDSL under all scenarios would be economically beneficial.

In two separate studies, Greenstein and McDevitt (2011a, 2011b) estimated the consumer surplus based on what users in various countries would be willing to pay for substituting their narrowband access with broadband. For estimating changes to the consumer surplus in the Unites States, Greenstein and McDevitt relied on one set of estimates from Savage and Waldman (2004) who conducted an extensive survey of dial-up and broadband users in 2002. Savage and Waldman's estimates of the willingness to pay for broadband are net of benefits users receive from dial-up. The estimated consumer surplus is equal the conversion cost as the sum of the increase in subscription fees and the net savings in expense for a second line. Greenstein and McDevitt estimated gains in consumer surplus through broadband between $US 6.7 and 4.8 billion in 2006 not included in GDP. Greenstein and McDevitt also focused in their study for the United States on estimating the changes in revenue in the final output market rather than changes in producer surplus. The net benefits or so called "broadband bonus" are the sum of the estimated changes in consumer surplus and revenue. Greenstein and McDevitt (2011b) used a simplified approach for estimating changes of the consumer surplus resulting from broadband adoption and changes of the real price of broadband in Canada, United Kingdom, Spain, Mexico, Brazil and China. Greenstein and McDevitt (2012) have extended their analysis using a similar approach to thirty OECD countries.

In a study on behalf of the European Commission, Analysys Mason and Tech4i2 (2013) estimate the increase of consumer surplus based on assumed nominal average revenue per user (ARPU). The study period is 2011 to 2020 and the consumer surplus was estimates under three possible intervention scenarios. Since nominal ARPU tends to decrease in most countries over time, the consumer surplus on a per subscriber basis tends to be higher in countries with high penetration of high-speed broadband in the beginning of the study period. The cumulative effect of the individual surplus for each high-speed broadband subscriber of the 27 European countries contributes between 5% or EUR 29 billion ("modest intervention" scenario), 10% or EUR 32 billion ("major intervention" scenario) and 13% or EUR 27 billion ("do nothing" scenario) of total benefits arising from investment in broadband deployment (input-output analysis) and consumer surplus.

In a cost-benefit analysis (CBA) of the NBN in Australia, the Department of Communications and the Arts (2014a) also relied on a consumer surplus analysis to estimate the social benefits generated by the following:

- the use of new and existing products;
- pure time savings;
- reduced transaction costs;
- travel time savings; and
- productivity improvements.

The difference between the methodology utilised by Greenstein and McDevitt (2011a, 2011b, 2012) and the Department of Communications and the Arts (2014a) is that the latter focused on the social welfare of the community rather than estimating only the change in consumer surplus and revenue. The Department of Communications and the Arts (2014a) assumed in the CBA that a significant share of the benefits may be captured in consumer and producer willingness to pay for faster broadband speeds. The CBA also compared the estimated consumer valuation with the direct project costs of various broadband technology rollout scenarios. The results of the CBA suggest that the NBN as it is currently planned has a net cost of $AU 6 billion relative to the unsubsidised rollout scenario, and $AU 30 billion when compared with the reference case “no further rollout” scenario. The rollout of FTTP to 93% of premises has a net cost of $AU 22 billion relative to the unsubsidised rollout scenario.

The study on behalf of the Broadband Stakeholder Group (BSG, 2008) provides a mix of quantitative and qualitative analysis of the various impacts of next generation or high-speed broadband on developing a cost-benefit framework. The BSG study highlights, amongst other externalities, costs in terms of road traffic affected by the network deployment, transaction costs generated by efforts to tackle piracy and potential negative effects on the production and distribution of new content. A further aspect of the BSG study is the excess burden of taxation in cases where investment in high-speed broadband is subject to public funding. The excess burden of taxation was not quantified in the BSG study. This issue was not considered by the various studies of the economic impact of high-speed broadband reviewed above. Anyone attempting to quantify potential impacts of investments in broadband technologies on an economy may find substantial differences in the results depending upon the financing model they adopt. By the end of 2007, 57% of households in the UK had a broadband connection. DSL coverage was 99%, FTTP coverage only minor and unsubsidised rollout of cable broadband under way. Based on US estimates, the costs of providing 80% coverage with all FTTC were estimated to be £ 5.8 billion, and with all FTTP £ 16.8 billion, including £ 0.8 billion cost in terms of consumer time for installation. Annual benefits were estimated to be £ 2.2 billion including time saving (£ 900 million), online backup (£ 170 million), online video distribution (£ 320 million), time savings from less business flights (£ 190) and line server for small and medium businesses (£ 620 million). Other potential private, wider economic and social costs and benefits were considered but not quantified.

As diverse as the economic effects of broadband technology quoted in the literature are, so are the methodologies utilised in the various studies. The ITU (2012, p. 4) states that “the overarching condition guiding the selection of one approach over another is driven primarily by data availability". Other crucial aspects that may determine the methodology are the context and purpose of the research question posed. The methodology utilised for estimating the potential economic impact of broadband in the future might be different to the one utilised to estimate the economic impact of broadband that has occurred in the past. For example, results from the study conducted by Grimes et al. (2009) relying on econometric analysis using data from a large New Zealand micro-survey of firms linked to unit record firm financial data from 2006 suggest no statistically significant productivity differences across broadband types. Grimes et al. note that the finding could be a result of insufficient details in the datasets used or because the full future benefits may not be apparent in the existing data.

Studies of the economic impact of broadband based upon econometric analysis utilise regression models in which indicators such as GDP growth, employment and other output metrics are expressed as a function of one or more input factors. Input factors could be education, broadband deployment and broadband penetration, for example. The econometric models are developed by assigning a set of relationships between input factors and the output indicator. The result is a projected value of the output indicator matching historical values for which the input factors are known. Macro-economic causal models rely on historical time series and cross-sectoral analysis. The models enable econometric modelling to link projections of broadband penetration to growth and productivity. The data includes the rate of change of both dependent and independent variables in order to determine to what extent changes in broadband penetration affect the economy. Studies relying on econometric analysis are typically used to estimate the economic impact of broadband that has occurred in the past. Econometric models used in Waverman (2009), Czernich et al. (2009), Koutroumpis (2009), Thompson and Garbacz (2008) and Crandall et al. (2007) give therefore little insights in terms of the potential economic impact of broadband in the future.

The consumer or producer surplus determines the utility or revenue in excess of the actual retail price or cost. The consumer surplus is typically estimated based on what users would be willing to pay for the goods and services. Estimates from Analysys Mason and Tech4i2 (2013) of the minimum consumer surplus based on reductions of an assumed nominal average revenue per user (ARPU) in the future are not directly linked to broadband-enabled services and their potential benefits. This is a shortcoming all reviewed broadband impact studies methodologies have in common in the presence of information asymmetries. The estimated minimum consumer surplus does not account for the experience effect of households that subscribe to high-speed packages, which was documented in Dutz et al. (2009), and the subsequent increase in the willingness to pay. The experience effect refers to the typical findings in survey research that users express a larger willingness-to-pay to avoid having products taken away from them that they already have experienced positively, than for products that they have yet to experience (Dutz et al., 2009). Consumers and producers may be biased regarding the likely impact that faster broadband speeds may have on future innovations and the value of new applications, services and products due to a lack of information (Department of Communications and the Arts (2014a). If systematic biases across a sufficient number of consumers and producers are present, then estimates of private willingness to pay may not correctly reflect relevant benefits (Department of Communications and the Arts (2014a). A further limitation of studies relying on private willingness-to-pay estimates is related to economies of agglomeration,[1] which was discussed in Robson (2014) and observed by the Productivity Commission (2014) previously. The Productivity Commission (2014) states that numerous spill-over effects related to agglomeration economies may not be fully captured by measures of private willingness to pay.

The methodology or framework for evaluating the value of next generation broadband in BSG (2008) is primarily based on examples of productivity improvements not derived from existing research or case studies; these include saving time, doing more of the existing things such as online back-up, and doing new things such as telemedicine. Fornefeld et al. (2008) have adopted assumptions derived from two regional case studies in terms of the impact of broadband on productivity and the impact of productivity on growth of employment.

Input-output analysis is used to investigate the importance of a particular industry due to the interdependence of industries in an economy via market-based transactions. The interrelationship of various effects on employment and production resulting from input changes to one or more industries can then be measured through multipliers[2] and the "direct requirement table", (also called the Leontief inverse table[3]). Today, input-output analysis is based on input-output matrices that are frequently published by government and census and statistics departments. A common use of input-output multipliers is to quantify the economic impacts relating to policies and projects (Crandall et al., 2003, Katz et al., 2008, Atkinson et al., 2009). In part due to their inherent shortcomings and limitations for economic impact analysis, however, the Australian Bureau of Statistics (ABS) discontinued producing and publishing input-output multipliers in 2006 (ABS, 2010a). While more complex methodologies such as those inherent in CGE models are required to overcome these shortcomings (ABS, 2010a), the outcome is still to a great degree determined by the inputs.

The modelling approach and theory contained in Access Economics (2009) was the most advanced we have seen in a study on the economic impact of high-speed broadband. Using a detailed and dynamic CGE or economy-wide model of Australia, the authors were able to trace and explain the impacts of changes to broadband infrastructure on the local economy. This includes an estimate of what would happen to Australian broadband rollout over the projection period, and resulting bandwidth changes, in the absence of the proposed initiative aimed at expanding the broadband infrastructure. The study results from Access Economics (2009) are based on spatial modelling that considers the timing and geographical pattern of construction of a high-speed network. The focus is on the relative advantage of different timing and geographical pattern of construction of a hypothetical high-speed network and not the NBN. The inputs to the CGE model in terms of the potential benefits of broadband-enabled services fall short of detailed analysis of the various types of broadband-enabled services, their potential benefits and required access speeds.

[1] Economies of agglomeration is a concept used in urban economics and relates to the idea of economies of scale and network effects. It refers to the benefits that firms obtain by locating near each other. Agglomeration economies only lead to a positive outcome allowing cities to grow if the benefits of the concentration of economic activity outweigh the disadvantages (e.g. problems of crowding and traffic congestion).

[2] Multipliers can be calculated in several ways and also for several economic dimensions. Type I multipliers measure the direct and indirect effects and are the sum of the direct and indirect divided by the direct effect. Type II multipliers are calculated as the sum of the direct, indirect and induced divided by the direct effect. An explanation of each type of multiplier together with examples can be found in ABS (1995).

[3] The Leontief inverse table or matrix refers to a quantitative economic technique developed by Wassily Leontief in the late 1930's called input-output model (Leontief, 1941). It is the inverse of a matrix derived from subtracting a given matrix from an identity matrix.

The well-documented nature and wide range of applications to which CGE models have been applied helped make it a convincing choice for a first attempt of a general equilibrium analysis of the NBN as it is currently planned. To date, it is the only methodology utilised for estimating the potential economic impact of broadband in the future which accounts for changes in relative prices throughout the economy. Combined with detailed spatial modelling of high-speed networks and the NBN, and new services that have well-attested, published evidence of economic benefits, our methodology is more suitable than the ones utilised in any other broadband impact study published to date with a regional focus. We have studied the role of the NBN in providing broadband in non-metropolitan. This thesis is set apart by quantifying the different stimulatory effects occurring in major metropolitan and regional areas.

Most broadband impact studies estimate the budgetary or incremental costs of providing greater broadband coverage. The real economic costs from financing the proposed initiative aimed at expanding the broadband infrastructure depends on how it is financed. For example, raising the budgetary amounts through higher taxes distorts people's decisions in ways that makes them worse off (Productivity Commission, 2011). In this thesis, we have assumed that the NBN has been funded through increased borrowing overseas. We estimated an increase in the annual balance of trade in the long term by some amount to service this debt.

We accounted for different broadband speeds for each service that may impact the users' experience. This approach was conceptualised in the CBA by the Department of Communications and the Arts (2014a) but not in Access Economics (2009), which assumed average annual growth rates in economy-wide multifactor productivity with high-speed broadband available everywhere relative to an Australian economy without it.

In the following section, we review the literature concerned with the environmental impact of ICT in general and high-speed broadband in particular.

2.2 Environmental Impact of Broadband

Many studies to date have investigated the environmental impact of information and communications technology (ICT) but not looked at the impact of high-speed internet access specifically. One of the key questions which various reports (The Climate Group and GeSI, 2008; GeSI and Accenture, 2012; GeSI and The Boston Consulting Group, 2015) have attempted to address is what are the quantifiable emissions reductions that can be enabled through ICT applications in various sectors of the economy? From a research perspective, when focusing on this use of ICT referenced in the GeSI reports, the following two questions arise:

6. how many of the reported ICT-enabled solutions rely on high-speed internet access; and
7. how much of the estimated emissions abatement potential identified in the GeSI reports are due to high-speed internet access?

The study by the Columbia Telecommunications Corporation (CTC, 2008) set out to quantify the indirect benefits of a fibre-to-the-premises (FTTP) access network in the city of Seattle in the United States. These include cost avoidance, monetary savings accruing to stakeholders and environmental impact in the form of a reduction in CO_2 emissions. The source for the emissions reduction estimates are case studies related to telecommuting and teleconferencing. Based on “statistically valid market research CTC conducted in Seattle” (CTC, 2008, p.7 and 8) and data from other sources, CTC derived estimates of the potential emission reduction through fewer commuting vehicles, decreased traffic congestion and corporate air travel.

Matsumoto et al. (2007) studied the impacts of ubiquitous network technology advances on CO_2 emissions in Japan. Matsumoto et al. identified in the literature ‘ubiquitous applications’ and their potential impacts in terms of energy use, business trips, commuter traffic, logistics costs, paper use in offices, etc. These applications were then linked to the following four ‘ubiquitous society scenarios’:

- an expansion of wireless local area networks providing internet access inside buildings, which enables paperless offices and telework;
- large scale mobile communications providing mobile internet access in outdoor areas, which enables highly efficient logistics and transportation;
- close-range radio networks providing people with the ability to connect various devices to the internet in order to access their personal data from every terminal, and the industry to use radio frequency identification (RFID), which enables greater efficiency in logistic and advanced supply chain management;
- wireless tag, sensing, and home networks providing diffusion of RFID-based sensing networks and context aware services, which enables energy management systems for home and buildings, and advanced intelligent transportation systems.

The potential impact of each scenario on the Japanese economy in terms of CO_2 emissions was then evaluated. First, Matsumoto et al. developed a base-case 2010 input-output table by extending the trends in changes from the 1995 to 2000 input-output tables. The method used for developing the 2010 input-output tables is the RAS method (Bacharach, 1970) for data reconciliation and econometric analysis. The newly developed 2010 input-output table was then used as an input to the CGE model. Second, Matsumoto et al. calculated a consistent new input-output table using a static CGE modelling framework. In the static single-country CGE model of the Japanese economy, investment is not linked to the economy’s capital stock. The amount of import and export of each commodity is set exogenously. The CGE model inputs for each ubiquitous society scenario were derived from existing studies and applied to technical change coefficients in the Cobb-Douglas (Cobb and Douglas, 1928) production function of 39 sectors and 40 commodities, and consumption coefficient for electricity. Labour productivity was assumed not to be affected by the ubiquitous applications. The actual values and corresponding technical change coefficients were not presented in the published study. Finally, the CO_2 emissions resulting from the four ubiquitous society scenarios were calculated and compared with the CO_2 emissions calculated in the base-case. The results suggest that, while electricity consumption in all four ubiquitous society scenarios is increased by assumption due to greater use of IT equipment, the improved energy efficiency due to the effects of ubiquitous application systems leads to a net reduction of the national CO_2 emissions. Domestic output is increased in the scenario assumed to have the greatest impacts except for coal and crude oil mining, which is unchanged. Unfortunately, neither the actual values of the inputs used in the CGE model nor the references for the study assumptions were readily available in English. It is therefore difficult to compare or fully understand the results. Matsumoto et al.

conclude that a better model is needed to describe human consumption patterns and production activities in industries.

The work by Matsumoto et al. is a rare example of a general equilibrium analysis of the potential impacts of IT-enabled applications on CO_2 emissions at the national level. The advantage of the methodology utilised by Matsumoto et al. is that a general equilibrium analysis accounts for the rebound effect. The rebound effect refers to an increase in the consumption of energy services, such as thermal comfort, refrigeration and motive power, as a result of an improvement in the technical efficiency of delivering those services (Sorrell and Dimitropoulos, 2008). Greening et al. (2000) distinguish between direct rebound effects, indirect effects, and economy wide effects. According to Sorrell and Dimitropoulos, the basic mechanisms of these effects are widely accepted. While their magnitude and importance are disputed, the policy implication is that non-price regulations to improve energy efficiency may neither reduce energy demand nor help to mitigate climate change (Sorrell and Dimitropoulos, 2008).

CTC (2008) and GeSI (The Climate Group and GeSI, 2008; GeSI and Accenture, 2012) do not approach the rebound effect nor is the methodology utilised capable of quantifying it. A review of the possible impact from rebound effect was conducted by GeSI (GeSI and The Boston Consulting Group, 2015) in 2015. Results from a preliminary assessment of the possible rebound effect based on rebound data from existing research studies suggests a rebound effect of 11% (1.4 Gt CO_2 emissions) of total ICT-enabled greenhouse gas abatement potential.

In this thesis, we approach the rebound effect with a general equilibrium analysis of the NBN. The CGE model we have adopted assumes that the Australian economy will react in various complex ways to reach a new operating point as new services and new ways of working are deployed in the economy. We have been careful to only include new services that have well-attested economic benefits. In contrast to CTC and GeSI, our estimates of greenhouse gas emissions account for productivity improvements other than energy efficiency that increases economic activity and greenhouse gas emissions.

CTC did not provide an estimate of the energy consumption or carbon emissions of the proposed FTTP access network. While CTC states that "[...] any emissions reductions associated with a project must be measured against a "baseline scenario", which serves as the reference case for the project activity" (CTC, 2008, p.16), it fails to attempt analysing the additional or incremental energy consumption resulting from deployment and ongoing use of FTTP. In this thesis, we have included estimates of the additional or incremental electricity purchased and consumed by the NBN based on a detailed power consumption model built for this purpose.

The remaining sections in this chapter contain a literature review of the technologies that are part of the broadband infrastructure considered, and the new services which we have included in this thesis. These sections do not review the research and literature this thesis intends to contribute to. Rather, they provide a summary of material that the reader needs to know to follow the rest of the thesis.

The following section summarises the broadband technologies that are subject of the present study.

2.3 Broadband technologies

The term “broadband” and its synonym “wideband" are often used to distinguish it from "narrowband". Both terms “wideband” and “narrowband” are subjectively defined relative to the implied context (Weik, 1989). In the context of this study focusing on internet access, when using the term “broadband” we refer to the description used by the Department of Communications and the Arts (2013a) as ‘always on’ internet connections. The internet connections may rely on different technologies which differ in their physical characteristics and limitations. In this section, we provide a brief overview of the technologies that are relevant to our study. For a thorough examination of the historical evolution of terrestrial telecommunications technology in Australia and a more detailed description of the next generation of technologies available for deployment in the NBN, the interested reader may be referred to Ayre et al. (2010).

Asymmetric Digital Subscriber Line (ADSL)

ADSL is a technology designed to give basic broadband performance over copper pair telephone lines. The first generation high-speed data transmission technology called Digital Subscriber Line (DSL) allows more data to be sent than with dial-up internet. DSL technology involves communication between the modem at the end-user premises and a complementary DSL Access Modem (DSLAM) at the local telephone exchange (Ayre et al., 2010). There may be multiple DSLAMS in the local exchange building.

Each telephone exchange serves the area around it, called an Exchange Serving Area (ESA). The more than 5,000 ESAs come in various shapes and sizes and their boundaries in regional and remote Australia are much larger than the towns they encompass. An ESA is divided into Distribution Areas (DAs). Within a DA, which typically covers 100-200 premises, copper cables radiate from a single point (the pillar point) to serve every premises. The pillar points are connected to the exchange by feeder cables. For the delivery of ADSL service, the total cable length from the DSLAM in the exchange, through the feeder and distribution cables to the customer’s equipment is a critical parameter in terms of the access speed provided to end users.

ADSL “[...] is ‘asymmetric’ in that data rates are higher in the downstream direction (toward the end-user) compared to the upstream direction (toward the network)” (Ayre et al., 2010, p.2). The achievable access speeds depend on the line length, “[...] because longer lines result in higher signal loss and raised levels of interference between different signals on the same cable“(Ayre et al., 2010, p.2). Downstream data rates for ADSL are up to 8 Mbps and up to 1.3 Mbps upstream (Department of Communications and the Arts, 2013a).

ADSL2+ is an enhancement to ADSL that uses a wider frequency range to achieve substantially faster speeds over relatively short distances (Department of Communications and the Arts, 2013a). Subject to transmission loss and other network constraints, this will result in the ADSL2+ ports providing higher access speeds by replacing the existing ADSL ports (Telstra, 2013c). For users less than about 1 km from their telephone exchange, ADSL2+ speeds up to 24 Mbps downstream are theoretically possible (Ayre et al., 2010). ADSL2+ speeds reach up to 3.3 Mbps upstream (Department of Communications and the Arts, 2013a). Many competitive carriers in Australia have installed ADSL2+ equipment in local telephone exchanges and were planning to do so prior to the announcement of the NBN. Telstra's TopHat IP DSLAM rollout schedule report[4] provides ADSL2+ port capacity at existing roadside cabinets.

ADSL2+ is not part of the technology mix envisaged for the NBN. In the future with no NBN, we have assumed that ADSL2+ would be available in every exchange serving area where a DSLAM was installed in a local telephone exchange at the time of this study.

Fibre-to-the-node (FTTN)

In a FTTN network, the lines between the end-user premises and the local telephone exchange are effectively shortened by deploying the DSLAM equipment in street cabinets closer to the users' premises. Each cabinet requires electrical power and is connected to a parent exchange by optical fibre (Ayre et al., 2010). In established areas, FTTN is a popular choice for network rollouts as it delivers higher capacity services but avoids the expensive step of replacing the entire copper pair telephone lines (Ayre et al., 2010). By the time the development of the NBN was announced in Australia, no imminent upgrade to the incumbent's existing network had been announced.

FTTN is a predominant broadband technology choice for the NBN. We have assumed that, in the business-as-usual scenario without the NBN, the incumbent continues its strategy to date and would not invest to upgrade its existing network with FTTN.

Hybrid Fibre-Coax (HFC)

Cable-TV companies have typically installed extensive networks of coaxial cables throughout cities and suburbs in a tree-like network structure (Ayre et al., 2010). With the growing customer base, the long coaxial cable spans between television distribution centres and suburban nodes were replaced by optical fibre in an effort to extend the range of TV channels. Subject to the type of equipment and the number of channels being used, downstream transmission rates in excess of 100 Mbps can be delivered (Ayre et al., 2010). Upstream speeds in Australia are typically constrained to much lower speeds than the theoretically possible upstream transmission rates of up to 10 Mbps (Ayre et al., 2010).

The NBN Company has previously acquired the right to use the principal HFC networks in Australia as part of the NBN (NBN Company, 2015a). It is planning to upgrade these networks with new technology and equipment and has been supplying local trial users via their retail service providers' services with downstream and upstream speeds of 100 Mbps and 40 Mbps, respectively (NBN Company, 2015a). In the business-as-usual scenario without the NBN, we have assumed that Cable-TV companies will not expand their networks beyond what was already deployed in Australia by the time we have conducted this study. We have also assumed, however, that Cable-TV companies in Australia would invest to upgrade their networks with new technology and equipment to deliver higher capacity services comparable to the planned HFC network in the future with the NBN.

[4] An Excel workbook including ESA listings and detailed maps of IP DSLAM Rollout areas in pdf-format are available for download from the website under the following link (last accessed on 7 March 2017): https://www.telstrawholesale.com.au/download/document/tophat-1.xls.

Fibre-to-the-premises (FTTP)

Point-to-point (P2P) fibre networks are replicating the copper network with a dedicated fibre to every customer premises offering much higher capacity services and symmetrical upstream and downstream bit rates (Ayre et al., 2010). In a passive optical network (PON), a single fibre provides a two-way connection between the customer's modem, called an optical network unit (ONU), and an aggregation point, where signals to and from many customers in the same neighbourhood are combined (Ayre et al., 2010). A single fibre takes these signals back from the aggregation point to an optical line terminal (OLT) modem at the local telephone exchange (Ayre et al., 2010). This decreases the number of fibres coming into each exchange and the space required in the ducts and pits, as well as in the exchange to house the termination equipment compared to P2P fibre networks (Ayre et al., 2010). This in turn reduces the cost of deploying the network on a mass scale. The advantages of fibre networks are as follows:

- the low loss of optical fibre allows customers to be located 20 km or more from their exchange;
- fibre networks are capable of providing higher bidirectional capacity services; and
- the aggregation point in a PON network includes a simple passive optical splitter/combiner, while the aggregation point (or street cabinet) in fibre-to-the-node networks is powered (Ayre et al., 2010).

The disadvantage of fibre networks is that the entire copper pair telephone lines need to be replaced. This adds to the cost of deploying the network in already established areas.

The NBN in Australia was originally intended to be primarily a Gigabit PON network with some P2P capability for the highest end-users, for example large businesses, hospitals or schools (Ayre et al., 2010). In the business-as-usual scenario without the NBN, we have assumed that no fibre network will be deployed in already established areas beyond the incumbent's fibre network sites that were developed at the time we have conducted this study.

Wireless Technologies

"Wireless networks were initially established to provide a mobile telephone service" (Ayre et al., 2010, p.5). While data and Internet access technologies have evolved, various wireless broadband technologies have been developed, such as Wideband Code Division Multiple Access (CDMA) mobile service, Long-term Evolution-Advanced (LTE-A) and WiMAX (Ayre et al., 2010). Wireless broadband technologies share common features. The network operator establishes a base station to which users within the base station's coverage area connect to, using their own wireless modems (Ayre et al., 2010). More importantly, wireless broadband technologies must use radio spectrum, which is a limited resource (Ayre et al., 2010). Similar to HFC networks, radio spectrum in wireless networks is a shared resource (Ayre et al., 2010). Thus, the number of customers that can be served from a base station depends on the level of traffic and type of traffic they generate, and the bandwidth of available radio channels (Ayre et al., 2010). Network operators are facing the trade-off between the cost of acquiring a finite resource such as radio spectrum to be able to add more radio channels at a base station in densely populated areas, and deploying additional base stations in order to reduce the coverage area and provide more capacity (Ayre et al., 2010). While the capabilities and success of these technologies will depend ultimately on the availability of radio spectrum, it is unlikely that wireless networks could offer some of the more advanced broadband services in a cost- and energy-efficient manner in urban areas (Ayre et al., 2010). These services include, for example, delivery of individual high-definition, on-demand video programmes to hundreds of users within the area covered by a base station (Ayre et al., 2010).

The NBN fixed wireless network is engineered to deliver services to a fixed number of premises within each coverage area (NBN Company, 2015b). LTE-A wireless broadband technology is used in order to transmit signals to and from a small antenna fixed on the outside of a home or business, which is pointed directly towards the base station (NBN Company, 2015b). Given line of sight from the base station to the antenna, the capacity available to households is more consistent than mobile wireless, even in peak times of use (NBN Company, 2015b). That is, the access speed available to end-users is designed to remain relatively steady, unlike a mobile wireless service where speeds can be affected by the number of people moving into and out of the coverage area (NBN Company, 2015b). In the business-as-usual scenario without the NBN, we have assumed that the current mobile broadband deployments cannot reliably deliver the sustained bandwidths required by the services we consider. The NBN fixed wireless deployments are included in the NBN scenario.

Satellite Technology

Satellite broadband technology transmits and receives data from a satellite orbiting the Earth to a small antenna or dish installed on the roof of an end-user's premises (NBN Company, 2015c). The data is then transmitted back from the satellite to a network of satellite ground stations with much larger satellite dishes, which connect to the internet (NBN Company, 2015c). Of all other broadband technologies, satellites are the most efficient way of connecting rural and remote homes and businesses to the internet (NBN Company, 2015c).

The NBN provides a satellite access solution, the Sky Muster service, for Australians outside big cities or regional centres. According to NBN Company, the Sky Muster service "will provide homes in rural and remote Australia with better access to e-health services, distance education and entertainment-on-demand, whilst businesses will have the ability to increase productivity, reduce costs and access new markets" (NBN Company, 2015c). In this study, however, we have assumed that the physical characteristics and limitations of satellite access solutions, i.e. latency and data allowances, are insufficient for the provision of the broadband-enabled services considered in our study.

NBN Wholesale Services

Internet access services provided by the NBN deliver an active wholesale network connection from a point of interconnection (PoI) of the retail service provider's and the NBN network to the end user premises. PoIs serve defined selections of end user premises. Retail service providers can interconnect at designated PoIs and use the NBN network for delivering their applications and services to end users (NBN Company, 2010a).

The peak information rate (PIR) NBN wholesale services deliver is the theoretical speed that an end user is able to receive if he or she is the only active user at that time (NBN Company, 2010a). Typically, NBN wholesale services provide multiple configurations with asymmetric PIRs that differ for data sent from a network service provider to an end user (downstream or download) and vice versa (upstream or upload). Table 2.1 lists the configurations of the asymmetric PIRs provided to RSPs in the remaining access domains.

Table 2.1: PIR configurations of the NBN wholesale services available to RSPs

Access Domain	Downstream (PIR Mbps)	Upstream (PIR Mbps)	Source
FTTP	12	1	NBN Company (2010a)
	25	5	
	25	10	
	50	20	
	100	40	
	250	100	
	500	200	
	1,000	400	
FTTN	50	5	Commsday (2014)
	50	10	
	50	20	
	50	40	
	100	5	
	100	10	
	100	20	
	100	40	
HFC	12	1	NBN Company (2014b)
	25	5	
	25	10	
	50	20	
	100	40	
Fixed Wireless	25	5	NBN Company (a)
Satellite	12	1	NBN Company (2014c)

The highest PIR configuration for each access domain shown in Table 2.1 was assumed to be uniformly available within the coverage of respective broadband customer access networks under the NBN.

The following section describes new services enabled by broadband and reviews the literature on the services that are the subject of the present study.

2.4 Key Broadband Enabled Services

The role and potential benefits of the NBN were outlined in a submission from the Australian Government Department of Communications and the Arts formerly Department of Broadband, Communications and the Digital Economy (DBCDE, 2011) to the House Standing Committee on Infrastructure and Communications in 2011. In the DBCDE submission, the authors list opportunities presented by the NBN in terms of the following:

- delivering government services and programs;

- achieving health, education and skills outcomes;
- managing Australia's built and natural resources and environmental sustainability;
- regional economic growth and employment opportunities;
- business efficiencies, revenues and exports;
- research and development and related innovation investments; and
- facilitating community and social impact.

In particular, the benefits of services enabled by the NBN as discussed in the DBCDE submission include the following:

- more efficient service delivery:
  - "increasing the range of government services that can be fully completed online;
  - enabling clients to use video-conferencing with a customer service representative;
  - allowing specialist services to be delivered remotely thus reducing the need for either or both the client and the specialist officer to travel" (DBCDE, 2011, p.8);
  - enabling new capabilities for business and government through greater use of cloud computing and significant savings for existing business models supported by ICT;
- achieving health outcomes:
  - telehealth services;
  - in-home models of care for the frail and elderly with complex or chronic disease and living in regional and rural areas;
- achieving education and skills outcomes:
  - increased take-up of relevant skills development programs through electronic education at home and in the workplace;
- Australia's built and natural resources and environmental sustainability:
  - smart systems at home including smart meters;
  - telework;
- regional economic growth and employment opportunities:
  - electronic commerce;
- business efficiencies, revenues and exports:
  - 'just in time' delivery reducing inventory costs;
  - electronic commerce; and
  - cloud based services.

NBN Company (c) suggested that internet access speeds available over the NBN enable households to do the following:

- achieve greater work-life balance by working from home;
- connect with people via smoother video conferencing;
- more efficient online shopping and banking;
- video streaming, entertainment on demand, online games, music and photos, access to international TV, news and sport;
- improve the education landscape by extending learning opportunities beyond the classroom; and
- make use of e-health and telehealth via quick transfer of medical images and documents, video consultations, secure sharing of records, payments and systems.

An international literature review conducted by Analysys Mason and Tech4i2 (2013) covered more than 240 academic and commercial studies that have investigated the social and economic impact of broadband. Analysys Mason and Tech4i2 note that: “Many of these studies were based on suspect methodologies or studies seeking interviewees’ ideas about the impact of broadband” (Analysys Mason and Tech4i2, 2013, p.71). Less than 20% of studies reviewed examined high-speed broadband in particular. The studies reviewed can be grouped into the following categories:

- community,
- crime and public safety,
- education and skills,
- employment and economy,
- environment,
- equality and inclusion,
- finance and income,
- health and care, and
- wellbeing.

Analysys Mason and Tech4i2 identified a range of high socio-economic impact services that high-speed broadband can facilitate. Of these services, the ones that were identified to require an increase in available bandwidth include:

- E-learning and remote education; requires high-quality video and high-definition video-conferencing. This will reduce travel to physical learning centres.
- Telepresence; requires high-definition videoconferencing. This service will provide cost and environmental benefits due to reduced travel as well as potential business advantages;

- Homeshoring; the ability of call-centre employees to work from home using a broadband connection. Businesses might move to homeshoring instead of outsourcing staff overseas, potentially increasing employment domestically and saving costs;
- Cloud computing; may require a broadband connection to the home or Small & Medium Enterprise (SME). This service increases IT efficiency for businesses and improves quality of life, saving consumers time by accessing a range of cloud-based services from their home;
- New services for the digitally excluded in the form of access to job opportunities, training, government and local authority services;
- Remote monitoring. This will enable elderly to stay in their own homes for longer, improving quality of life of the elderly and providing savings in their healthcare;
- Telemedicine; requires high-definition video conferencing for medical examination and remote monitoring; and treatment; and
- Wellbeing: High-definition video VoIP services improving quality of life and saving money.

According to Analysys Mason and Tech4i2, services requiring high-bandwidth video are most likely to benefit from high-speed broadband deployment, including HDTV, tele-monitoring and medicine, online gaming or simulations, video-on-demand, IPTV and videoconferencing.

Based on the literature we have reviewed and discussed above, the services and underlying quantitative impact studies we have considered in the present study are shown in Table 2.2.

Table 2.2: Broadband-enabled services and their estimated impact

Service	**Service description**	**Impact**	**Quantitative studies**
Online higher education	Interactive learning online at public universities	Space cost savings	Bowen et al. (2012)
Cloud computing	The use of public cloud[5] by small and medium enterprises	Reduced ICT capital and operating expenditures	KPMG (2012)
Electronic commerce	Companies using electronic banking and electronic government and the internet to receive and provide after-sales services, online supply chain activities (e.g. order tracking, logistics)	Productivity improvements	Atrostic and Nguyen (2006), Rincon-Aznar et al. (2005)
Telework	Formal arrangement whereby an employee leverages technology to work from home one or more days every week	Productivity improvements, employee retention, and other forms of competitive advantage	Bentley et al. (2013), England (2012)

[5] Public cloud refers to computing resources accessed as external services replacing products that are typically purchased, installed and managed within an organisation. The resources are hosted and managed by a third-party provider and can be used and accessed through the internet by multiple organisations on a shared basis (KPMG, 2012).

Service	Service description	Impact	Quantitative studies
Telework	As above	Employment opportunities for those who have a mobility limitation	DBCDE (2012)
Telehealth practice	Tele-monitoring elderly with particular chronic diseases	Reduced health system expenditure	DBCDE (2010)
Telehealth practice	Secure, private patient communications with clinicians	As above	Bartlett et al. (2010)
Telehealth practice	Provider to provider tele-consulting	As above	CUSACK ET AL. (2007)
Online entertainment	Online movies and games	Increased household spending on entertainment	Deloitte Access Economics (2013)
Transport	Secure, private patient communications (Telehealth) with clinicians replacing in-person physician visits	Decreased household spending on transport	Yamamoto (2014), Deloitte Access Economics (2013)

We have made the general assumption that the NBN will have no impact on the service adoption levels in areas where the broadband access technologies in the 'business-as-usual' future without the NBN meet the service bandwidth requirements.

The following sections provide a description of the services listed in Table 2.2 and their quantitative impact.

Online higher education

As of 2011, Australia's education and training sector contributed 4.5% to overall GDP estimated at approximately $AU 1,400 billion (IBISWorld, 2012). Forecasts suggest that this is likely to increase to 5.2% by 2050 as part of the growth in information and finance-related industries (IBISWorld, 2012). In the financial year 2009/2010, approximately 7.5% ($AU 5.8 billion) of Australia's education services were exported overseas, which was approximately 2.4% of the country's total exports of Australian production ($AU 245.6 billion) (ABS, 2013a). However, by restructuring the ways in which parts of instruction are provided, particularly quantitative courses that have a fairly common curriculum across institutions, online technologies can assist in educating more people in innovative ways that can lower costs for universities and colleges (Buck, 2013; Ithaka S+R, a). According to Buck (2013), many respected and reputable schools are acting quickly to take part in popular massive open online courses (MOOCs) networks. Others are developing alternative online and distance learning models that could be considered hybrid MOOCs. While there are many ways in which hybrid learning could be implemented on a college campus, the Open Learning Initiative at Carnegie Mellon University consists of sophisticated, interactive online courses with an embedded feedback system for each student. Students also attend a one-hour physically face-to-face session per week where they can ask questions and review concepts that they did not learn adequately through the online system.

A recent study by Griffiths et al. (2014) tested the use of interactive online learning platforms in seventeen courses across seven universities in Maryland. Griffiths et al. found that the use of technology to redesign large introductory courses has the potential to reduce costs in the long run by reducing the time instructors spend planning and delivering courses. While the IT and administrative support required by those instructors was found to be minimal, designing courses using MOOCs or hybrid courses was found to be a substantial undertaking. Griffiths et al. suggest that in the long run it may well be possible to offset the significant start-up costs involved. Redesigning courses to incorporate existing online content over multiple iterations of efforts could help mitigating start-up costs. Future research would therefore need to examine time use of a much larger population of instructors over multiple iterations of a course to see whether the up-front investment pays off over time.

According to Bowen et al. (2012), in the long run, using hybrid models for some large introductory courses would allow institutions to expand enrolment without an equivalent increase in space costs. This can in turn support an increase in access to higher education by making it more affordable for an institution to enrol more students and by accommodating more students because of greater scheduling flexibility. Beneficiaries may be students who have other commitments or who may live a distance from the campus. Bowen et al. estimated that the hybrid course especially designed for their study requires 67% to 75% less classroom use than a traditional course, assuming that no additional space is required under the hybrid course such as additional computer labs, for example.

In this thesis, we have focused on the space savings in tertiary education based on the findings from Bowen et al. (2012).

Cloud computing

A study by KMPG (2012) modelled the economic impact of cloud computing. The benefits of the following cloud service offerings were included in the analysis:

- software as a service;
- platform as a service; and
- infrastructure as a service.

In terms of the benefits, however, KPMG focused specifically on public cloud which was identified as the cloud deployment model with “the greatest growth potential over the coming decade” (KPMG, 2012, p.9). Public cloud, unlike private cloud, is not for exclusive use by a single organisation, but for use by multiple organisations or tenants on a shared basis. It is hosted and managed by a third party service provider such as Amazon EC2 and Google Apps. Benefits associated with the adoption of the above cloud service offerings as described by KPMG include the following:

- the direct cost savings from changes within the organisation away from internal data centres to large external data centres housing the IT infrastructure, resulting in reduced IT maintenance;
- productivity improvements of organisations that change business without the need for detailed capacity planning, changes to installed technology or new technology purchases, resulting in increased output per unit of cost; and

- innovation in organisations due to greater flexibility and agility, collaboration, and taking new products and services to market, resulting in the ability to deliver new and evolving products.

Based on industry consultations[6] and an international literature review, KPMG estimated that the accumulated benefits of adopting the above cloud service offerings over a 10-year time period results in a 25% reduction of operating expenditure (Opex) and a 50% reduction of capital expenditure (Capex) related to the organisation's ICT. According to KPMG, the smaller percentage reduction for operating expenditure reflects the costs that are related to new activities associated with the adoption of cloud computing. Since the study period is 10 years, it was assumed that potential challenges to adoption resulting in a barrier to the uptake of cloud computing will at least in part be overcome, as examples of early adopter countries such as the United States have shown (KPMG, 2012). KPMG have derived cost shares of ICT for 18 sectors in the future with no take-up of public cloud services, 50% and 75% take-up. With the estimated reduction of operating and capital expenditure on ICT, firms can produce the same goods and services with less input from ICT supplying industries, which implies a technological change in terms of the use of ICT-related commodities. The findings from KPMG were used in this thesis for the impact of cloud computing made more widely available through the NBN.

Electronic commerce

Three studies provide data on the potential benefits of e-commerce. Previous research by Atrostic and Nguyen (2005) has shown computers linked into networks are associated with significantly higher labour productivity. In a more recent study, Atrostic and Nguyen (2006) extended their analysis with information about the ways that manufacturing plants in the United States use their networks. The results of their empirical study suggest that, in particular, online supply chain activities such as order tracking and logistics have positive and statistically significant productivity impacts, subject to the age of the plant. Furthermore, the analysis from Atrostic and Nguyen (2006) shows that each new e-business technology used increases the company's productivity and that the effect of e-business technologies is cumulative. The estimates from Atrostic and Nguyen indicate the productivity improvements in the case of a complete integration of broadband technology into the company's processes. The findings from Atrostic and Nguyen (2006) suggest that the evolution of the impact on productivity between the initial situation and complete e-business integration can be considered linear.

Rincon-Aznar et al. (2005) examined the direct impact that e-commerce activity has had on productivity of enterprises in the United Kingdom between 1997 and 2001. Rincon-Aznar et al. used survey data from the Annual Business Inquiry (ABI) and an e-commerce survey specifically designed to reveal information about the use of the internet in the production processes of the enterprises included in the survey. They focused on the way firms in both the manufacturing and service sectors use the internet, in particular, the factors that affect their choice to carry out transactions over the Internet and how it affects their revenue. Their findings suggest that goods and services ordered over the Internet or over other computer mediated networks have significant and positive impacts on productivity.

[6] Between August 2011 and March 2012, 29 organisations were interviewed covering sectors accounting for 80 percent of Australia's GDP and ranging in size from 20 employees up to many thousands.

The study by Fornefeld et al. (2008) commissioned by the European Commission derives the productivity improvements in information-intensive functions of a company involving contact with outside bodies based on the results from Atrostic and Nguyen (2006), and Rincon-Aznar et al. (2005). While the share of information-intensive functions in a company's activity is one factor influencing the impact of e-commerce on productivity, Fornefeld et al. (2008) point out that the level of integration of e-commerce into a company's processes is a second important factor. Typically in the service sector, the integration occurs progressively first by using the internet to search for information about providers, second by using e-banking and e-government, third by having a website, then by integrating an online shop into the website, etc. However, each new e-commerce technology used increases the company's productivity. Analysis from Atrostic and Nguyen (2006) shows in fact that the effect of e-commerce technologies is cumulative. In the case of a complete integration of broadband technology into the company's processes, the productivity of the company has improved up to the estimated values. Similar to Atrostic and Nguyen, Fornefeld et al. (2008) suggest that the impact on productivity between the initial situation and complete integration of e-commerce can be considered linear.

A study by Grimes et al. (2009) on the impacts of internet connectivity on business productivity in New Zealand finds that the estimated productivity gains as part of their study can be attributed to adoption of slow relative to no broadband. Furthermore, Grimes et al. find no discernible additional effect arising from a shift from slow, i.e. DSL, cellular, wireless or satellite, to fast broadband, i.e. cable connection. While this raises the question to what extent mobile broadband in Australia is capable of providing benefits due to electronic commerce, Grimes et al. state that their results should be interpreted with care, providing various explanations that could account for this result.

The leading Australian provider of secure e-commerce solutions eCorner (2013) published information regarding costs and issues related to e-commerce. From a human resources perspective, for example, the management of an online shop requires different skills and fewer human resources than the management of a physical shop. eCorner estimated the number of hours per day dedicated to content and order management subject to the number of stock keeping units and daily visitors online. The new resources required for producing and selling goods and services online might decrease labour productivity and therefore offset the productivity improvements resulting from e-commerce to a certain degree.

In this thesis, we have focused on the productivity improvements found by Atrostic and Nguyen (2006) and Rincon-Aznar et al. (2005). We have assumed that potential offsetting effects indicated by eCorner (2013) are already reflected in the productivity improvements.

Telework

The sources for the potential benefits of telework are a study by Deloitte Access Economics and Colmar Brunton (2012) on behalf of an Australian Government Department focusing on the potential impact on employment, a CBA template with respect to telework provided by England (2012), and an independent study on trans-Tasman telework practices (Bentley et al., 2013).

Deloitte Access Economics and Colmar Brunton (2012) estimated the number of additional jobs in full-time equivalent (FTE) terms by 2020-21 through NBN-enabled telework. The results are based on the assumption that the NBN and better quality telework applications will see the gradual shift over time towards the doubling of current telework opportunities in Australia by the end of this decade, similar to what is already achieved in some other developed economies. The additional FTEs were estimated in reference to surveys on the likely delay of retirement for mature workers, likely increase of working hours for part-time workers, and likely labour force participation of persons currently not in the labour force. The findings from the survey were then weighted using data from the ABS to ensure each group was representative in terms of age, gender and location of the broader population of mature workers employed full-time, part-time, casual workers and people not in the labour force. In their study, Deloitte Access Economics and Colmar Brunton also take into account survey findings regarding the likelihood of employers to change their employment model because of the NBN.

The CBA template from England (2012) included assumptions in terms of savings and costs associated with telework. The productivity gain of teleworking employees was investigated by the Trans-Tasman Telework Survey (Bentley et al., 2013) of 50 organisations in a project collaboration among researchers from the Auckland University of Technology and the University of Melbourne. The survey showed that teleworkers had significantly higher perceived performance and productivity than non-teleworkers. The difference in mean scores for teleworkers and non-teleworkers for each variable was reported to be between around 7% and 11%, suggesting a meaningful practical productivity advantage for teleworking employees.

In this thesis, we have used estimated productivity improvements from the Trans-Tasman Telework Survey (Bentley et al., 2013) and England (2012), and increases in the labour force estimated by Deloitte Access Economics and Colmar Brunton (2012).

Telehealth practice

Various studies that have estimated the potential benefits of telehealth provide the source to determine the potential benefits of electronic health services. Access Economics (2010a) studied the cost and benefits of introducing a telehealth intervention into existing aged care programs on behalf of the Department of Communications and the Arts, formerly Department of Broadband, Communications and Digital Economy (DBCDE). The Access Economics' study was based on a potential pilot program over two years with a selection of sites with early access to the NBN. The intervention was designed to target particular chronic diseases, such as cardiovascular disease (CVD), diabetes and chronic obstructive pulmonary disease (COPD). These chronic diseases were identified in the literature as being an effective target for telehealth intervention and sufficient data was available on the efficacy of interventions in this group of elderly suffering from the above diseases. A study by Begg et al. (2007) for the Australian Institute of Health and Welfare estimated the prevalence of these diseases amongst the population aged 65 and older. Based on an international literature survey, the Access Economics' study provides estimates in terms of the impact of telehealth intervention on aged care for all three chronic diseases. This includes estimates of future hospital shares of health expenditure by payers and health system expenditure for all three types of chronic diseases.

In this thesis, we have estimated the impact of telehealth in aged care made more widely available through the NBN based on findings from Access Economics (2010a).

Cusack et al. (2007) have estimated the net benefits for a hypothetical nationwide adoption of tele-consulting between health providers in the United States. The estimated benefits mostly result from the use of either store-and-forward image transfer or real-time video capabilities, and the ability to simultaneously transmit high-resolution images in real time during a high-resolution videoconferencing encounter between physicians and specialists. The cost savings have been identified due to:

- a lower number of patient transports between emergency departments in cases where a particular type of specialist is not available at presentation time in the originating emergency department;
- less expensive transfers from prisons to medical centres;
- fewer transfers from nursing homes to health facilities;
- reduction in unnecessary tests and trials using real-time video consulting and store-and-forward image transfers.

Results from Cusack et al. (2007) suggest that the total annual net savings of nationwide implementation of hybrid technologies are $US 4.28 billion. Cusack et al. noted that they have considered all specialities together on a macro level. Modelling results may differ substantially when examining provider specialties in isolation (Cusack et al., 2007).

To estimate the impact of health provider to provider tele-consulting in this thesis, we have used the estimates from Cusack et al. (2007).

A study by Bartlett et al. (2010) provides an estimate of patient self-management services including secure, private patient communications with clinicians for Australia. Results from the Global E-Health Investment Model in Bartlett et al. (2010) suggest that the annual value of patient self-management is $AU 0.9 billion based on a 10-year investment horizon from 2010 to 2020.

In this thesis, we have used findings from Bartlett et al. (2010) to estimate the impact of secure, private patient communications with clinicians.

The largest not-for-profit medical organisation in the United States, Kaiser Permanente, has developed microclinics in neighbourhood retail plazas, where health plan members can receive primary care services or be stabilised and referred to a more acute setting. The ambulatory care facilities give providers the opportunity to meet patients closer to their home instead of insisting that patients meet the health care provider where they are located. The concept of microclinics was first introduced in 2007 when Kaiser Permanente began a series of trials with a high-tech office with two doctors, no pharmacy, no radiology, and a high-definition video conferencing add-on to link patients to a nearby hospital for a quick consultation with a specialist if need be. According to Capps (2009), the findings of the trial were that the two doctors working out of a microclinic could meet 80% of a typical patient's needs. Capps (2009) suggests that patients would still need to travel to a full-size facility for major trauma, surgery, or access to expensive diagnostic equipment. However, those are situations that arise infrequently. These clinics might enable Kaiser to add thousands of new members, decreasing the per-member cost at a microclinic to roughly half that of a full Kaiser hospital.

We have used estimates from Capps (2009) in this thesis to estimate the impact of microclinics in regional areas made more widely available through the NBN.

Online entertainment

Findings from the 2009-2010 Household Expenditure Survey (ABS, 2011a) suggest that household spending on entertainment, such as DVDs and computers games, has increased 29 per cent between the financial year 2004 and 2010 in real terms (Deloitte Access Economics, 2013). The Australian entertainment and media market has grown steadily in recent years due to growth in advertising and consumer spending supported by a strong growth in the internet segment (PricewaterhouseCoopers, 2012). A growth rate of 29 per cent was assumed in a study conducted by Deloitte Access Economics (2013) on behalf of the Australian Government to project out the increase in entertainment spending including online movies and games over seven years, on an annual basis, to $AU 1,522 per household in 2020.

In this thesis, we have used estimates from Deloitte Access Economics (2013), including findings from ABS (2011a), to estimate the impact of online entertainment made more widely available with the NBN.

Transport

Deloitte Access Economics (2011) states that benefits to society when people telework more include reduced traffic congestion, particularly during peak periods, and infrastructure demand. Deloitte Access Economics suggests that in reality, however, these are more likely deferred rather than avoided expenses and traffic levels are likely to again reach the point where capacity increases are needed. Clarke (2010) indicates that those not using the road will create temporary congestion relief that again induces a surge in demands that were previously latent, with the result that congestion remains the same. Such effects of supply-oriented policies in releasing latent demands were well documented in Down (1992) and described as 'triple convergence'. That is, drivers who had been avoiding peak-hour traffic, using alternative routes or public transport would start driving on again congested roads during peak periods. Duranton and Turner (2009) provide evidence supporting Down's 'Law of Peak-Hour Traffic Congestion' for cities in the United States where peak-hour traffic congestion on urban commuter expressways rises to meet maximum capacity.

Mokhtarian (1988) has discussed several examples of the potential complementary relationship of telecommunications and travel. An example over the long-term is a complex three-way relationship between telecommunications, transportation, and land use, which might result in increased travel. Mokhtarian suggests that changes in employment and/or residential location induced by increases in telecommuting could result in longer trips. Mokhtarian provides a sample calculation where the longer trips or distances travelled more than offset the avoided trips when telecommuting (Mokhtarian, 1988). This notion is supported by Zhu (2012) who finds that the complementary effect of telecommuting on personal travel is statistically significant. Based on data from the National Household Travel Survey (NHTS) in the United States, between 2001 and 2009 telecommuting incurs not only longer one-way commute trips but also longer and more frequent daily total work trips and total non-work trips. Furthermore, the positive impact of telecommuting on trip frequency has decreased over time and the increase in the distance and duration of work trips has outweighed the decrease in frequency.

The constant travel time budget found in Marchetti (1994), which also applies in Kenworthy and Laube (1999) for a large sample of international cities, limits people's commute time, activity time, and the subsequently induced non-work travel time. Telecommuters might adjust to the new situation and fully utilise their travel budget again. With regard to teleconferencing, Mokhtarian (1988) has argued that: "Organizations who have implemented teleconferencing systems find that more meetings are held than would take place without teleconferencing" (Mokhtarian, 1988, p. 284) and it therefore "becomes virtually meaningless to compare total travel costs when one is dealing with different numbers of meetings and different numbers of people involved" Mokhtarian, 1988, p. 284).

In the study of the benefits of high-speed broadband for Australian households, Deloitte Access Economics (2013) on behalf of the Australian Government estimated the benefits from avoided travel using regional data. Based on data from various reference sources, including unpublished data, Deloitte Access Economics estimated the average out-of-pocket costs per one-way car trip to the doctor or Department of Human Services Service Centre for metropolitan ($AU 5.20), inner regional ($AU 9.40), outer regional ($AU 19.20), and remote Australia ($AU 29.00), assuming that travel speeds in all areas are the same.

In an assessment of the feasibility and cost of replacing in-person care with acute care telehealth services, Yamamoto (2014) collected data from telehealth service vendors in the United States from 2011 to 2013. The results of the study suggest that the average number of telehealth visits per patient is 1.3 visits per annum and that approximately 83 percent of the time patient issues are able to be resolved during the initial telehealth visit.

To estimate the reduction in the use of transport in this thesis, we have used findings from Yamamoto (2014) in terms of telehealth visits replacing physical visits with a doctor, and estimated average costs per car trip to the doctor from Deloitte Access Economics (2013).

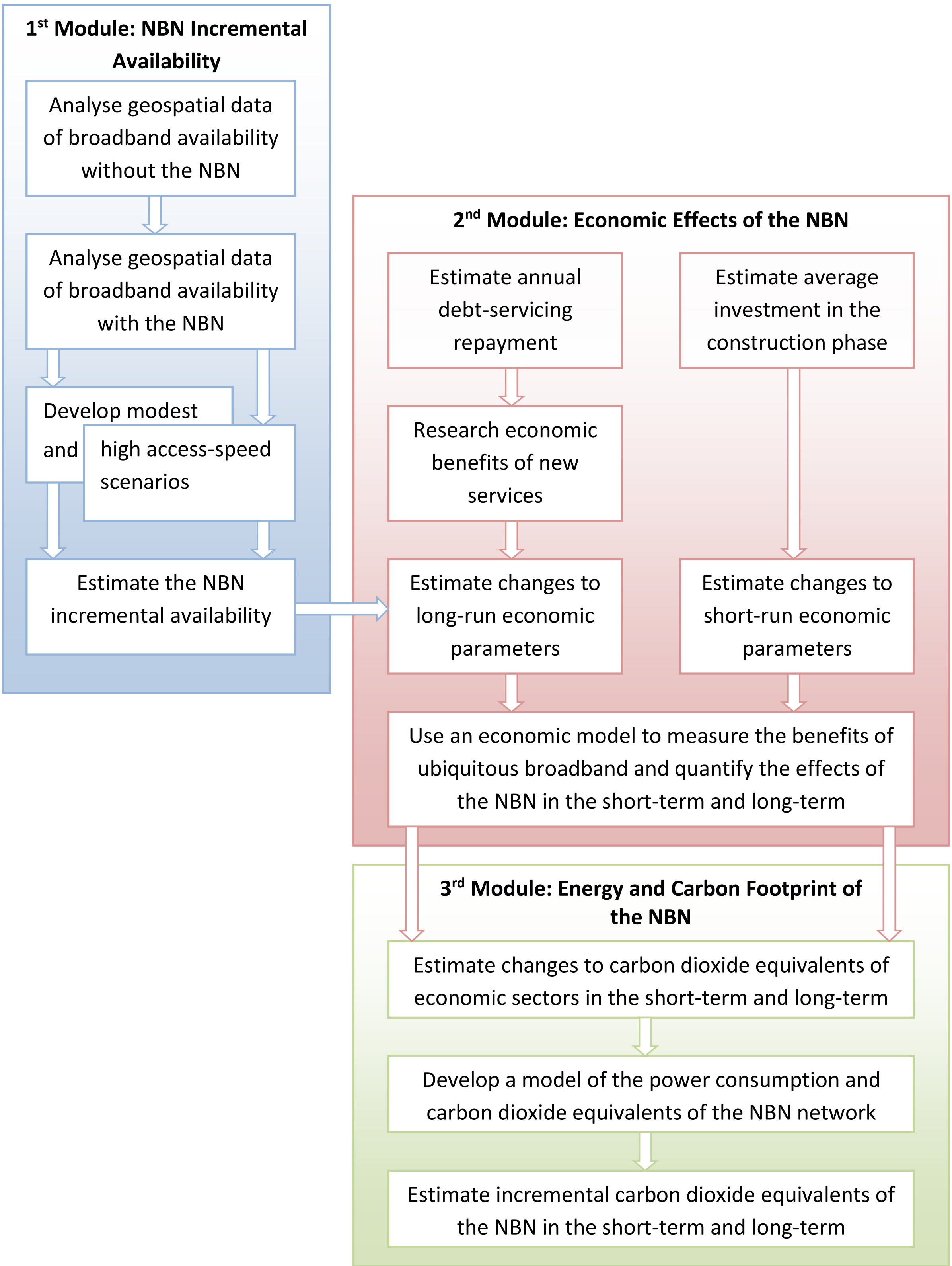
The findings from the literature reviewed in this section provide the basis for modelling the economic and environmental impact of the NBN in the present study. Our methodology and the structure of our model are described in chapter 3.

CHAPTER 3
MODEL STRUCTURE

3.1 Introduction

The structure of the model we have developed for the purpose of this thesis has three core modules. The modules are interlinked through their inputs and outputs as indicated in Figure 3.1. In the first module, we analyse the regional coverage impacts of broadband in the future with the NBN as it is currently planned. In this module, we also analyse the coverage impacts of broadband in an alternative future, the reference case without the NBN. This enables us to determine the NBN's regional contribution to the provisioning of new services and their respective benefits. The results from the analysis of the first module are used in the second module for our analysis of the economic effects of the NBN. For this purpose, we have adopted an economic model to quantify the effects of the NBN in a typical short-run and long-run year. In the short-term, the inputs to the economic model focus on the additional investment required in the construction phase. In the long-term, the inputs to the economic model comprise of estimates of the NBN's regional contribution, derived from the first module, the potential benefits new services have to offer, derived from case studies of the economic benefits of the key broadband enabled services, and increased balance of trade surplus, which can be thought of as a payment arising from foreign investment in the NBN. The uncertainty of the service requirements has led to the development of two scenarios: the economic effects of the NBN when services require relatively modest bandwidths; or, alternatively, the economic effects of the NBN when services require higher bandwidths than today's offerings. Outputs of the second module feed into the third module for estimating the energy and carbon footprint impact of the NBN. In particular, we have derived estimates of the carbon dioxide equivalents for all economic sectors in the future with the NBN from results of our economic modelling. We have refined these estimates with an energy model of the NBN network which we have developed for this purpose. Figure 3.1 provides an overview of the modules and key steps involved in the modelling process.

Figure 3.1: Overview of the model structure



The key steps in each module and how the modules are interlinked are briefly discussed in the remaining sections.

3.2 NBN Incremental Availability

The purpose of the geospatial data analysis is to map the coverage of broadband in Australian regions using an open-source geographical information system (GIS). There are two scenarios we needed to consider in our analysis. One scenario reflects the broadband coverage in the future with the NBN. For an assessment of the impact of the NBN, however, it is necessary to take into consideration the ability of the evolved broadband environment of the future without the NBN to satisfy the needs of the broadband-enabled services considered. This means that a business-as-usual scenario must also be modelled reflecting what would have been likely to happen if the NBN had not gone ahead as planned. By comparing the coverage impacts of the two different scenarios, we can derive the incremental use of broadband services on the NBN.

We have mapped broadband technologies in the GIS and conducted spatial analyses of both the future without the NBN and the future with the NBN, which we have described in sections 4.4 and 4.5, respectively. This approach has enabled us to identify the areas that will benefit from the NBN. An area then benefits from the NBN if the NBN provides higher usable access speeds than would have been available without the NBN. To model this, we have developed two scenarios: one in which services require only modest access speeds similar to today's offerings; and an alternative in which services require higher access speeds. More areas will benefit from the NBN in the scenario of higher access speeds. These areas are then linked to information about population, health and industry statistics to determine the numbers of people, health services or volumes of industry that will be affected by the new services made more widely available through the NBN. This is described in more detail in section 4.3.

3.3 Economic Effects of the NBN

A broadband service will have an economic effect based on the magnitude of its potential change and the availability of the service to those sectors that can directly benefit from it. Telework, for example, can have beneficial effects on productivity and labour-force participation. Research has shown that economic and employment benefits increase with broadband take-up rather than with the particular advantages of high-speed broadband (Analysys Mason and Tech4i2, 2013). Our approach focusing on selected services and their service requirements provides a plausible link between the NBN and the economic benefits resulting from the services that are made more widely available through the NBN. The scope of the present study in terms of broadband-enabled services captures the economic benefits the NBN can provide in the long term given today's knowledge. We have included services that published studies had identified as providing the greatest economic benefits. Only new services that have well-attested economic benefits were included in our analysis. Some services of significant national interest such as online entertainment are included even though they are not considered to provide substantial economic benefits according to the literature. We recognise that new broadband services are being deployed all the time and some new service, as yet unenvisioned, may have substantial economic impact not accounted for in the present study.

The geospatial analysis described in the previous section has determined where the NBN has extended the availability of the services included in this study in comparison to the business-as-usual scenario. The literature review in chapter 2 emphasised applicable case studies and the benefits of key broadband-enabled services we have focused on in this study.

During the construction phase of the NBN, the economic impacts are subject to increased investment in NBN deployment.

To model the effects of the NBN in the construction and mature phase, we have used a general equilibrium economic (CGE) model called TERM ("The Enormous Regional Model"), which has been developed at the Centre of Policy Studies. TERM is constructed from the "bottom up" and has been used in previous economic studies (Wittwer, 2012). A brief overview of TERM is provided in chapter 6.1. We have chosen TERM for our economic modelling, because it can handle a relatively large number of regions or sectors. It is therefore a useful tool to examine the regional impacts of policy changes, particularly changes to the supply- or production-side of the economy that may be region-specific, as is the case with the NBN.

We have modified TERM to model the presence of the NBN and have constructed inputs to it in the form of changes to economic parameters in the long term that reflect the incremental use of broadband services provided by the NBN. The modification to the model and the construction of the inputs are described in Appendix B and chapter 6.4, respectively. We assumed that the NBN has been funded through increased borrowing overseas and we estimated an increase in the annual balance of trade in the long term by some amount to service this debt.

During the construction phase, the NBN increases investment predominantly in the construction industry. We estimated the maximum annual effect during the construction phase and have included other changes to avoid a crowding-out effect of investment in other projects.

The output of the economic model indicates a new operating point of the Australian economy in the long term once the NBN, the new services and new ways of working are deployed in the economy. We have linked the output of the economic model to the carbon dioxide equivalents of all economic sectors in the third module of our model, described in the following section.

3.4 Energy and Carbon Footprint of the NBN

Our estimates of the energy and carbon footprint of the NBN account for the changes in energy demand and carbon dioxide equivalents resulting from deployment of the NBN in the short term. In the long term, we estimate the changes in energy demand and carbon dioxide equivalents resulting from the ongoing use of the NBN network and the impact on the economy. This is described in sections 8.2 and 8.3, respectively. We used TERM to estimate changes to the industries' activity level or output and private household consumption with the NBN. This includes the potential rebound effect in the form of increased economic growth resulting from greater efficiency. We have linked our modelling results to the Australian Government's Greenhouse Emissions Information System to estimate the carbon dioxide equivalents of all economic sectors of the Australian economy with the NBN.

We constructed an NBN power consumption model to estimate the purchased electricity and carbon dioxide equivalents of the NBN network. The inputs to the model were derived from energy modelling of various broadband technologies conducted by researchers at the Centre for Energy-

Efficient Telecommunications (CEET). We have then converted the incremental power consumption of the NBN to carbon dioxide equivalents to determine the total environmental impact of the NBN.

3.5 Summary of Major Contributions

Our analysis of the NBN contributes to the existing literature in a variety of ways. For example, earlier studies (Grimes et al., 2009; Greenstein and McDevitt, 2011a, 2011b, 2012) have suggested that there is an economic benefit in moving to broadband from earlier forms of access to the internet. There is, however, little published evidence for greater benefits as higher broadband speeds are made available. The economic benefits of the NBN in the long term arise from how it is put to use. Only new services that have well-attested economic benefits were included in our analysis. We have taken the uncertainty of expected service requirements into consideration when modelling the economic benefits of the NBN. This has led to the development of two scenarios recognising the alternatives of comparatively modest or high access-speed requirements of the services included in this study.

Another distinctive feature of the present study is that we have been careful to conduct a geospatial data analysis which accounts for the NBN as it is currently planned. This has led to a study of ubiquitous broadband which makes a clear comparison between the economic situation in Australia in the short run and in the long run without the NBN and with the NBN.

The type of economic model we have adopted to simulate an evolved broadband environment of the future with the NBN has been used in previous studies – notably by Access Economics (2009) – for assessing broadband benefits in Australia. What sets our model apart from previous examples is that it relies on inputs that take into consideration the following:

- investment in the short term required for NBN deployment as it is currently planned;
- economic costs in the long term in the form of debt-servicing repayments subject to the peak funding requirements of the NBN;
- likely coverage maps of the NBN multi-technology mix deployment and access networks in the business-as-usual scenario subject to their technical constraints;
- coverage impacts in the long term for the use of new services made more widely available through the NBN;
- benefits of a range of new services enabled by broadband and the NBN;
- different stimulatory effects occurring in major metropolitan and regional areas;
- additional or incremental electricity purchased and consumed by the NBN based on a detailed power consumption model built for this purpose; and
- national greenhouse gas emissions that are affected by NBN deployment in the short term, and increases in economic activity in the long term.

Not only does our analysis provide new insights in terms of the various impacts of the NBN as it is currently planned, it has led to the development of the first model to explore and investigate the economic, energy, and carbon footprint impacts of the NBN. Our model thus reflects the notion that there may well be more than one goal in society as a whole and that efficiency is not about which goals are chosen, but how to achieve goals. For the many efficient outcomes that usually exist for an economy, economics alone cannot tell us which one is better (Krugman and Wells, 2009). The present study contributes to the debate on efficiency and economic fairness, also known as equity, and the possible trade-offs when evaluating economic policy faced by various individuals or groups.

CHAPTER 4
Broadband in Australia

4.1 Introduction

The difference the NBN makes in terms of the coverage of broadband access technologies and practical access speeds depends on the existing internet infrastructure. More specifically, the NBN incremental availability is subject to broadband access in the long term without the NBN. In this chapter, we analyse broadband availability without the NBN and with the NBN.

Fixed broadband in Australia is currently delivered by a variety of access means. The most common means for delivering broadband service is ADSL over the copper telephony access. Cable modem service over the hybrid fibre-coax, pay-TV network, is available to residential customers in the suburbs of Brisbane, Sydney, Melbourne and Adelaide and in some regional areas. Fibre to the premises is available in central business districts, major business hubs and some recent housing estates.

As before, telecommunications carriers continue to invest in infrastructure. In a future without the NBN, we have assumed that ADSL availability will continue to improve, with all current telephone exchanges equipped with DSLAMs and all planned distribution areas in Telstra's "top-hat" program being upgraded to ADSL2+, the fastest option. In terms of delivery capability, we have assumed that fibre to the premises and hybrid fibre-coax can support all the services included in the present study. But we expect low incentives for telecommunications carriers to expand the footprint of the hybrid fibre-coax network, or to significantly increase fibre to the premises and fibre to the node.

For ADSL, the downstream (to the customer's premises) and upstream speeds depend on the cable distance from the ADSL head-end. For downstream speed, we have assumed the industry standard (ACIF, 2005) for expected performance and standard regulatory parameters with 80% take-up rate for estimating cable lengths. For upstream speed, we have assumed a maximum of less than 2.5 Mbps or, if lower, one-quarter of the download speed.

The NBN is being delivered through a mix of existing and future access mechanisms. The access mechanisms we expect to be able to support some if not all the services included in the present study are:

- fibre to the premises where it already exists or is planned for the next few years;
- hybrid fibre-coax where it already exists and with full coverage of businesses and an expansion to a further 0.9 million homes passed to fill in "black spots";
- fibre to the node with VDSL running on short copper lengths between the "node" and the customers' premises; and
- fixed wireless in less densely populated areas.

At the time of our analysis, NBN Company published (up to June 2014) plans for its fixed-line footprint. Within this footprint, we have assumed that telephone exchange areas not covered by plans for fibre to the premises, hybrid fibre-coax or fixed wireless access will be enhanced with fibre to the node.

Similar to ADSL, the capabilities of fibre to the node and fixed wireless access depend on transmission distance. For fibre to the node, we assume that the copper-cable lengths will be short enough to deliver at least 25 Mbps downstream and up to 10 Mbps upstream. For fixed wireless access, we assume up to 25 Mbps downstream and no more than 5 Mbps upstream.

For our spatial analysis of broadband availability without the NBN and with the NBN, we have used the smallest geographical unit feasible. All geospatial data used in the spatial analysis described in this chapter was processed in QGIS (previously known as Quantum GIS), which is a cross-platform free and open-source geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data. Once we have established what broadband capabilities will be delivered to a geographical unit without or with the NBN, we were able to aggregate up for all of Australia how many residences, businesses or people could benefit from each of the broadband services considered in the present study. The economic benefit of the NBN, which is the subject in the second module of our model, described in chapters 6 and 7, arises from the difference between what broadband capability is delivered by the NBN above what would be available without the NBN.

In the following section, we give a brief overview of Australia's broadband infrastructure today, a snapshot of broadband access as at 2013. We describe the basic unit of geography in the present study, its parameters and aggregations in the section after next. In the two sections that follow, we conduct spatial analyses of broadband availability without the NBN and with the NBN, which is then followed by some concluding remarks.

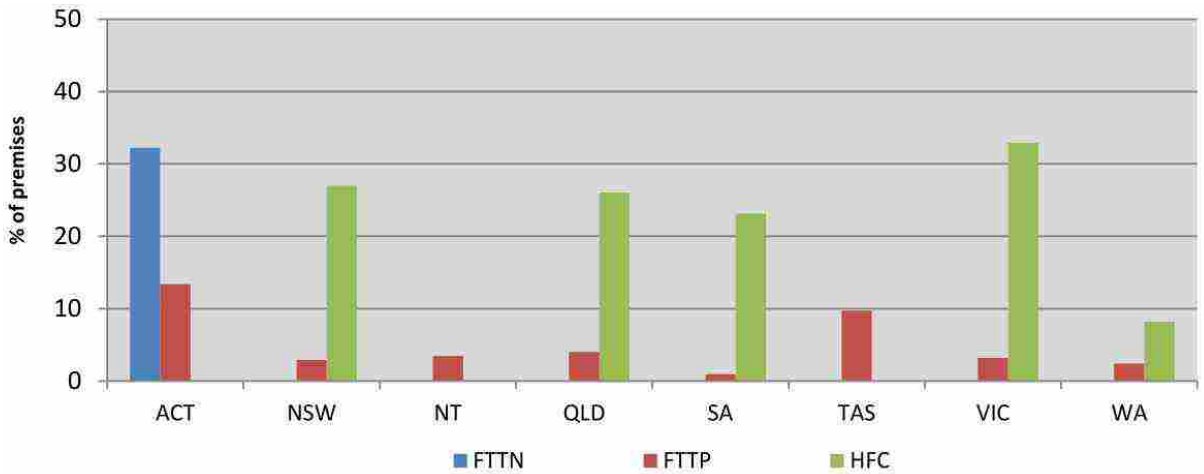
4.2 Overview of broadband access technology deployments in Australia

At June 2013, there were 32 million internet subscribers in Australia according to the Australian Communications and Media Authority (ACMA, 2014). Approximately 81% were mobile-internet service subscribers and the remaining 19% were fixed-internet service subscribers (ACMA, 2014). More than 80% of Australian premises had access to an effective 3G mobile broadband service and about 60% of premises had access to 4G mobile broadband services (Department of Communications and the Arts, 2013a).

There were 419 internet service providers (ISPs) operating in Australia of which 77 had more than 1,000 subscribers and 9 ISPs had more than 100,000 subscribers (ACMA, 2014). The incumbent operator, Telstra, had nearly 4.8 million fixed, including fixed-broadband wholesale, and 3.5 million mobile broadband subscribers (ACMA, 2014). The second largest ISP, Optus, had about one million fixed broadband subscribers and more than one million 4G mobile services in operation (ACMA, 2014). Other ISPs include iiNet, TPG and M2 Group, which together had nearly 2 million fixed broadband subscribers (ACMA, 2014).

Of the fixed-line broadband services available in Australia, almost 10 million (91%) premises had access to DSL services of which about half were in operation (Department of Communications and the Arts, 2013a; ACMA, 2014). Premises in the Australian Capital Territory had the highest level of access to ADSL (94%) while premises in Tasmania had the lowest (84%). Approximately 384,000 premises were connected to the copper network but are unable to access ADSL services because no DSLAM infrastructure has been deployed in the local exchange building (Department of Communications and the Arts, 2013a). More than 3 million premises, or approximately 28% of premises, have access to fixed-line broadband services other than ADSL, such as FTTP, FTTN, HFC and fixed wireless networks (Department of Communications and the Arts, 2013a). Various FTTP networks were deployed in urban areas including Telstra's Fibre Access Broadband (FAB) and the TransACT's FTTP network in the Australian Capital Territory previously acquired by the NBN Company.[7] The only large-scale deployment of FTTN was the TransACT network in Canberra. Optus' and Telstra's HFC networks are available in most States except in the Australian Capital Territory. Both networks overlap up to about 80% and collectively pass approximately 2.7 million unique premises in metropolitan areas across Adelaide, Brisbane, Gold Coast, Melbourne, Perth and Sydney (NBN Company, 2013a). An additional 0.7 million premises are in the geographic area bounded by the networks, but currently not passed (NBN Company, 2013a). As of 2001, other geographic areas with access to HFC services included Mildura, Ballarat, Bendigo, Albury-Wodonga and Darwin covering a total of 147,000 homes with an additional 10,000 homes planned in Perth (Ellenbrook) (Leong, 2001). Figure 4.1 shows the proportion of premises in each state or territory that can access a high-speed broadband platform (FTTP, FTTN, and HFC).

Figure 4.1: Availability of FTTP, FTTN and HFC by state and territory



Source: Department of Communications and the Arts (2013a), Figure 6, p. 15

Analysis of broadband availability and quality shows the significant differences in the availability and quality of broadband across states and territories, regional and remote, and metropolitan areas (Department of Communications and the Arts, 2013a). In particular, the Northern Territory, Tasmania and Western Australia have more areas with poor access to quality broadband services compared to the remaining states (Department of Communications and the Arts, 2013a).

[7] More information about the agreement can be found on NBN Co Limited's website under the following link (last accessed on 8 June 2015): http://www.nbnco.com.au/corporate-information/media-centre/media-releases/nbn-co-welcomes-accc-clearance-of-transact-iinet-deal.html.

The extent of mobile broadband coverage across the regions varies considerably (Department of Communications and the Arts, 2013a). Satellite broadband networks cover all Australian premises (Department of Communications and the Arts, 2013a). The capacity provided by satellites in orbit in 2013 is limited and it is not the most cost-effective way of providing broadband services in metropolitan areas (Department of Communications and the Arts, 2013a).

The Department's premises-level analysis has also identified "[...] a large number of premises that can access a basic broadband service only at download speeds less than 9 Mbps" (Department of Communications and the Arts, 2013a, p. 4), and "[...] many small metropolitan areas where there is limited availability of fixed broadband" (Department of Communications and the Arts, 2013a, p. 4).

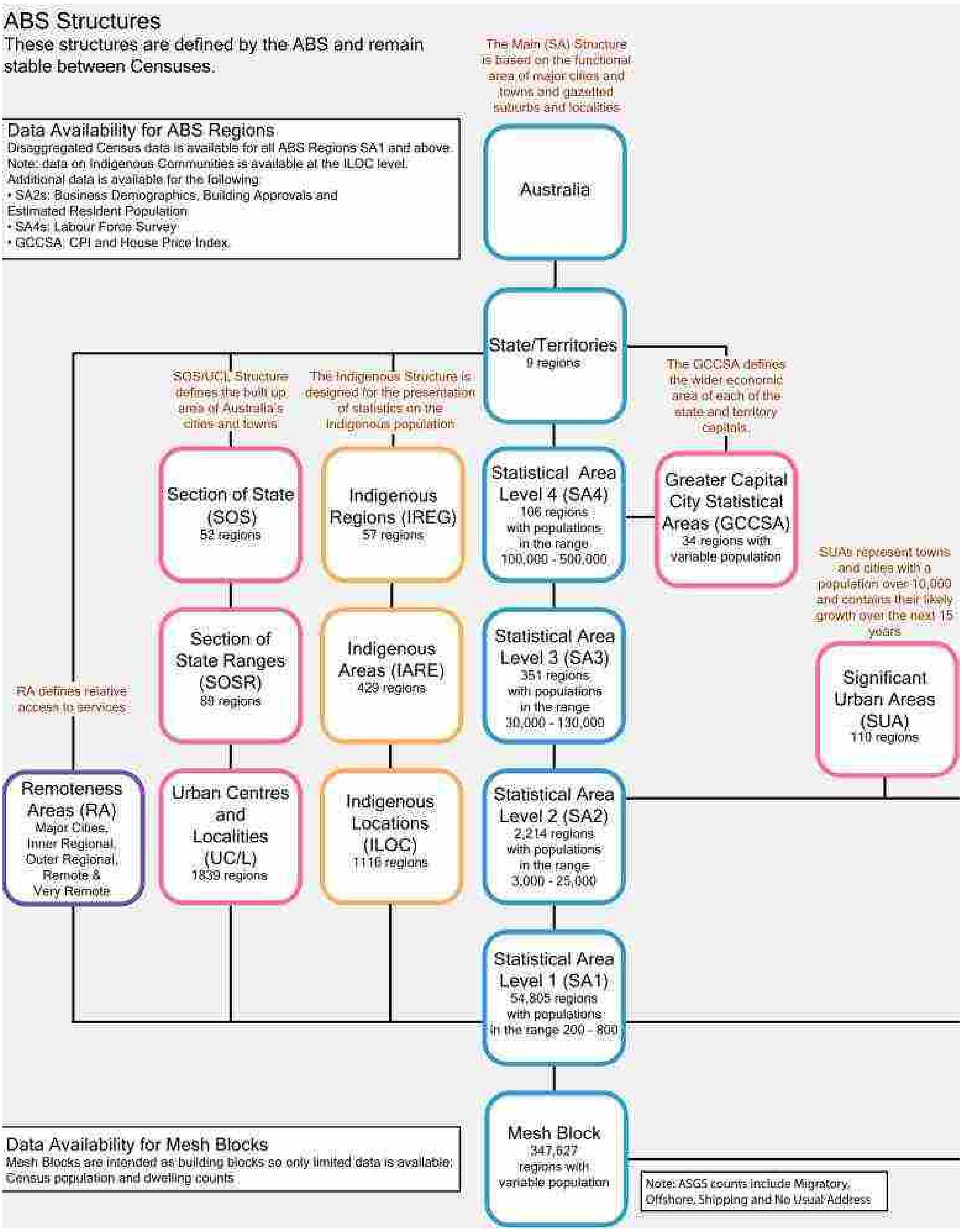
Similar to the analysis in Department of Communications and the Arts (2013a), we have conducted a spatial analysis on the smallest spatial resolution feasible using publicly available data of the coverage of fixed broadband customer access networks, along with an estimate of their likely performance using known constraints.

In the following section, we will describe the data and spatial resolution we have used for our analysis.

4.3 Mesh block parameters and aggregations

The primary unit of analysis for this thesis is the "mesh block", which is the smallest geographical unit defined by the Australian Statistical Geography Standard (ASGS) for which Census data are available from the ABS (2013b). There are 347,600 mesh blocks covering all of Australia. The size of the mesh blocks generally increases as population density decreases. Because of their generally small size, it is possible in many cases to assume that customer premises in a mesh block have access to the same standard of broadband service. We have had to divide mesh blocks that cross telephone exchange boundaries in QGIS, resulting in a total of 411,400 detailed mesh blocks in our analysis. This was to ensure each mesh block is attributable to a single ESA, since ESA and DA boundaries do not correspond to mesh block boundaries. The structure of the ASGS has six hierarchical levels starting from the mesh block up to State and Territory. Each level shown in Figure 4.2 directly aggregates to the level above and covers all of Australia. That is, a Statistical Area Level 1 (SA1) is an aggregate of Mesh Blocks and aggregate to Statistical Area Level 2, et cetera. Digital boundaries are available for all statistical areas as Shapefiles from the ABS.

Figure 4.2: The Australian Statistical Geography Standard (ASGS) 2011 Structure



Source: ABS (2013c), p. 1

For each mesh block, there are two data items: the “census population”, the count of people where they usually live, which may or may not be where they were on Census Night, and the “dwelling counts”, the count of structures that are intended to have people live in it, and that are habitable on Census Night. In addition, there are land-use categories (ABS, 2010b), such as residential, commercial, industrial, agricultural and parks, etc., and area size, measured using the Albers conic equal-area projection (Snyder, 1987) method, for each mesh block. Other data we have used in this thesis, including more disaggregated Census data, was available on a more aggregated level than mesh blocks. Therefore, any additional parameters we have used we have had to be mapped to mesh blocks. These parameters include:

- General medical practitioners (GP) services, available as GP services by statistical local area (SLA) from the Australian Urban Research Infrastructure Network (AURIN);
- Older people, available as persons aged 65 and older by SA1 from ABS (2011b); and
- Businesses, available as businesses by industry division by SA2 by turnover size ranges as of June 2012 from ABS (2013d).

We retrieved counts of GP services by SLA from the AURIN Portal.[8] The SLA is an Australian Standard Geographical Classification (ASGC) defined area and functions as a bridging unit between the ASGC and the replacing ASGS. SLAs are Local Government Areas (LGAs) or part thereof and are also defined for areas for which LGAs are not defined (ABS, 2011c). The data provided by the AURIN Project was originally compiled by the Public Health Information Development Unit (PHIDU) based on data from Medicare Australia, supplied by the Department of Health of Ageing from 2009/10, and average of ABS Estimated Resident Population, 30 June 2009 and 30 June 2010. We have used the data from the AURIN Project because of the convenient format for further processing. Mesh blocks were designed to align with the SLAs (ABS, 2013e, p. 2). We divided the number of GP services by the population in a SLA to get the average number of GP services per person in an SLA. We then multiplied the average number of GP services per person with the population in a mesh block to get an estimate of the number of GP services in a mesh block.

Similar to the allocation of GP services to mesh blocks described above, we allocated persons aged 65 and older to mesh blocks. We multiplied the persons of the respective age group with the ratio of population in a mesh block to population in a SA1 to get an estimate of the aged population in a mesh block.

We have estimated businesses located in the geographical area of a mesh block. For this purpose, we have estimated businesses' turnover by mesh block. The ABS publishes numbers of businesses by industry division, SA2, employment or turnover size ranges. We have focused our analysis on turnover size because estimates of total turnover by industry division are more readily available. This matters for estimating the NBN impact on service delivery to businesses.

The statistics we have retrieved from the ABS (2013d) were available in the following turnover size ranges:

- \$AU 0 to less than \$AU 50,000;
- \$AU 50,000 to less than \$AU 100,000;
- \$AU 100,000 to less than \$AU 200,000;

[8] The AURIN portal can be access through the website under the following link (last accessed on 7 March 2017): https://portal.aurin.org.au/.

- $AU 200,000 to less than $AU 500,000;
- $AU 500,000 to less than $AU 2 million; and
- $AU 2 million or more.

We have assumed that businesses with an annual turnover of $AU 2 million or more are able to afford private or business-grade IP networks in the reference case. We have therefore excluded the numbers of these businesses from our analysis and focused solely on small and medium businesses with an annual turnover of less than $AU 2 million. We have estimated the total turnover of small and medium businesses by SA2 and industry division by multiplying number of businesses with the average turnover of the turnover size ranges. That is, number of businesses multiplied with $AU 25,000 in the first turnover size range, $AU 75,000 in the second, et cetera, and added up the results for each SA2 and industry division.

We then allocated estimated turnover by SA2 agricultural industry division to mesh blocks in proportion to the area of the mesh blocks of agricultural land-use to the sum of area of "agricultural" mesh blocks that aggregate to the same SA2. The same approach was followed for commercial and industrial industry divisions. Table 4.1 shows our mapping of Australian and New Zealand Standard Industrial Classification (ANZSIC) industry divisions to the mesh block land-use classification agricultural, commercial and industrial.

Table 4.1: ANZSIC divisions mapped to agricultural, commercial industrial mesh block classifications

ANZSIC division code	ANZSIC division name	Mesh block classification (agricultural, commercial, industrial)
A	AGRICULTURE, FORESTRY AND FISHING	Agricultural
B	MINING	Industrial
C	MANUFACTURING	Industrial
D	ELECTRICITY, GAS, WATER AND WASTE SERVICES	Industrial
E	CONSTRUCTION	Industrial
F	WHOLESALE TRADE	Commercial
G	RETAIL TRADE	Commercial
H	ACCOMMODATION AND FOOD SERVICES	Commercial
I	TRANSPORT, POSTAL AND WAREHOUSING	Commercial
J	INFORMATION MEDIA AND TELECOMMUNICATIONS	Commercial
K	FINANCIAL AND INSURANCE SERVICES	Commercial
L	RENTAL, HIRING AND REAL ESTATE SERVICES	Commercial
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES	Commercial
N	ADMINISTRATIVE AND SUPPORT SERVICES	Commercial
O	PUBLIC ADMINISTRATION AND SAFETY	Commercial
P	EDUCATION AND TRAINING	Commercial
Q	HEALTH CARE AND SOCIAL ASSISTANCE	Commercial
R	ARTS AND RECREATION SERVICES	Commercial
S	OTHER SERVICES	Commercial

We have allocated the mesh block parameters described above to the Project Mesh Blocks using the ratio of area of the Project Mesh Block to the area of the original mesh block where applicable. For this purpose, we have recalculated the land area of mesh blocks in the geographical information system using the coordinate reference system World Equidistant Cylindrical (Sphere) to avoid inconsistencies with the Albers conic equal-area projection method used by the ABS.

In the economic model of the Australian economy that we will introduce later in this thesis, we have used 13 geographical areas. For the more populated States, we have separated the capital-city area (represented by the corresponding Greater Capital City Statistical Area (GCCSA) from the ABS (2012a) for that capital city) from the rest of the State. For the less populated States and Territories, we have used a single geographical area. That is, the regional aggregation in the database adopted for this study distinguishes metropolitan and urban areas from regional and remote areas in Australia. The 13 geographical areas we have used in the economic model are shown in Table 4.2.

Table 4.2: List of aggregated regions in the economic model database

No.	Name	Description
1	SydneyNSW	Sydney, New South Wales
2	RoNSW	Rest of New South Wales
3	MelbourneVic	Melbourne, Victoria
4	RoVic	Rest of Victoria
5	BrisbaneQld	Brisbane, Queensland
6	RoQld	Rest of Queensland
7	AdelaideSA	Adelaide, South Australia
8	RoSA	Rest of South Australia
9	PerthWA	Perth, Western Australia
10	RoWA	Rest of Western Australia
11	Tas	Tasmania
12	NT	Northern Territory
13	ACT	Australian Capital Territory

Hence, in our final analysis of the geographical availability of broadband networks, we will be concerned to aggregate the data from the level of mesh blocks to that of these 13 geographical areas (hereafter “Regions”).

In the following section, we will describe our spatial analysis of the future broadband structure in the reference case.

4.4 Reference case: Broadband access technologies in the future without the NBN

In order to assess the incremental impact of the NBN, we will compare two future scenarios for Australia and its regions. The first scenario is based on our estimated coverage of broadband access technologies and their capabilities in terms of access speeds in the mid- to long-term future without the NBN. The first scenario reflects our assumptions about the future development of broadband under a “business-as-usual” scenario in which there is no deployment of the NBN, and is described below. This will serve as the reference case for our analysis in this thesis of the impact of deploying NBN. The second scenario deviates from the first by assuming the construction and operation of the NBN over coming years. We will discuss the development and analysis of the second scenario in the next section.

The reference case assumes some growth in broadband service. The growth in broadband services in the reference case rests upon the following two key assumptions:

- Current ADSL-enabled exchanges and distribution areas will be upgraded to deliver ADSL2+ access speeds; and
- HFC cable networks will be upgraded over time to match the access speeds of the HFC cable network in the future with the NBN.

We also assumed that the access speeds of broadband access technologies such as FTTN and FTTP in their respective coverage will be the same in the two scenarios. Compared to the actual coverage of broadband access technologies, in the reference case we assume no noticeable increase in the coverage of fixed-line broadband access technologies. On the basis of the above assumptions, we conducted a spatial analysis of the coverage of the broadband access technologies in the reference case.

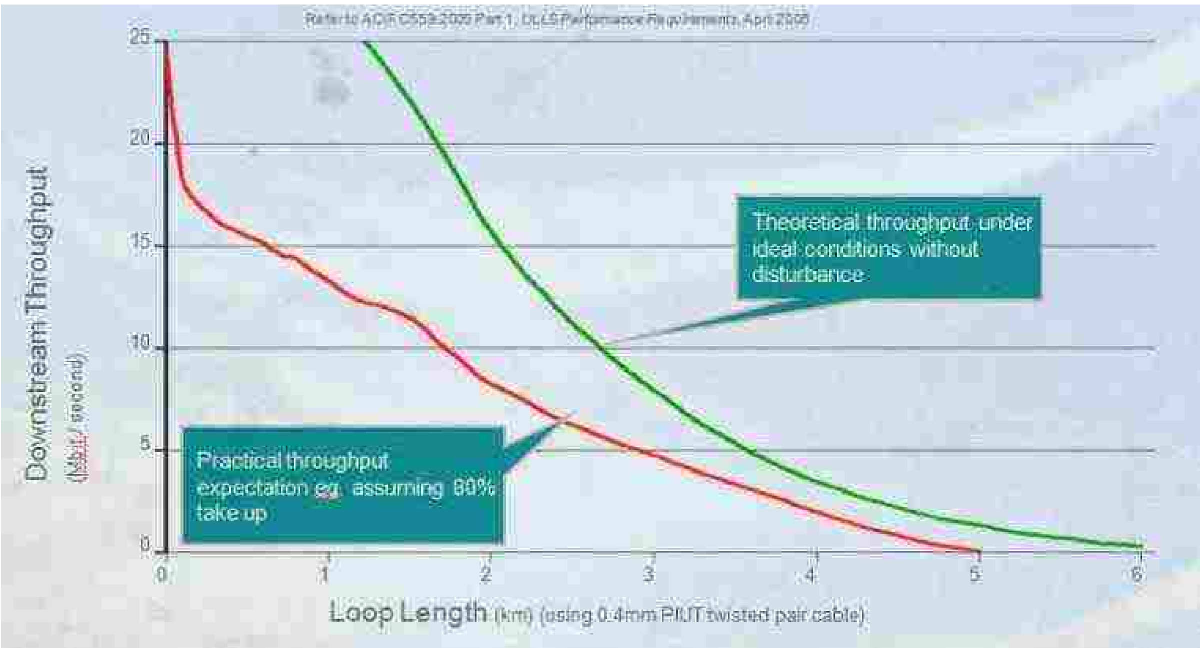
In the remaining section, we describe our spatial analysis of the coverage of broadband customer access networks, along with an estimate of their likely performance or access speeds in the reference case.

Asymmetric Digital Subscriber Line 2+ (ADSL2+)

Traditional telephone and ADSL services use the copper network. The Telstra copper telecommunications network connects 99 per cent of Australian homes and businesses to the telecommunications network via telephone exchanges (Department of Communications and the Arts, 2013a). Therefore, we have focused our spatial analysis of areas covered by ADSL access networks entirely on Telstra's copper network infrastructure. Information about general DSL availability was available from Telstra including lists of ESAs with telephone exchanges containing a DSLAM (Telstra Wholesale, 2013a), DAs with street cabinets containing a DSLAM (Telstra Wholesale, 2013b), and Telstra's TopHat IP DSLAM Rollout Schedule (Telstra Wholesale, 2013c).

Similar to the analysis of the likely ADSL download speeds provided to end users by the Department of Communications and the Arts (2013a), we used the notional access speed versus distance profile shown in Figure 4.3 to identify the mesh blocks covered by ADSL2+ with practical download speeds provided to end users. The estimated distances for practical download speeds assumed a 0.4 mm twisted pair copper cable with an 80% take-up rate and the technical specifications from the Australian Communications Industry Forum (ACIF, 2005).

Figure 4.3: Theoretical and expected ADSL2+ performance of Telstra's copper network

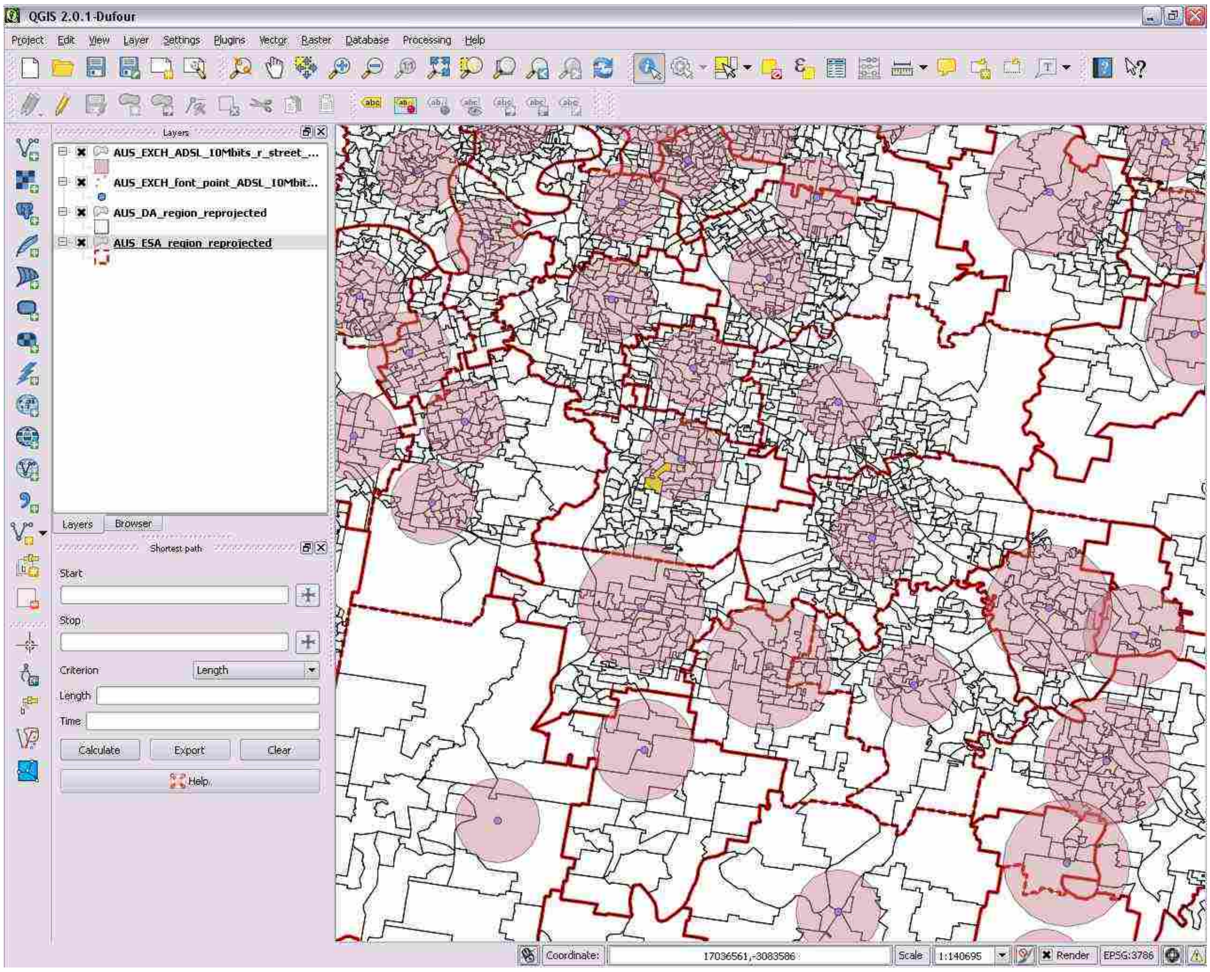


Source: Clark (2013), Slide 16

The ADSL download speed versus distance profile in Figure 4.3 shows that, for a specified minimum download speed, there is a maximum cable reach on 0.4 mm cable. The cable distance to premises is not uniformly distributed around an exchange site. Given that we did not have data on the detailed cable runs, we have assumed a circular area around an exchange site can be served by DSL at a specified minimum download speed. The radius of this circle is calculated in two parts. First, the maximum cable distance for the specified minimum download speed is determined from Figure 4.3. We have extracted the data from the plot of the practical download speed in Figure 4.3 and used the maximum distances between the customer's premises and the exchange to provide end users with at least 1 Mbps, 1.5 Mbps, 2.5 Mbps, 10 Mbps, 20 Mbps and 24 Mbps. The resulting distances are then reduced to a corresponding geographical distances that account for cabling laid in trenches along roads by using a formula described by the Australian Competition and Consumer Commission (ACCC, 2008). We have adopted the parameters for this function from Analysys (2008) estimated by geotype except the trench sharing coefficient. Geotypes comprise of ESAs that share the same common characteristics such as the ratio of road length to number of addresses and were originally derived to reduce the data computation time of a regulatory cost model for Australian fixed network services (Analysys, 2008). A list of ESAs mapped to geotypes was available from the ACCC (2009). Without applying the trench sharing coefficient, which was originally derived to capture the actual deployment distance of the trench, may result in a marginal overestimate of DSL availability.

We have multiplied the values, derived using the function described by the ACCC (2008) for turning geographic distances into corresponding cable lengths, with the maximum distances between the customer's premises and the exchanges in the ESAs of the same geotype. We then used the calculated cable lengths as the radius of the circular coverage area from an exchange in QGIS. Exchange location points, digital boundaries of ESAs and DAs as of 2008, were available from a previous CEET project as Shapefiles from ExchangeInfo Australia (ExchangeInfo). Figure 4.4 shows the results for the estimated DSL availability with a minimum download speed of 10 Mbps in an area south of Brisbane (Queensland).

Figure 4.4: Estimated DSL availability with a minimum download speed of 10 Mbps



The window on the right hand side in Figure 4.4 shows digital boundaries imported and displayed in QGIS for ESAs in dash lines highlighted in red, and DAs in black solid lines. Location of exchange sites are displayed in light blue dots. The circular areas highlighted in light red around the exchange sites indicate the estimated areas that can be served by DSL at the minimum download speed of 10 Mbps. The maximum cable distance derived from the plot in Figure 4.3 in this example is approximately 1.7 kilometres. The size of the circular areas around the exchange sites vary according to the approximate cable distance by geotype. The exchange site displayed in the left bottom corner refers to Greenbank. The Greenbank ESA falls into the category specified as geotype 11. Using the formula with the parameters described by the ACCC, the estimated value for cable distance in geotype 11 is approximately 1.61. The estimated cable distance and radius for the circular area around the exchange site for the specified minimum download speed is therefore 1.1 (1.7 kilometres / 1.61) kilometres. Located east of Greenbank is the ESA of the exchange site Park Ridge (geotype 10), and located north of Park Ridge is Browns Plains (geotype 5). The calculated values for geotype 10 and 5 are 1.34 and 1.07, respectively. The estimated cable distances and radii for the circular areas around the exchange sites Park Ridge and Browns Plains are therefore 1.3 (1.7 kilometres / 1.34) and 1.6 (1.7 kilometres / 1.07) kilometres, respectively.

In areas where telephone lines are routed via a street cabinet containing a DSLAM, the cable length from the DSLAM in the cabinet to the customer's premises is the critical parameter. Exact locations of Telstra street cabinets were not available for this thesis. To approximate the locations of cabinets, we used the central point of DSL-enabled DAs instead. We have used the calculated cable lengths as the radius of the circular coverage area from the approximate location of the street cabinets.

To estimate the maximum distance between the customer's premises and the location of the DSLAM for certain upload speeds, we assumed the download to upload ratio of 4:1 and referred to the practical ADSL2+ download speed versus distance profile shown in Figure 4.3. That is, the estimated cable distances for a minimum upload speed of 2.5 Mbps will be the same as estimated for a minimum download speed of 10 (4 x 2.5 Mbps) Mbps in the example above.

We have identified the mesh blocks that intersect with the estimated coverage of the ADSL2+ access network for the above access speeds through the use of spatial queries in QGIS. Customer premises in overlapping mesh blocks were treated as having access to the same standard of broadband service as inside the estimated coverage area.

Our approximation of street cabinet locations described above may result in inaccurate circular coverage areas. This might have an effect on the number of mesh blocks we have identified using the approach described above. We expect the overall effect to be only marginal for two reasons. First, the TopHat upgrades were deployed only in a few cases for a first-in ADSL installation (Telstra Wholesale, 2013c). Second, the parameters of the mesh blocks that unintentionally overlap with incorrectly modelled circular coverage areas will be partly offset by parameters of the mesh blocks that unintentionally do not overlap with incorrectly modelled circles.

In 305 out of 5069 ESAs, ADSL-enabled DAs were missing from the Exchangeinfo geospatial datasets. For the 305 ESAs that are affected, we have assumed that ADSL services are available at the maximum access speed throughout the entire ESA. An additional parameter was added to each mesh block indicating whether or not it intersects with any of the 305 ESAs that are affected. Our assumption has potentially a significant impact on our estimates of DSL availability when ADSL services meet the minimum service requirements i.e. for higher bandwidths. It has no effect in the high access-speed scenario in which services require higher bandwidths than today's offerings, because we have assumed that ADSL services do not meet the minimum service requirements in this scenario. In the modest access-speed scenario, DSL availability is increased outside metropolitan areas reducing the NBN impact on service delivery by an estimated maximum of 2 percentage points predominantly in the rest of Victoria and Queensland, and Tasmania. This suggests a marginal underestimate of the regional impact of the NBN in the modest access-speed scenario in particular.

Table 4.3 shows the results of our spatial analysis described above in terms of people usually resident in the geographic area of mesh blocks, based on 2011 Census data, with access to DSL download speeds of 10 Mbps or above in the reference case.

Table 4.3: Estimated number of persons with access to DSL download speeds of 10 Mbps or above in the reference case based on ABS 2011 Census data

Region	Persons with access to DSL download speeds of 10 Mbps or above	Percent of persons with access to DSL download speeds of 10 Mbps or above
Australian Capital Territory	234,996	65.76%
Greater Adelaide	903,777	73.76%
Greater Brisbane	1,432,127	69.32%
Greater Darwin	105,882	87.81%
Greater Hobart	107,414	50.75%
Greater Melbourne	2,130,513	53.26%
Greater Perth	1,410,372	81.58%
Greater Sydney	2,757,632	62.79%
Rest of New South Wales	1,807,556	71.93%
Rest of Northern Territory	53,234	59.56%
Rest of Queensland	1,810,032	80.31%
Rest of South Australia	233,951	63.53%
Rest of Tasmania	155,945	55.20%
Rest of Victoria	932,876	69.32%
Rest of Western Australia	348,023	69.25%

Fibre-to-the-premises (FTTP)

Detailed information of the Telstra Development Sites for Fibre Access Broadband (FAB) was available from the Telstra Wholesale website[9]. We have assumed that the FAB as of 15 October 2013 will stay unchanged in the reference case. To identify mesh blocks overlapping Telstra FAB sites in QGIS, we have reduced FAB sites to a single point. That is, we have assumed that the area of a single mesh block overlapping the single point, which approximate the location of an FAB site, can be served by FTTP. From the report which details the Telstra Development Sites where FAB is available, we extracted the state the FAB site resides in, the FAB site name and respective Call Collection Area. We then entered these details for each FAB site in an address-to-a-single-point conversion website. The resulting single points were imported in QGIS to identify the overlapping mesh blocks in a spatial query.

We have also taken the TransACT/iiNet FTTP access network in the Australian Capital Territory into consideration in the reference case. We have assumed that the geospatial datasets of active and build fibre serving area modules (FSAMs) as of December 2013 from NBN Company include the coverage of the TransACT/iiNet FTTP network in Canberra that was acquired by the NBN Company in November 2013.[10] We then ran a spatial query in QGIS to identify the mesh blocks that intersect with the geospatial datasets of the NBN FTTP network in Canberra.

Table 4.4 shows the results of our spatial analysis described above in terms of people usually resident in the geographic area of mesh blocks, based on 2011 Census data, with access to FTTP

[9] A copy of the latest publically available update of the rollout boundaries for all Fibre and Fixed Wireless footprints active and in build as of December 2013 were provided to us in a private email from the operator of the independent tracking website www.mynbn.info which has moved to the website www.finder.com.au in February 2016.

[10] The NBN Company's media release of the purchase agreement of the TransACT-branded FTTP access network in Canberra can be found on the website under the following link (last accessed on 14 April 2016): http://www.nbnco.com.au/corporate-information/media-centre/media-releases/nbn-co-welcomes-accc-clearance-of-transact-iinet-deal.html.

services in the reference case. The GCCSA regions with an estimate of zero are not included in the results.

Table 4.4: Estimated number of persons with access to FTTP in the reference case based on ABS 2011 Census data

Region	Persons with access to FTTP	Percent of persons with access to FTTP
Australian Capital Territory	37,859	10.59%
Greater Adelaide	64	0.01%
Greater Brisbane	1,193	0.06%
Greater Melbourne	1,850	0.05%
Greater Perth	661	0.04%
Greater Sydney	646	0.01%
Rest of New South Wales	401	0.02%
Rest of Queensland	651	0.03%
Rest of Western Australia	314	0.06%

Hybrid Fibre-Coax (HFC)

HFC network coverage maps were only publicly available for the Optus HFC network (Leong, 2001). Since the Telstra and Optus HFC networks overlap up to about 80% (NBN Company, 2013a), we have used the coverage maps provided in Leong (2001) for an initial estimate of the coverage of the HFC networks in the reference case. We factored in additional coverage described further below. We have imported screen captures of areas covered by the Optus HFC network provided in Leong (2001) in QGIS. We then ran a spatial query in QGIS to identify the mesh blocks that intersect with the estimated areas covered by the Optus HFC network shown in Figure 4.5.

Figure 4.5: Estimates of Optus' HFC network coverage in Sydney, Melbourne and Brisbane

The results of our spatial analysis suggest that, in 2011, more than 6 million people usually lived in less than 2.5 million dwellings that were in the geographic area of mesh blocks covered by the Optus HFC network in Sydney (1.1 million), Melbourne (1 million) and Brisbane (0.4 million). As of 2013, the Telstra and Optus HFC networks collectively pass around 2.7 million premises (NBN Company, 2013a). An additional 0.7 million premises are in the geographic coverage area of the HFC networks, but currently not passed (NBN Company, 2013a). Therefore, we have assumed that, in the geographic area of mesh blocks covered by the Optus HFC network, only about 80% (2.7/(0.7+2.7)) of premises are passed. This corresponds roughly to the actual 2 million households covered by the Optus HFC network according to Leong (2001).

As of 2001, coverage of the Telstra HFC network spanned 2.5 million homes including areas in Perth (Western Australia), Adelaide (South Australia) and the Gold Coast (Queensland) that had no coverage of the Optus HFC access network (Leong, 2001). Given our assumption that most parts of the Optus and Telstra HFC networks overlap in Sydney, Melbourne and Brisbane, about 0.5 million dwellings (2.5 million dwellings covered by the Telstra HFC network minus 2 million dwellings covered by the Optus HFC network) are passed by the Telstra HFC network in Perth (Western Australia), Adelaide (South Australia) and the Gold Coast (Queensland). To estimate the additional 0.5 million dwellings covered by the Telstra HFC network in those areas, we made reference to the coverage information of HFC by state and territory provided by the Department of Communications and the Arts (2013a). The Department's analysis found that the number of premises covered by either FTTN or HFC in Western Australia, South Australia and Queensland is 0.1 million, 0.2 million and 0.6 million, respectively (Department of Communications and the Arts, 2013a).

Since the only large-scale deployment of FTTN was located outside these three states, we can safely assume that the stated numbers of premises are covered by HFC only. Results from our spatial analysis suggest that about 0.4 million dwellings are located in the geographic area of mesh blocks covered by the Optus HFC network in Brisbane (Queensland). We therefore assumed that 0.2 (0.6-0.4) million dwellings were covered by the Telstra HFC access network in the Gold Coast. The geographic areas by statistical area level 3 (SA3) which we assumed to be covered by the Telstra HFC network in Perth, Adelaide and the Gold Coast are shown in the Table 4.5. Our selection of SA3 was guided by relevant postings in the Australian discussion forums, such as Whirlpool,[11] and the estimated total number of dwellings covered by the Optus HFC network.

Table 4.5: Selected statistical areas (level 3) indicating coverage of HFC access networks in the reference case in Perth, Adelaide and the Gold Coast

Gold Coast	Adelaide	Perth
Broadbeach - Burleigh	Adelaide Hills	Belmont - Victoria Park
Coolangatta	Burnside	Cottesloe - Claremont
Gold Coast - North	Campbelltown (SA)	Melville
Gold Coast Hinterland	Charles Sturt	South Perth
Mudgeeraba - Tallebudgera	Holdfast Bay	
Nerang	Marion	
Ormeau - Oxenford	Mitcham	
Robina	Norwood - Payneham - St Peters	
Southport	Port Adelaide - East	
Surfers Paradise		

In our estimated coverage of HFC access networks in the reference case, we have not included HFC networks in Mildura, Ballarat, Bendigo, Albury-Wodonga, Darwin and Perth (Ellenbrook) because of the comparatively small number of dwellings covered by these networks. This may result in a marginal overestimate of the regional impact of the NBN.

Table 4.6 shows the results of our spatial analysis described above in terms of the people usually resident in the geographic area of mesh blocks, based on 2011 Census data, covered by HFC

[11] For a discussion on Telstra HFC network coverage in Perth, see, for example, the website under the following link (last accessed on 26 February 2017): https://forums.whirlpool.net.au/archive/1931824.

networks in the reference case. The GCCSA regions with an estimate of zero are not included in the results.

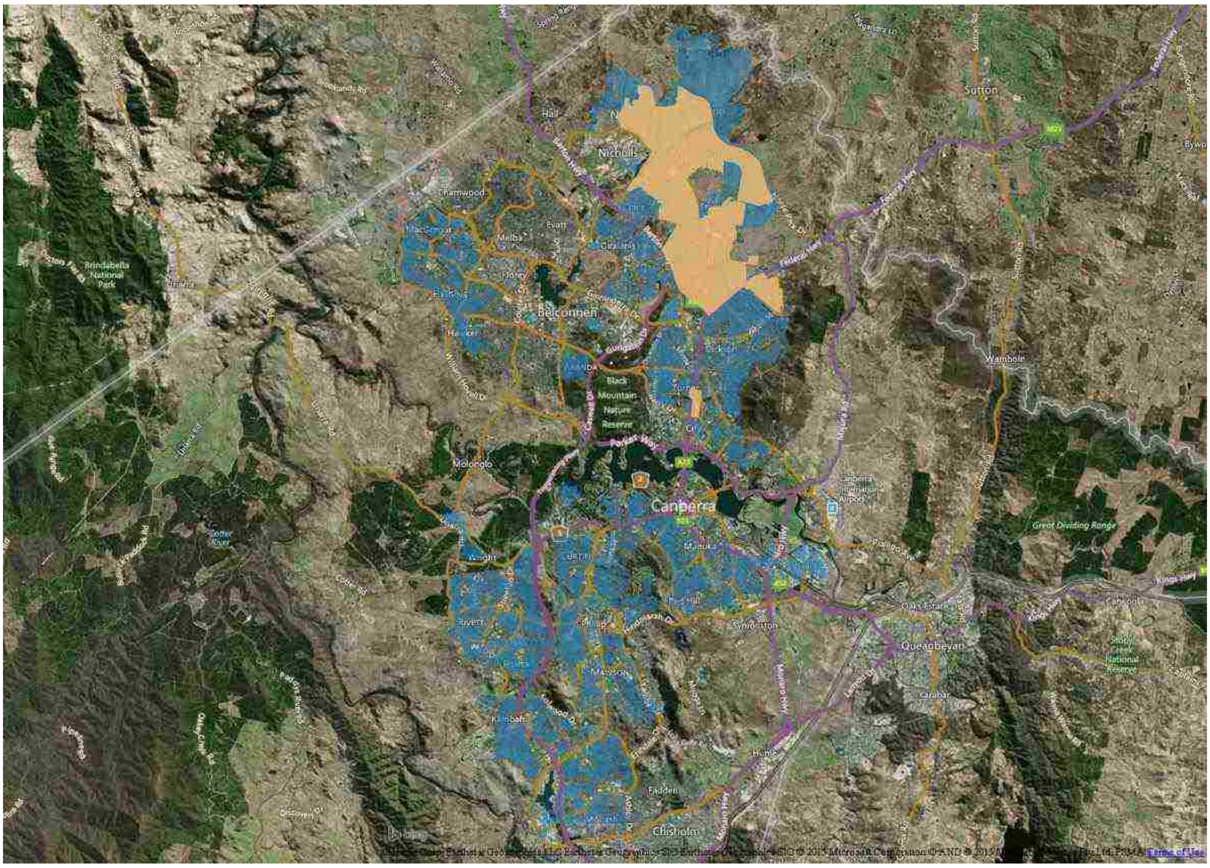
Table 4.6: Estimated number of persons with access to HFC networks in the reference case based on ABS 2011 Census data

Region	Persons with access to HFC	Percent of persons with access to HFC
Greater Adelaide	409,491	33.42%
Greater Brisbane	760,148	36.79%
Greater Melbourne	1,820,493	45.51%
Greater Perth	211,806	12.25%
Greater Sydney	2,265,364	51.58%
Rest of Queensland	402,027	17.84%

Fibre-to-the-node (FTTN)

Large scale deployments of FTTN currently only exist in the Australian Capital Territory (Department of Communications and the Arts, 2013a). We have imported screen captures of areas in QGIS covered by FTTP and FTTN networks in Canberra and surrounding areas published by the Department of Communications and the Arts (2013a). The geospatial datasets of the NBN FTTP network in Canberra from NBN Company, which we have assumed to show the TransACT/iiNet FTTP network which NBN Company had acquired in November 2013, and our estimate of the geographic area covered by the FTTN network in Canberra and surrounding areas are shown in the Figure 4.6. The orange and blue shaded areas in Figure 4.6 indicate our estimate of the geographic area covered by FTTP and FTTN networks, respectively, in the Australian Capital Territory.

Figure 4.6: Estimates of FTTP and FTTN access networks in Canberra and surrounding areas



We ran a spatial query in QGIS to identify the mesh blocks that intersect with our estimated coverage of the FTTP and FTTN networks in the Australian Capital Territory. We excluded the mesh blocks that intersect with the geospatial datasets of the NBN FTTP access network in the Australian Capital Territory from the results of the spatial query described above. We assumed that the remaining mesh blocks are covered by the FTTN network in the Australian Capital Territory.

Table 4.7 shows the results of our spatial analysis described above in terms of people usually resident in the geographic area of mesh blocks, based on 2011 Census data, covered by FTTN networks in the reference case. The GCCSA regions with an estimate of zero are not included in the results.

Table 4.7: Estimated number of persons with access to the FTTN access networks in the reference case based on ABS 2011 Census data

Region	Persons with access to FTTN	Percent of persons with access to FTTN
Australian Capital Territory	183,432	51.33%

The findings from our spatial analysis of mesh blocks covered by access networks in the reference case described in this section feed into the spatial database we have developed in MS Access. For each mesh block, we have included fields for mesh block parameters and network coverage in the reference case. Table 4.8 shows field names and the data types we have used in the spatial database to estimate the broadband impact on service delivery in the reference case.

Table 4.8: Selected field names and data types in the spatial database used to estimate the broadband impact on service delivery in the reference case

Field name	Description	Data type
Dwellings	Dwellings	Number
Area_inter	Area of Project Mesh Blocks in square metres	Number
Pers_inter	Persons usually resident in Project Mesh Blocks	Number
Pers_65Plus_inter	Persons aged 65 and older in Project Mesh Blocks	Number
GP_Services_200910	GP services	Number
1Mbps	ADSL2+ access speeds of 1Mbps and above	'1' or 'FALSE'
1P5Mbps	ADSL2+ access speeds of 1.5Mbps and above	'1.5' or 'FALSE'
2P5Mbps	ADSL2+ access speeds of 2.5Mbps and above	'2.5' or 'FALSE'
10Mbps	ADSL2+ access speeds of 10Mbps and above	'10' or 'FALSE'
20Mbps	ADSL2+ access	'20' or 'FALSE'

	speeds of 20Mbps and above	
>24Mbps	ADSL2+ access speeds above 24Mbps	'>24' or 'FALSE'
FAB_site	Telstra FTTP network coverage	'TRUE' or 'FALSE'
HFC	Optus HFC network coverage	'TRUE' or 'FALSE'
FTTN_iiNet	iiNet FTTN network coverage	'Yes' or 'No'
FTTP_iiNet	iiNet FTTP network coverage	'Yes' or 'No'
Missing_DA	Mesh blocks that overlap with ESAs where DA boundaries are missing from the geospatial datasets	'TRUE' or 'FALSE'

Tables 4.9 to 4.14 show the data selected from queries summarising our findings in terms of residential mesh block parameters for various download speeds in the reference case.

Table 4.9: Estimated number of persons usually resident, persons aged 65 and older and GP services in geographical areas with access to download speeds of 1 Mbps or above

Region	Persons usually resident	Persons aged 65 and older	GP services
Australian Capital Territory	350,199	37,656	1,449,508
Greater Adelaide	1,196,907	186,013	6,911,592
Greater Brisbane	2,018,674	236,648	8,153,010
Greater Melbourne	3,866,423	503,129	21,903,301
Greater Perth	1,718,155	214,897	8,053,401
Greater Sydney	4,248,443	545,842	26,275,827
Northern Territory	189,155	10,818	515,766
Rest of New South Wales	2,290,486	418,786	11,452,307
Rest of Queensland	2,119,954	307,048	4,310,689
Rest of South Australia	300,331	57,943	1,646,820
Rest of Victoria	1,213,952	216,091	6,342,899
Rest of Western Australia	419,521	49,741	1,372,449
Tasmania	430,654	71,571	2,259,603

Table 4.10: Estimated number of persons usually resident, persons aged 65 and older and GP services in geographical areas with access to download speeds of 1.5 Mbps or above

Region	Persons usually resident	Persons aged 65 and older	GP services
Australian Capital Territory	347,944	37,604	1,440,266
Greater Adelaide	1,195,237	185,764	6,902,411
Greater Brisbane	2,021,067	236,771	8,143,152

Region	Persons usually resident	Persons aged 65 and older	GP services
Greater Melbourne	3,848,144	500,495	21,798,455
Greater Perth	1,715,441	214,589	8,040,665
Greater Sydney	4,237,672	544,462	26,206,534
Northern Territory	188,772	10,772	514,902
Rest of New South Wales	2,280,880	417,177	11,403,111
Rest of Queensland	2,159,540	312,176	4,350,457
Rest of South Australia	298,708	57,706	1,638,163
Rest of Victoria	1,207,300	215,042	6,307,027
Rest of Western Australia	418,425	49,595	1,369,310
Tasmania	425,048	70,723	2,229,150

Table 4.11: Estimated number of persons usually resident, persons aged 65 and older and GP services in geographical areas with access to download speeds of 2.5 Mbps or above

Region	Persons usually resident	Persons aged 65 and older	GP services
Australian Capital Territory	342,960	37,302	1,417,972
Greater Adelaide	1,189,952	185,039	6,873,194
Greater Brisbane	1,996,664	233,794	8,060,308
Greater Melbourne	3,803,789	494,469	21,544,820
Greater Perth	1,707,731	213,649	8,003,465
Greater Sydney	4,213,707	541,625	26,049,304
Northern Territory	188,300	10,732	513,822
Rest of New South Wales	2,257,133	413,261	11,282,479
Rest of Queensland	2,105,516	305,150	4,300,725
Rest of South Australia	294,472	57,050	1,614,635
Rest of Victoria	1,193,127	212,877	6,232,482
Rest of Western Australia	415,735	49,401	1,361,590
Tasmania	411,492	68,887	2,156,961

Table 4.12: Estimated number of persons usually resident, persons aged 65 and older and GP services in geographical areas with access to download speeds of 10 Mbps or above

Region	Persons usually resident	Persons aged 65 and older	GP services
Australian Capital Territory	289,111	32,319	1,177,444
Greater Adelaide	1,023,088	158,671	5,895,657
Greater Brisbane	1,717,295	198,798	6,892,054
Greater Melbourne	3,155,074	409,879	17,910,081
Greater Perth	1,452,299	183,037	6,800,224
Greater Sydney	3,699,864	472,651	22,817,702
Northern Territory	159,116	8,746	436,010
Rest of New South Wales	1,807,639	332,078	9,069,902
Rest of Queensland	1,886,756	272,672	4,032,398
Rest of South Australia	233,951	47,119	1,282,584
Rest of Victoria	932,876	168,930	4,849,053

Rest of Western Australia	348,023	42,037	1,154,340
Tasmania	263,359	46,776	1,371,555

Table 4.13: Estimated number of persons usually resident, persons aged 65 and older and GP services in geographical areas with access to download speeds of 20 Mbps or above

Region	Persons usually resident	Persons aged 65 and older	GP services
Australian Capital Territory	229,538	26,926	927,809
Greater Adelaide	492,916	81,476	2,810,733
Greater Brisbane	1,072,974	120,362	4,551,584
Greater Melbourne	2,117,017	296,948	12,378,482
Greater Perth	504,076	64,495	2,348,122
Greater Sydney	2,502,451	328,487	15,689,235
Northern Territory	41,319	1,607	58,624
Rest of New South Wales	559,401	98,235	2,726,130
Rest of Queensland	1,054,062	150,727	2,637,707
Rest of South Australia	48,354	7,647	250,663
Rest of Victoria	353,088	59,532	1,794,216
Rest of Western Australia	86,743	8,450	298,986
Tasmania	50,900	7,851	258,745

Table 4.14: Estimated number of persons usually resident, persons aged 65 and older and GP services in geographical areas with access to download speeds above 24 Mbps

Region	Persons usually resident	Persons aged 65 and older	GP services
Australian Capital Territory	221,297	26,330	893,835
Greater Adelaide	450,177	75,770	2,567,384
Greater Brisbane	973,973	110,033	4,250,115
Greater Melbourne	1,994,777	287,623	11,734,321
Greater Perth	413,385	54,160	1,924,025
Greater Sydney	2,377,447	313,297	14,990,638
Northern Territory	3,583	181	4,975
Rest of New South Wales	363,147	66,861	1,735,519
Rest of Queensland	874,733	124,791	2,388,658
Rest of South Australia	3,852	540	18,608
Rest of Victoria	262,724	44,815	1,327,100
Rest of Western Australia	33,179	2,842	112,494
Tasmania	29,569	4,352	148,184

Similarly, our findings of commercial mesh block parameters can be summarised by region and industry. In order to identify the mesh block parameters that represent the NBN impact on service delivery, we have included additional fields for mesh block parameters and network coverage in the future with the NBN, which we will describe below.

In the following section, we describe our spatial analysis of the coverage of the NBN's broadband access technologies in the future under the proposed multi-technology approach and the results that feed in to the spatial database.

4.5 Broadband access technologies in the future with the NBN

Under the proposed multi-technology approach, existing broadband access networks will be upgraded or overbuilt by the NBN. On 23 June 2011, NBN Company signed definite agreements with Optus and Telstra to migrate their subscribers to the NBN and to decommission Telstra's copper and the Telstra and Optus HFC networks (NBN Company, 2013a). Telstra's copper network will be overbuilt by the NBN FTTN, or replaced by the NBN FTTP access network. The technologies used outside the fixed-line footprint will be fixed wireless and satellite, along with some FTTN (NBN Company, 2013a).

During our analysis for this thesis, the proposed technology mix of the NBN network has changed several times. The latest proposed NBN network was planned to cover more than 12.4 million premises passed by a mix of FTTP (3.1 million premises), FTTN (3.6 million premises), Fibre-to-the-distribution point or building (FTTdp/B) (1.4 million premises) and HFC (3.3 million premises) in the fixed-line footprint. In addition, we have assumed that FTTN (30.6 thousand premises) will be introduced in the original non-fixed-line footprint, reducing the number of premises covered by satellite (408 thousand premises) and fixed wireless (581 thousand premises), as proposed in a scenario by NBN Company (2014d).

The spatial analysis we have conducted to estimate the coverage of the above broadband access networks is described in this section. Our analysis relied on a wide variety of data. Not all of this information refers to the same technology mix. Where reliable data was missing or related to diverging technology mixes, we made assumptions to the best of our knowledge at the time of our analysis.

Hybrid Fibre-Coax (HFC)

The proposed multi-technology approach assumes capacity investments and completing construction of the HFC network to connect all premises within the geographic area that the Telstra and Optus HFC networks cover, that is, 3.4 million total potential HFC premises (NBN Company, 2013a). This includes 0.7 million premises that are in the geographic coverage area of the HFC networks, but currently not passed (NBN Company, 2013a). We have adopted our estimates of the Optus and Telstra HFC networks in the reference case described in section 4.4. In these estimates, we had assumed only about 80% of residences were passed in the coverage areas. For the NBN, we assume that the remaining 20% (0.7 / 3.4) of residences are covered, and hence the additional 20% of the relevant residential parameters of intersecting mesh blocks account for the NBN impact on service delivery. In addition, we have assumed that all businesses in the estimated HFC coverage area will be passed in the future with the NBN.

Table 4.15 shows the results of our spatial analysis described above in terms of people usually resident in the geographic area of mesh blocks, based on 2011 Census data, covered by HFC networks in the future with the NBN. Regions with an estimate of zero are not included in the results.

Table 4.15: Estimated number of persons with access to the NBN HFC access network based on ABS 2011 Census data

Region	Persons with access to HFC	Percent of persons with access to HFC
Greater Adelaide	516,067	42.12%
Greater Brisbane	957,882	46.36%
Greater Melbourne	2,294,153	57.35%
Greater Perth	266,910	15.44%
Greater Sydney	2,854,562	65.00%
Rest of Queensland	506,625	22.48%

Fibre-to-the-premises (FTTP)

Under the proposed multi-technology approach, FTTP could cover between 20% and 26% of premises in the fixed line footprint (NBN Company, 2013a). To estimate the coverage of the NBN FTTP network, we conducted a spatial analysis of geospatial datasets of NBN Company's current and planned FTTP deployment as of 2013. We have assumed that the coverage of the NBN FTTP network is the geographic area of the mesh blocks that intersect with the NBN FTTP geospatial datasets, excluding the geographic area of the mesh blocks covered by HFC deployments.

The results of our spatial analysis in terms of people usually resident in the geographic area of mesh blocks, based on 2011 Census data, covered by FTTP networks in the future with the NBN are shown in Table 4.16. Regions with an estimate of zero are not included in the results.

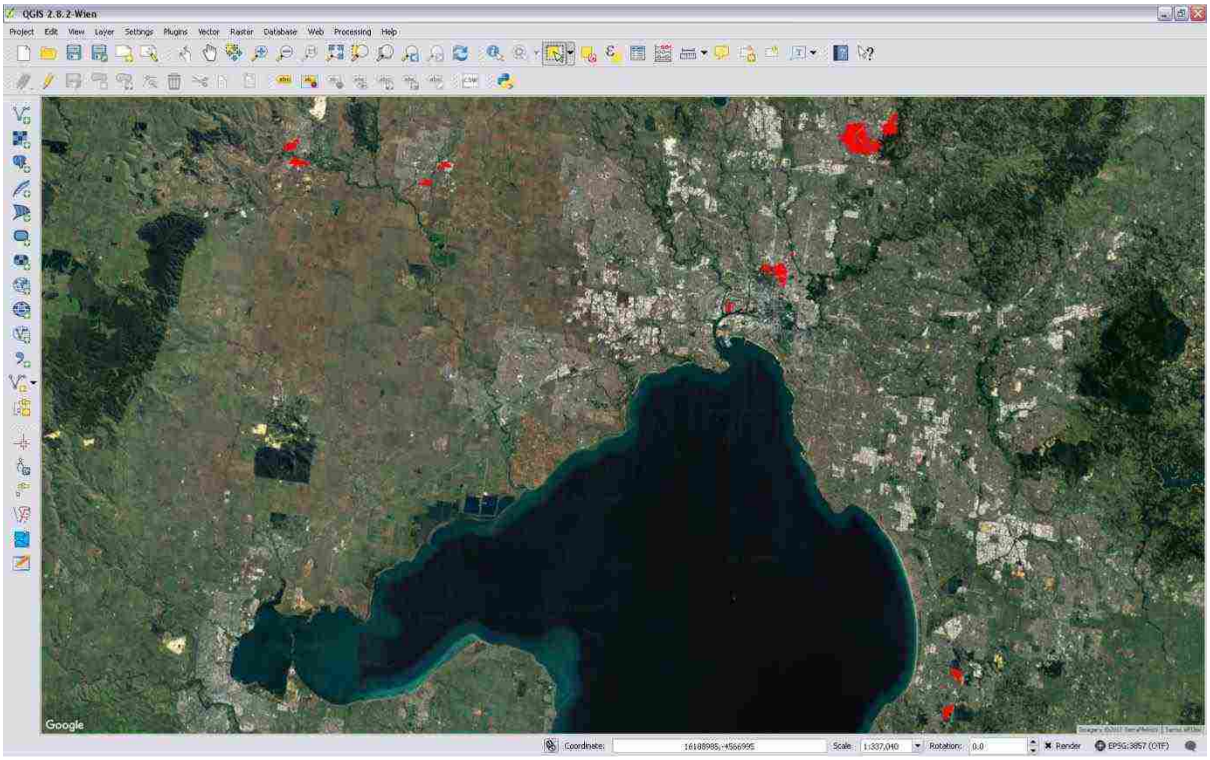
Table 4.16: Estimated number of persons with access to the NBN FTTP network based on ABS 2011 Census data

Region	Persons with access to FTTP	Percent of persons with access to FTTP
Australian Capital Territory	37,859	10.59%
Greater Adelaide	41,842	3.42%
Greater Brisbane	51,404	2.49%
Greater Melbourne	131,155	3.28%
Greater Perth	19,593	1.13%
Greater Sydney	99,927	2.28%
Northern Territory	39,732	18.92%
Rest of New South Wales	118,991	4.74%
Rest of Queensland	127,424	5.65%
Rest of Victoria	43,558	3.24%
Rest of Western Australia	13,246	2.64%
Tasmania	116,175	23.51%

Since we have used data from various sources over a time period in which the proposed technology mix of the NBN has changed several times, we have excluded FTTP coverage areas where they overlap with our estimated coverage area of HFC.

Figure 4.7 shows an example area (mesh blocks) in Greater Melbourne (Victoria) highlighted in red where premises can access NBN FTTP with no HFC and no DSL availability for a minimum download speeds of 10 Mbps in the reference case.

Figure 4.7: Estimates of NBN FTTP in Melbourne (Victoria) with no access to HFC and no access to DSL for download speeds of 10 Mbps or above in the reference case



Fibre-to-the-node (FTTN)

Under the proposed multi-technology approach, most of Telstra's copper network will be overbuilt by FTTN covering about half of all premises in the fixed-line footprint (NBN Company, 2013a). The originally proposed fixed-line footprint was defined by NBN Company by a list of localities that would have received some fibre coverage.[12] We have assumed that the originally proposed fixed-line footprint is identical to the one proposed under the multi-technology approach. We took the list of localities and identified each locality's geographic location. To do this, we relied on a mapping of place names to geography. The naming convention in the lists of localities best matches the one used for the statistical areas of 2006 Urban Centres and Localities (UCLs). We then assumed that the ESAs in these locations would be covered by FTTN, but we excluded any areas already identified as receiving FTTP or HFC deployments.

The results of our spatial analysis in terms of people usually resident in the geographic area of mesh blocks, based on 2011 Census data, covered by FTTN networks in the future with the NBN are shown Table 4.17.

Table 4.17: Estimated number of persons with access to the NBN FTTN network based on ABS 2011 Census data

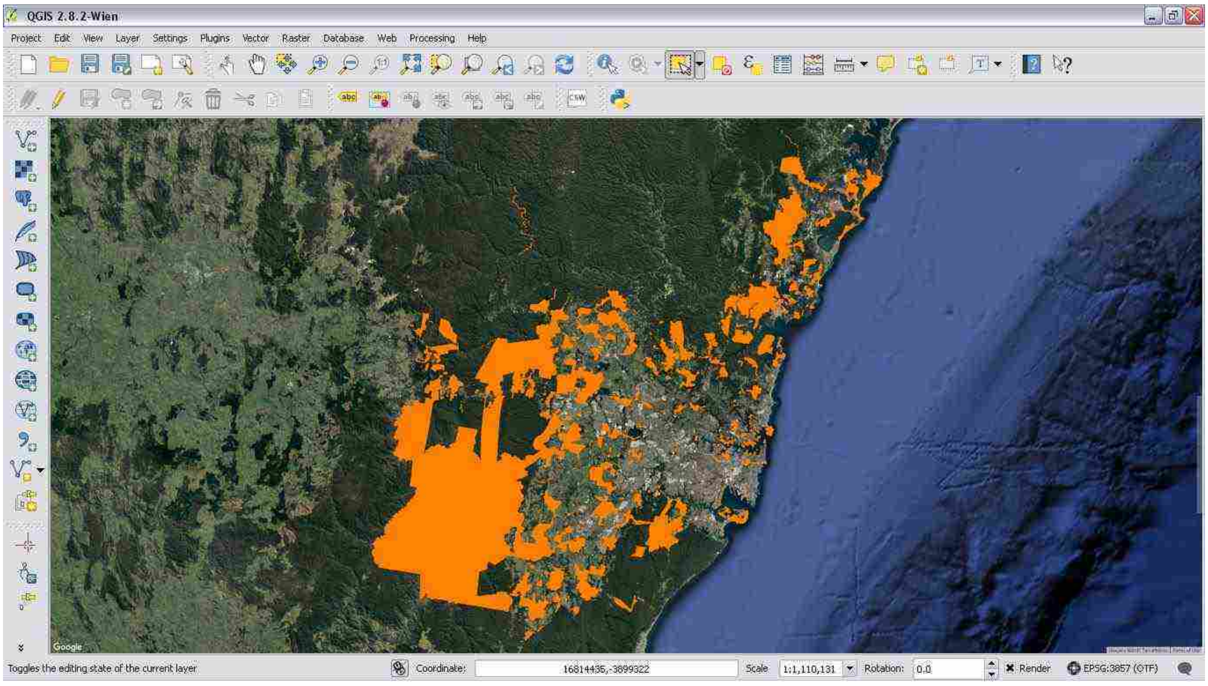
Region	Persons with access to FTTN	Percent of persons with access to FTTN
Australian Capital Territory	612	0.17%
Greater Adelaide	641,957	52.39%
Greater Brisbane	1,015,851	49.17%

[12] Copies of the lists in pdf-format were provided to us in a private email from a work colleague at CEET who downloaded the lists from the NBN Company website before they were removed from the website.

Region	Persons with access to FTTN	Percent of persons with access to FTTN
Greater Melbourne	1,507,574	37.69%
Greater Perth	1,433,308	82.90%
Greater Sydney	1,326,934	30.21%
Northern Territory	119,996	57.15%
Rest of New South Wales	2,091,619	83.23%
Rest of Queensland	1,392,747	61.80%
Rest of South Australia	273,211	74.19%
Rest of Victoria	1,009,550	75.02%
Rest of Western Australia	374,971	74.61%
Tasmania	319,170	64.59%

Figure 4.8 shows an example area (mesh blocks) in Greater Sydney (New South Wales) highlighted in orange where premises can access NBN FTTN with no HFC and no DSL availability for a minimum download speeds of 10 Mbps in the reference case.

Figure 4.8: Estimates of NBN FTTP in Sydney (NSW) with no access to HFC and no access to DSL for download speeds of 10 Mbps or above in the reference case



Fixed Wireless

The proposed multi-technology approach assumes that about 6% of premises outside the NBN fixed-line footprint will be covered by fixed wireless and satellite technologies. Our estimates of the coverage of the NBN fixed wireless network relied on three data sources. First, we used geospatial datasets of active and in build wireless serving area modules (WSAMs) as of December 2013 from NBN Company.[13] We excluded the area of a mesh block that is not overlapping, and recalculated the parameters in proportion of the remaining area to the total area of the mesh block. This has resulted

[13] A copy of the latest publically available update of the rollout boundaries for all Fibre and Fixed Wireless footprints active and in build as of December 2013 were provided to us in a private email from the operator of the independent tracking website www.mynbn.info which has moved to the website www.finder.com.au in February 2016.

in 226,478 persons usually resident in the estimated area covered by fixed wireless, or about 46% of the 494,515 total persons usually resident in the area of overlapping mesh blocks.

When processing the geospatial datasets in QGIS, we found that the average coverage of NBN WSAMs spans approximately the average size of an SA2. We therefore assumed that the SA2 with a matching name among the localities in the updated list of WSAMs published on the independent NBN tracking website,[14] our second data source, is in the coverage area of the NBN fixed wireless access network. Our third data source was a list of localities that would have received some wireless coverage under the originally proposed wireless footprint defined by NBN Company.[15] We took the list of localities and identified each locality's geographic location similar to the approach described above. We then assumed that the ESAs in these locations would be covered by fixed wireless. Based on our estimated example above, however, we have assumed that about 46% of the parameters associated with mesh blocks that overlap selected SA2 and ESAs are included in our estimate of the effects of the NBN, but we have excluded any areas already identified as receiving FTTP, HFC and FTTN deployments. In addition, we have assumed that the location of businesses in the geographical area of mesh blocks that intersect with our estimated NBN fixed wireless coverage area are within the NBN fixed wireless coverage area.

Table 4.18 shows the results of our spatial analysis in terms of people usually resident in the geographic area of mesh blocks, based on 2011 Census data, covered by the fixed wireless access network in the future with the NBN. Regions with an estimate of zero are not included in the results.

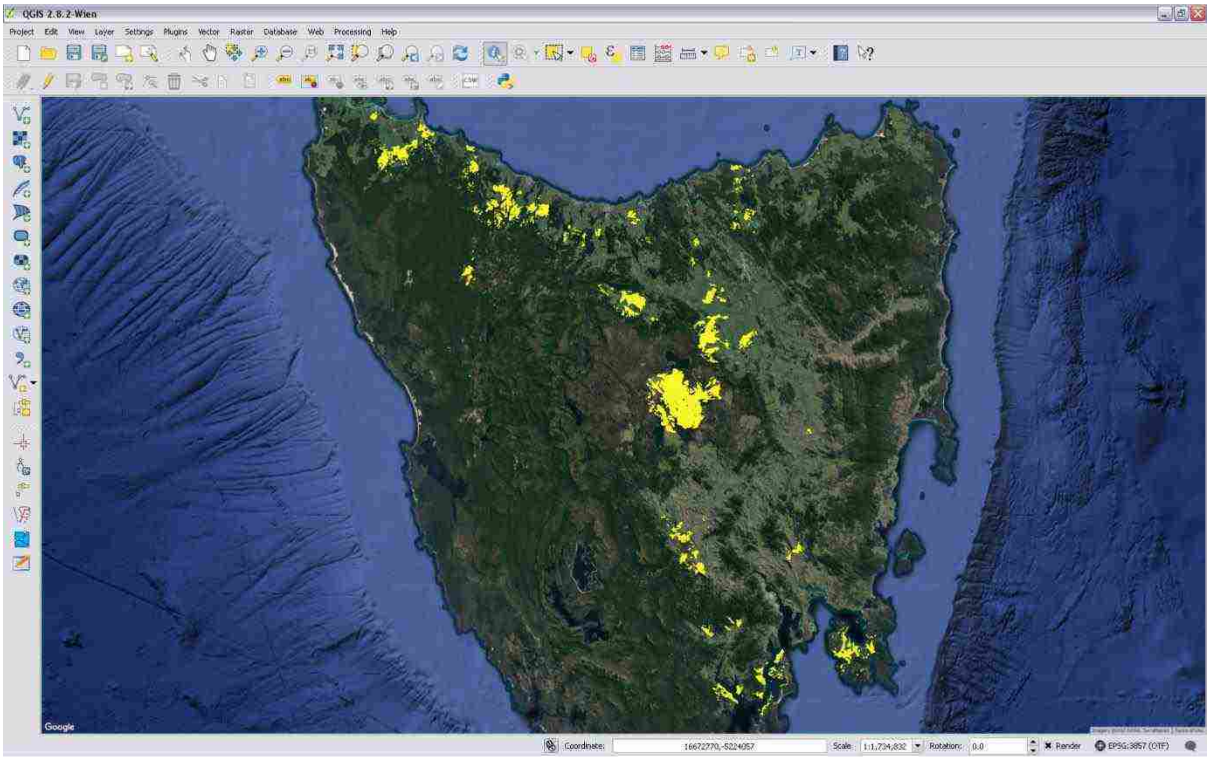
Table 4.18: Estimated number of persons with access to the NBN fixed wireless network based on ABS 2011 Census data

Region	Persons with access to fixed wireless	Percent of persons with access to fixed wireless
Greater Adelaide	8,041	0.66%
Greater Brisbane	7,497	0.36%
Greater Melbourne	7,902	0.20%
Greater Perth	2,689	0.16%
Greater Sydney	24	0.00%
Rest of New South Wales	41,582	1.65%
Rest of Queensland	38,148	1.69%
Rest of South Australia	20,786	5.64%
Rest of Victoria	115,772	8.60%
Rest of Western Australia	16,626	3.31%
Tasmania	19,419	3.93%

Figure 4.9 shows an example area in Tasmania highlighted in yellow where premises can access NBN fixed wireless with no NBN FTTP and FTTN, and no DSL availability for a minimum download speeds of 10 Mbps in the reference case.

[14] The NBN tracking website can be accessed under the following link (last accessed on 19 November 2017): https://www.finder.com.au/nbn-tracker/rollout/list.
[15] Copies of the lists in pdf-format were provided to us in a private email from a colleague at CEET who downloaded the lists from the NBN Company website before they were removed from the website.

Figure 4.9: Estimates of NBN fixed wirelesses in Tasmania with no access to NBN FTTP and FTTN, and no access to DSL for download speeds of 10 Mbps or above in the reference case



The estimated areas in Figure 4.9 highlighted in yellow are work in progress and a result of our spatial analysis based on NBN fixed wireless geospatial datasets only.

Table 4.19 shows field names and the data types we have used in the spatial database to estimate the NBN impact on service delivery.

Table 4.19: Selected field names and data types in the spatial database used to estimate the NBN impact on service delivery

Field name	Description	Data type
Dwellings	Dwellings	Number
Area_inter	Area of Project Mesh Blocks in square metres	Number
Pers_inter	Persons usually resident of Project Mesh Blocks	Number
Pers_65Plus_inter	Persons aged 65 and older of Project Mesh Blocks	Number
Pers_WSAM_inter	Persons usually resident in the coverage area of WSAMs	Number
GP_Services_200910	GP services	Number
FTTP_NBN	NBN FTTP network	'TRUE' or 'FALSE'
HFC	Optus HFC network	'TRUE' or 'FALSE'
FIBRE	NBN FTTN network	'TRUE' or 'FALSE'
WIRELESS	NBN Fixed Wireless network	'TRUE' or 'FALSE'

Our spatial database in MS Access is populated with the results of our spatial analysis of broadband networks in the reference case and the future with the NBN. This enables us to process the mesh block parameters and estimate the NBN impact on service delivery subject to the service requirements, which we will describe in the following chapter.

4.6 Concluding Remarks

With the rare exception of Access Economics (2009), studies focusing on the impact of broadband often ignore the evolution of broadband in the absence of the proposed initiative aimed at expanding the broadband infrastructure, such as the NBN, for example. Competitive forces and innovation, along with other government policies, will continue to drive rollout of higher speed broadband than the prevailing level. Without considering changes occurring in the reference case, the estimated effects are only partly linked to the proposed initiative.

In this chapter, we have described our spatial analyses to estimate the coverage of Australia's NBN. Our main contribution in this chapter is the spatial analysis of broadband network coverage in Australia in two alternative future scenarios: one in which the NBN would not have been built and existing networks evolve over time, and another one in which the NBN is being deployed and overbuilding existing networks. We have considered major broadband access networks and real network deployment on the smallest spatial level feasible with publicly available data.

We have developed a spatial database populated with the results of our spatial analysis. We have provided summaries of selected mesh block parameters under both scenarios. Subject to the access speed requirements of new services and the benefits they provide, we are able to investigate and explore the economic impact as higher broadband speeds are made available through the NBN.

In the following chapter, we derive the NBN impact on service delivery. We will use our spatial database to estimate the incremental impact of the NBN for respective service requirements.

CHAPTER 5
Service Requirements

5.1 Introduction

In this chapter, we describe our approach to estimate the incremental impact of the NBN subject to the access-speed requirements of broadband-enabled services made widely available through the NBN. We have used our spatial analysis of broadband access networks described in the previous chapter to estimate the expected access speeds which would be available to the end user in a mesh block in the future with and without the NBN. From this analysis, it is possible to determine, for any required access speed, the incremental NBN impact on service delivery or those mesh blocks in which the required access speed is available in the future with the NBN but not in the future without the NBN. We therefore turn our attention in this chapter first to the access speeds required for the services and, second, to the economic benefits of those services we have identified in section 2.5.

The access-speed requirements for similar services stated in the literature we have reviewed often refer to a range of access speeds. That is why we have considered two scenarios encompassing the lower and upper bounds of the access speeds ranges. We will present the download and upload speeds assumed for the new services in each scenario in the next section.

In the last section of this chapter, we will summarise the benefits of the new services suggested by the literature and the parameters of selected mesh blocks. As a result of our analysis described in this chapter, we have derived all the inputs to the economic model described in detail in chapter 6.

5.2 Scenarios for service access-speed requirements

Our assumptions about access-speed requirements were guided by recommendations stated in the literature cited in this section and in discussions with researchers in the relevant field from the University of Melbourne during a workshop held for this purpose. Participants[16] of the half-day workshop held at the University of Melbourne premises on 14 November 2013 are subject-matter experts with research interests in IT-related aspects of a range of areas relevant to this study and have several years of experience in a diverse range of industries from broadband services, telecoms, medical technology and education. Workshop participants were introduced to each service in turn and given the following categories of download and upload speeds: 'very low' (256 Kbps to <2.5 Mbps), 'low' (2.5 Mbps to <10 Mbps), 'medium' (10 Mbps to <24 Mbps), high (24 Mbps to <100 Mbps), and 'very high' (>=100 Mbps).

The recommendations in the literature usually refer to a range of access speeds that are required by the new services. However, it is often not clear if these speeds just refer to the data rate required to deliver the service information or if they include the various control and signalling overheads that are required in the implementation of the service. These so-called encapsulation overheads are

[16] People who attended and contributed to the workshop included Robert Ayre, Kerry Hinton, Leith Campbell, Ken Clarke, Jim Park, Adam Lodders and Rachelle Bosua.

required to achieve the reliable transmission of the desired data in question (Szigeti et al., 2013). Encapsulation overheads can be quite significant in size and in some cases more than double the access speeds required by the services.[17] In all cases, we have assumed that the required access speed can support both the service data and the required encapsulation overheads.

It should be noted that, if actual network access speeds including encapsulation overheads are significantly higher than the service access-speed requirements we have assumed in this thesis, it could be the case that we have over- or underestimated the NBN impact on service delivery. For example, when actual network access-speed requirements are met by the NBN and not met by the broadband access technologies in the future without the NBN, because of the encapsulation overheads, it is likely that we have underestimated the NBN impact on service delivery. In other words, our estimates of the NBN impact on service delivery are conservative. On the other hand, when actual network access-speed requirements are not met by the NBN because of the encapsulation overheads and not met by the broadband access technologies in the future without the NBN, it is likely that we have overestimated the NBN impact on service delivery. We will see later that this can only be an issue for telework in some circumstances with a marginal effect on our estimates of the NBN impact on service delivery.

In the remainder of this section we describe the expected service access-speeds we have considered in this thesis. Because of the uncertainty in the actual service requirements, we have developed two scenarios – for "modest" access speeds and for "high" access speeds – and considered the effect of the NBN in both scenarios.

Modest access-speed requirements

For this scenario, we have assumed that the access speeds required to deliver the services we have chosen are about the levels that could be obtained today in well served areas. We have assumed, however, that there is some pressure for greater access speeds for Entertainment services, as is seen in today's market for streaming services and online games (Analysys Mason and Tech4i2, 2013). Where applicable, we have chosen the lower bound of the access speeds suggested in the literature. The minimum download- and upload speeds we have assumed in this scenario for each service group are shown in the Table 5.1.

Table 5.1: Download and upload bandwidth assuming services require modest access speeds

Service group	Min. download (Mbps)	Min. upload (Mbps)
Cloud Computing	2.5	2.5
Electronic Commerce	2.5	0.256
Online Higher Education	0.256	0.256
Telehealth Practice	0.256	0.256
Telehealth Practice (Microclinics)	0.256	2.498
Teleworking	1.5	0.256
Online Entertainment	12	5

[17] Cisco (2014) suggests that the addition of tunnel headers and encryption overhead in a virtual private network (VPN) increases the packet sizes of all encrypted applications including voice, video, and data. The additional overhead for voice for the most widely deployed codecs G.711 and G.729 results in a 40 percent and a 227 percent increase in the bandwidth required for an encrypted G.711 and G.729 call, for example.

Service requirements for cloud computing were discussed at a workshop organised by the European Commission in Dublin (European Commission, 2013). Robert Pepper[18], a specialist in communications policy, stated that sound cloud requires more than 2Mbps and latency of less than 100ms (European Commission, 2013). Participants of the workshop at the University of Melbourne pointed out that cloud services commonly have symmetric bandwidth requirements. It was agreed that the lower bound of expected download and upload-speed requirements for cloud computing is 2.5Mbps.

Access-speed requirements for high-definition video links used in Microclinics in outer regional and remote geographical areas were based upon Cisco (2012). The bandwidth recommendations outlined in Cisco's HealthPresence Solution Design Guide can vary based on a number of parameters, such as video endpoints, resolution, and frames per second (fps). The recommended minimum Committed Information Rate (CIR) for the HealthPresence solution is 512kbps regardless of the capabilities or specifications of the video endpoint (Cisco, 2012). Based on discussions with workshop participants and the information from Cisco (2012) that Jabber Video requires between 128kbps to 720kbps using low resolution, we assumed 256kbps for the lower bound of the expected access-speed requirements for all telehealth applications. For the telehealth applications involving patients-to-general-practitioners and provider-to-provider online consultations, we assumed the same lower bound of the expected access speeds for download and upload, i.e. 256kbps. We have assumed 2.5Mbps for the lower bound of the expected upload-speed requirements for high-definition video links used in remote Microclinics. This includes the upper bound of the Jabber Video bandwidth requirements with low video resolution, i.e. 720kbps, and 1,778kbps for the Cisco HealthPresence medical device data/content (Cisco, 2012).

The Australian Government's Telework Kit (Department of Communications and the Arts, 2013b) suggests that "Speeds of 1.5Mbps down and 256kbps up (e.g. ADSL) may struggle depending on the number of things teleworkers try to do at once" (Department of Communications and the Arts, 2013b, p. 14). In this thesis, we assumed 1.5Mbps and 256kbps for the lower bound of expected download- and upload-speed requirements, respectively.

Our assumptions about the lower bound of the expected access-speed requirements for electronic commerce, online higher education and online entertainment were derived from discussions with the researchers from the University of Melbourne in a separate project meeting. Online entertainment includes, among other things, online games which generally place significant strain on the upload speed of today's internet connection.

High access-speed requirements

The access-speed requirements we have assumed in this scenario model the likely case where, to obtain the benefits from the services, richer content or greater detail are needed. In this scenario, required access speeds are uniformly higher than in the modest scenario. Where applicable, we have chosen the upper bound of the access speeds suggested in the literature. The minimum download- and upload speeds we have assumed in this scenario for each service group are shown in the Table 5.2.

[18] Robert Pepper is Vice President at Cisco. He leads the Global Technology Policy team advising governments across the world on the development in areas such as broadband, IP enabled services, wireless and spectrum policy, security, privacy, Internet governance and ICT (Cisco, a).

Table 5.2: Expected download and upload speeds in the high access-speed requirements scenario

Service group	Min. download (Mbps)	Min. upload (Mbps)
Cloud Computing	10	10
Electronic Commerce	10	2.5
Online Higher Education	2.5	2.5
Telehealth Practice	2.5	2.5
Telehealth Practice (Microclinics)	2.5	6.406
Teleworking	20	4
Online Entertainment	25	5

For telehealth practice (microclinics), we have adopted the upper bound of the recommended access speeds for the Cisco TelePresence System 500. The transmission bandwidth requirements for the Cisco TelePresence System 500 configured for 1920x1080 or 2.1 megapixels is 4,628kbps (Cisco, 2012). The Cisco HealthPresence medical device data/content requires additional bandwidth of 1,778kbps (Cisco, 2012), resulting in a total of 6,406kbps not including encapsulation overhead. Allowing 20% for overhead as recommended for the Cisco TelePresence System 500 (Cisco, 2012) has no effect on our estimates of the NBN impact on service delivery.

For telework, we have adopted the recommendations from the Australian Government's Telework Kit (Department of Communications and the Arts, 2013b) that broadband in excess of 20Mbps for download and 4Mbps for upload are ideal for all teleworker activities, including high-definition video conferencing. As noted earlier, we have assumed that the service access-speed requirements recommended in the Telework Kit (Department of Communications and the Arts, 2013b) refer to network access speeds including encapsulation overheads. If the true access-speed requirements were higher than this, our resulting estimates of the NBN impact on service delivery would be overestimated marginally for telework, because telework would then not be supported in the NBN Fixed Wireless areas. This is the only case in which the uncertainty about encapsulation overheads has an effect on our results. Because NBN fixed wireless technology is to serve less than 6% of households in regional and remote areas outside the fixed-line footprint, any overestimate is small.

For the expected access-speed requirements for online entertainment, we have adopted assumptions made by researchers from the University of Melbourne in a separate project meeting.

For service groups other than telehealth practice (microclinics), telework and online entertainment, we have assumed the next higher category of access speed discussed at the workshop for the access-speed requirements in this scenario. Thus, for example, a modest requirement of 2.5 Mbps (in the 'low' category of 2.5-10 Mbps) becomes 10 Mbps (in the 'medium' category of 10-24 Mbps) in the high scenario.

In the next section, we describe how we have used the access-speed requirements described above to select the mesh blocks where the broadband-enabled services are only made available through the NBN.

5.3 Processing service requirements and technology capabilities

In Chapter 4, we showed how various demographic data could be mapped to mesh blocks and how we determined what access speeds would be available in each mesh block with and without the

NBN. In this section, we apply the two access-speed scenarios described in the previous section to determine how many people and other entities benefit from the NBN. This is the demographic data, as we will see later, that we need to construct our model of the additional economic benefits produced by the NBN.

We have developed a tool for the purpose of processing the demographic data mapped to mesh blocks. The inputs and their computation in the tool that lead to the results presented at the end of this section are described in the Appendix A. The effects on four demographic statistics are required for the model, as follows:

- persons usually resident, for the following services:
    - telehealth practice (secure, private tele-consulting and microclinics);
    - online higher education;
    - teleworking; and
    - online entertainment;
- persons aged 65 and older, for the following services:
    - telehealth practice (aged care);
- GP services, for the following services:
    - telehealth practice (provider-to-provider tele-consulting);
- turnover of businesses with an annual turnover of less than 2 million Australian dollars by industry, for the following services:
    - cloud computing; and
    - electronic commerce.

To estimate the numbers of people, general practitioner services and small and medium businesses that will benefit from the NBN, two criteria need to be met. First, the broadband access network capabilities in the future with the NBN meet the service access-speed requirements. Second, the broadband access network capabilities in the reference case do not meet the service access-speed requirements. The results are needed in percentage terms in each region. Tables 5.3 to 5.10 show the results from the data processing tool. Our estimate of the NBN incremental impact on service delivery for telework for each region in the modest service requirements scenario is shown in Figure 5.1.

Figure 5.1: NBN incremental impact on service delivery for telework in the modest service requirements scenario

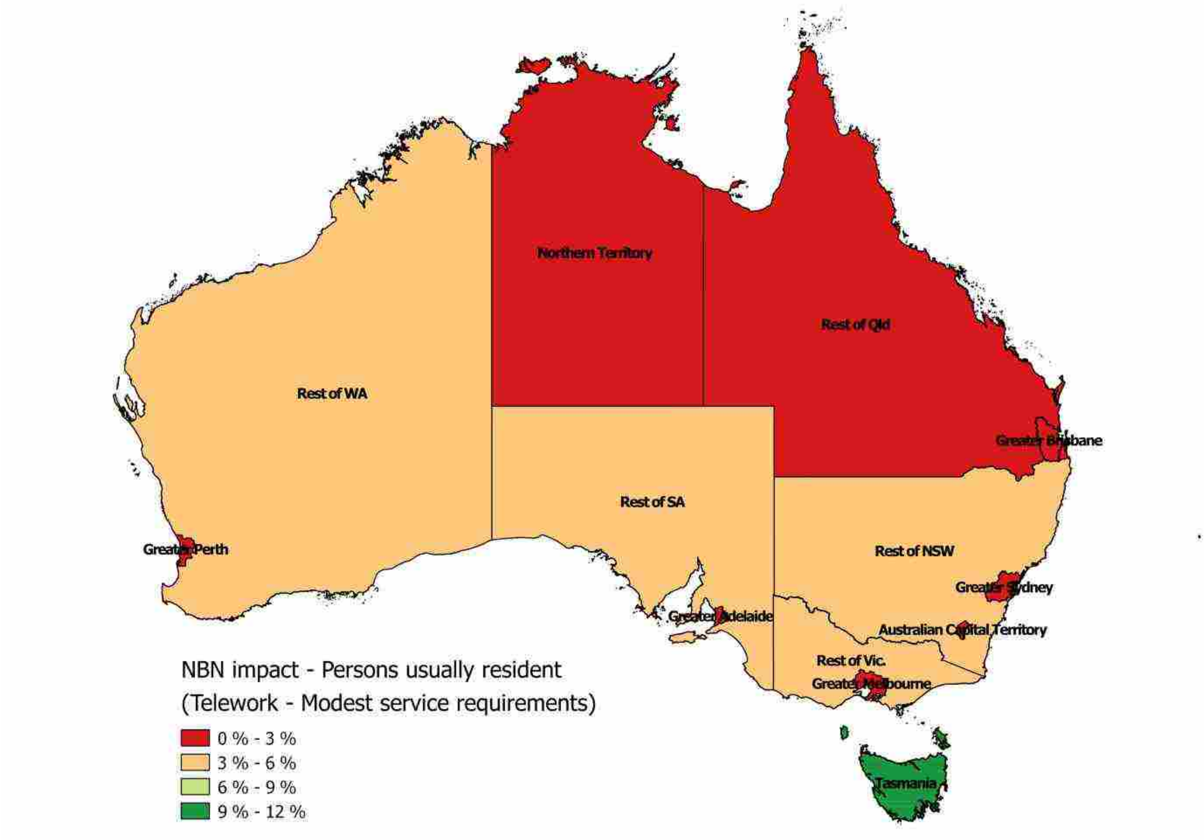


Table 5.3: NBN impact on service delivery in the *modest* service access-speed requirements scenario in percent of persons usually resident by region

Access speed	Telehealth Practice - Microclinics^	Telehealth Practice - Private tele-consulting	Online Higher Education	Telework	Online Entertainment
Min. download (Mbps)	0.256	0.256	0.256	1.5	12
Min. upload (Mbps)	2.498	0.256	0.256	0.256	5
Region	**Persons usually resident**				
Greater Sydney	0%	1%	1%	1%	46%
Rest of NSW	13%	3%	3%	3%	90%
Greater Melbourne	0%	2%	2%	3%	53%
Rest of Vic.	13%	4%	4%	4%	85%
Greater Brisbane	0%	2%	2%	2%	61%
Rest of QLD	27%	2%	2%	2%	73%
Greater Adelaide	0%	1%	1%	1%	65%
Rest of SA	52%	5%	5%	5%	78%
Greater Perth	0%	0%	0%	1%	87%
Rest of WA	48%	4%	4%	4%	79%
Tasmania	28%	9%	9%	10%	93%
Northern Territory	77%	2%	2%	3%	77%
Australian Capital Territory	0%	0%	0%	0%	0%

^ Excludes by assumption Major Cities of Australia and Inner Regional Australia

Due to the online entertainment's comparatively high service access-speed requirements for upload and the upload constraints of ADSL2+ in the future without the NBN, the NBN impact on service delivery is comparatively high in the modest service access-speed requirements scenario. The NBN impact on online entertainment service delivery in the high service access-speed requirements scenario shown in Table 5.4 is slightly lower mainly outside major metropolitan areas. This is due to the service access-speed requirements exceeding the capabilities of the NBN fixed wireless network.

Table 5.4: NBN impact on service delivery in the *high* service access-speed requirements scenario in percent of persons usually resident by region

Access speed	Telehealth Practice - Microclinics†	Telehealth Practice - Private tele-consulting	Online Higher Education	Telework	Online Entertainment
Min. download (Mbps)	2.5	2.5	2.5	20	25
Min. upload (Mbps)	6.406	2.5	2.5	4	5
Region	**Persons usually resident**				
Greater Sydney	0%	46%	46%	46%	46%
Rest of NSW	0%	90%	90%	90%	88%
Greater Melbourne	0%	53%	53%	53%	53%
Rest of Vic.	0%	85%	85%	85%	78%
Greater Brisbane	0%	61%	61%	61%	61%
Rest of QLD	3%	73%	73%	73%	72%
Greater Adelaide	0%	65%	65%	65%	64%
Rest of SA	0%	78%	78%	78%	74%
Greater Perth	0%	87%	87%	87%	87%
Rest of WA	3%	79%	79%	79%	77%
Tasmania	4%	93%	93%	93%	88%
Northern Territory	19%	77%	77%	77%	76%
Australian Capital Territory	0%	0%	0%	0%	0%

† Excludes by assumption Major Cities of Australia and Inner Regional Australia

Estimates of the NBN impact on service delivery in the high service access-speed requirements scenario shown in Table 5.4 are the same for Telework, tele-consulting and online higher education even though the service access-speed requirements for Telework is different. This suggests that there is no broadband access network that is capable of one or the other service access-speed requirements.

Our regional estimates of the NBN incremental impact on service delivery for introducing telehealth intervention into existing aged care programs in the high service requirements scenario is shown in Figure 5.2.

Figure 5.2: NBN incremental impact on service delivery for telehealth for aged care

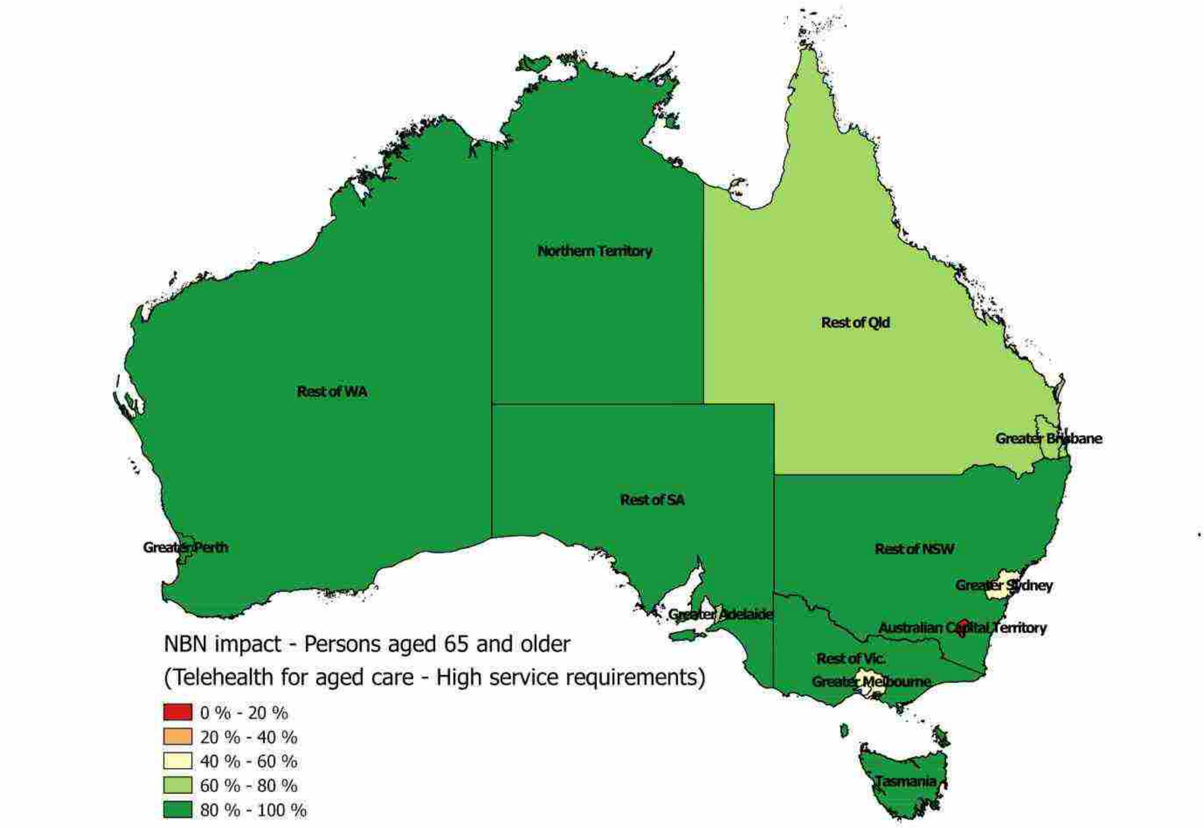


Table 5.5: NBN impact for telehealth for aged care in the *modest* and *high* service access-speed requirements scenario in percent of persons aged 65 and older by region

Access speed	Modest access-speed requirements	High access-speed requirements
Min. download (Mbps)	0.256	2.5
Min. upload (Mbps)	0.256	2.5
Region	**Persons aged 65 and older**	
Greater Sydney	1%	45%
Rest of NSW	3%	91%
Greater Melbourne	2%	47%
Rest of Vic.	3%	85%
Greater Brisbane	2%	62%
Rest of QLD	2%	74%
Greater Adelaide	0%	61%
Rest of SA	4%	83%
Greater Perth	0%	85%
Rest of WA	4%	82%
Tasmania	8%	93%
Northern Territory	2%	85%
Australian Capital Territory	0%	0%

Table 5.6: NBN impact for provider-to-provider tele-consulting in the *modest* and *high* service access-speed requirements scenario in percent of GP services by region

Access speed	**Modest access-speed requirements**	**High access-speed requirements**
Min. download (Mbps)	0.256	2.5
Min. upload (Mbps)	0.256	2.5
Region	**GP services**	
Greater Sydney	1%	46%
Rest of NSW	3%	91%
Greater Melbourne	2%	52%
Rest of Vic.	4%	84%
Greater Brisbane	2%	55%
Rest of QLD	1%	46%
Greater Adelaide	0%	66%
Rest of SA	5%	80%
Greater Perth	0%	88%
Rest of WA	4%	80%
Tasmania	9%	93%
Northern Territory	1%	96%
Australian Capital Territory	0%	0%

Table 5.7: NBN impact for cloud computing in the *modest* service access-speed requirements scenario (2.5Mbps min. download and upload) in percent of businesses turnover by industry and region

Industry	Greater Sydney	Rest of NSW	Greater Melbourne	Rest of Vic.	Greater Brisbane	Rest of Qld	Greater Adelaide	Rest of SA	Greater Perth	Rest of WA	Tasmania	Northern Territory	Australian Capital Territory
1 AgriForFish	40%	68%	52%	74%	32%	52%	75%	64%	46%	58%	59%	26%	4%
2 Mining	5%	5%	6%	6%	3%	8%	6%	4%	4%	3%	5%	2%	3%
3 FoodDrinkTob	38%	27%	56%	35%	25%	33%	48%	20%	31%	28%	36%	15%	8%
4 TCFs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 MiscManuf	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6 WoodProds	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7 PaperPrint	0%	0%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%
8 ChemCoalPrds	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	1%
9 NonMetMinPrd	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 MetalPrds	2%	1%	2%	2%	1%	2%	2%	1%	1%	1%	1%	1%	1%
11 TransEqp	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
12 OthMachEqp	1%	1%	1%	1%	0%	1%	1%	0%	1%	0%	1%	0%	0%
13 EGW	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	1%	0%
14 Construction	18%	20%	18%	22%	7%	26%	20%	17%	9%	12%	24%	10%	1%
15 WholesalTrad	5%	5%	5%	4%	3%	8%	6%	4%	3%	3%	4%	2%	3%
16 RetailTrade	13%	13%	13%	14%	7%	19%	13%	16%	11%	13%	13%	8%	3%
17 RecPersSrvc	21%	16%	13%	11%	11%	29%	18%	12%	16%	13%	7%	7%	8%
18 Transport	11%	16%	13%	20%	7%	18%	14%	26%	10%	17%	10%	7%	2%
19 PostalSrvcs	1%	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%	0%	0%
20 Telecomms	6%	2%	5%	3%	4%	11%	5%	3%	7%	5%	1%	5%	1%
21 FinBusSrvces	16%	12%	18%	13%	10%	28%	18%	12%	15%	10%	11%	10%	3%
22 PubAdmDef	35%	16%	22%	15%	19%	41%	29%	29%	21%	14%	27%	26%	6%
23 Education	21%	12%	19%	9%	11%	21%	15%	7%	13%	9%	13%	13%	5%
24 Community	47%	35%	42%	30%	22%	53%	39%	27%	33%	29%	28%	20%	5%

Table 5.8: NBN impact for cloud computing in the *high* service access-speed requirements scenario (10Mbps min. download and upload) in percent of businesses turnover by industry and region

Industry	Greater Sydney	Rest of NSW	Greater Melbourne	Rest of Vic.	Greater Brisbane	Rest of Qld	Greater Adelaide	Rest of SA	Greater Perth	Rest of WA	Tasmania	Northern Territory	Australian Capital Territory
1 AgriForFish	7%	0%	3%	0%	2%	0%	36%	0%	0%	0%	3%	1%	0%
2 Mining	5%	0%	5%	0%	2%	3%	2%	0%	0%	0%	2%	0%	0%
3 FoodDrinkTob	25%	2%	34%	2%	18%	13%	22%	0%	7%	1%	21%	7%	0%
4 TCFs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 MiscManuf	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6 WoodProds	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7 PaperPrint	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
8 ChemCoalPrds	1%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
9 NonMetMinPrd	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 MetalPrds	1%	0%	1%	0%	1%	1%	1%	0%	0%	0%	1%	0%	0%
11 TransEqp	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12 OthMachEqp	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13 EGW	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14 Construction	14%	1%	12%	1%	4%	9%	10%	0%	1%	1%	9%	0%	0%
15 WholesalTrad	4%	0%	3%	0%	2%	4%	3%	0%	1%	0%	2%	1%	0%
16 RetailTrade	10%	1%	9%	1%	4%	7%	7%	0%	2%	1%	6%	2%	0%
17 RecPersSrvc	14%	1%	8%	1%	7%	15%	10%	0%	5%	1%	4%	4%	0%
18 Transport	8%	1%	8%	1%	3%	5%	6%	0%	2%	1%	4%	3%	0%
19 PostalSrvcs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20 Telecomms	3%	0%	3%	0%	4%	5%	3%	0%	1%	0%	1%	2%	0%
21 FinBusSrvces	10%	1%	11%	1%	7%	13%	8%	0%	4%	1%	7%	4%	0%
22 PubAdmDef	25%	1%	14%	1%	12%	20%	12%	0%	2%	0%	10%	11%	0%
23 Education	15%	1%	11%	0%	8%	9%	7%	0%	4%	0%	8%	6%	0%
24 Community	36%	3%	26%	3%	16%	24%	19%	0%	11%	3%	18%	8%	0%

Table 5.9: NBN impact for electronic commerce in the *modest* service access-speed requirements scenario (2.5Mbps min. download and 0.256Mbps min. upload) in percent of businesses turnover by industry and region

Industry	Greater Sydney	Rest of NSW	Greater Melbourne	Rest of Vic.	Greater Brisbane	Rest of Qld	Greater Adelaide	Rest of SA	Greater Perth	Rest of WA	Tasmania	Northern Territory	Australian Capital Territory
1 AgriForFish	4%	45%	11%	46%	11%	33%	14%	46%	4%	43%	35%	16%	0%
2 Mining	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3 FoodDrinkTob	1%	1%	3%	1%	2%	1%	0%	0%	0%	1%	0%	0%	0%
4 TCFs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 MiscManuf	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6 WoodProds	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7 PaperPrint	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
8 ChemCoalPrds	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9 NonMetMinPrd	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 MetalPrds	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11 TransEqp	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12 OthMachEqp	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13 EGW	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14 Construction	1%	1%	1%	1%	0%	1%	1%	2%	0%	1%	3%	0%	0%
15 WholesalTrad	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16 RetailTrade	1%	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
17 RecPersSrvc	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
18 Transport	1%	0%	1%	1%	0%	1%	0%	1%	0%	1%	0%	0%	0%
19 PostalSrvcs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20 Telecomms	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
21 FinBusSrvces	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
22 PubAdmDef	2%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
23 Education	1%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
24 Community	1%	0%	2%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%

Table 5.10: NBN impact for electronic commerce in the *high* service access-speed requirements scenario (10Mbps min. download and 2.5Mbps min. upload) in percent of businesses turnover by industry and region

Industry	Greater Sydney	Rest of NSW	Greater Melbourne	Rest of Vic.	Greater Brisbane	Rest of Qld	Greater Adelaide	Rest of SA	Greater Perth	Rest of WA	Tasmania	Northern Territory	Australian Capital Territory
1 AgriForFish	40%	68%	52%	74%	32%	52%	75%	64%	46%	58%	59%	26%	4%
2 Mining	5%	5%	6%	6%	3%	8%	6%	4%	4%	3%	5%	2%	3%
3 FoodDrinkTob	38%	27%	56%	35%	25%	33%	48%	20%	31%	28%	36%	15%	8%
4 TCFs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5 MiscManuf	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6 WoodProds	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7 PaperPrint	0%	0%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%
8 ChemCoalPrds	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	1%
9 NonMetMinPrd	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 MetalPrds	2%	1%	2%	2%	1%	2%	2%	1%	1%	1%	1%	1%	1%
11 TransEqp	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
12 OthMachEqp	1%	1%	1%	1%	0%	1%	1%	0%	1%	0%	1%	0%	0%
13 EGW	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	1%	0%
14 Construction	18%	20%	18%	22%	7%	26%	20%	17%	9%	12%	24%	10%	1%
15 WholesalTrad	5%	5%	5%	4%	3%	8%	6%	4%	3%	3%	4%	2%	3%
16 RetailTrade	13%	13%	13%	14%	7%	19%	13%	16%	11%	13%	13%	8%	3%
17 RecPersSrvc	21%	16%	13%	11%	11%	29%	18%	12%	16%	13%	7%	7%	8%
18 Transport	11%	16%	13%	20%	7%	18%	14%	26%	10%	17%	10%	7%	2%
19 PostalSrvcs	1%	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%	0%	0%
20 Telecomms	6%	2%	5%	3%	4%	11%	5%	3%	7%	5%	1%	5%	1%
21 FinBusSrvces	16%	12%	18%	13%	10%	28%	18%	12%	15%	10%	11%	10%	3%
22 PubAdmDef	35%	16%	22%	15%	19%	41%	29%	29%	21%	14%	27%	26%	6%
23 Education	21%	12%	19%	9%	11%	21%	15%	7%	13%	9%	13%	13%	5%
24 Community	47%	35%	42%	30%	22%	53%	39%	27%	33%	29%	28%	20%	5%

5.4 Service parameters of economic benefit

In this section, we describe the actual values in terms of the economic benefits of services which we have derived from the literature. Table 5.11 summarises the services included in this thesis and their quantifiable economic benefits published in earlier economic analyses of past data, surveys or other data. In the remaining section, we describe the benefits we have adopted from the literature and include the estimates we have used to derive the inputs to the economic model in chapter 6.

Table 5.11: Direct impact of services included in this thesis

Service group	Description	Impact	Source
Cloud computing	The use of public cloud by small and medium enterprises	Reduced ICT capital and operational expenditures	KPMG (2012)
Electronic commerce	Companies using electronic banking and electronic government and the internet to receive and provide after-sales services, online supply chain activities (e.g. order tracking, logistics)	Productivity improvements	Atrostic and Nguyen (2006), Rincon-Aznar et al. (2005)
Electronic education	Interactive learning online at public universities	Space cost savings	Bowen et al. (2012), Griffiths et al. (2014)
Telehealth practice	Tele-monitoring elderly with particular chronic diseases	Reduced health system expenditure	Access Economics (2010a)
Telehealth practice	Teleconsulting by patients with a clinician	As above	Bartlett et al. (2010)
Telehealth practice	Teleconsulting between doctors and specialists	As above	Cusack et al. (2007)
Telehealth practice	Broadband-enabled locations (microclinics) in regional areas with two general practitioners	Reduced health system expenditure in regional areas	Capps (2009)
Telework	Formal arrangement whereby an employee leverages technology including broadband to work from home one or more days every week	Productivity improvements, employee retention, and other forms of competitive advantage	Bentley et al. (2013), England (2012)
Telework	As above	Employment opportunities for those who have a mobility limitation	Deloitte Access Economics and Colmar Brunton (2012)

Cloud computing

Our estimates of the economic benefits of cloud services were based on an earlier study conducted by KPMG (2012). Table 5.12 shows estimated percentages of operating and capital expenditure as a cost share of ICT by industry. The percentages shown for each sector of the economy under the base case indicate higher cost shares of ICT compared to the 50% and 75% public cloud take-up scenarios.

Table 5.12: KPMG assumptions of businesses' ICT expenditure (operational and capital) by economic sector

Sector	Cost shares of ICT					
	Opex	Capex	Opex	Capex	Opex	Capex
	Base Case		75% take up		50% take up	
Agriculture, forestry and fishing	0.2%	1.3%	n/c	n/c	n/c	n/c
Mining	0.4%	3.2%	0.4%	2.3%	0.4%	2.6%
Manufacturing	1.3%	9.1%	1.2%	6.7%	1.2%	7.5%
Electricity, gas and water	0.3%	8.2%	0.3%	6.0%	0.3%	6.8%
Construction	1.2%	9.8%	1.0%	7.2%	1.1%	8.1%
Wholesale trade	1.7%	17.8%	1.5%	13.1%	1.5%	14.7%
Retail trade	0.6%	16.4%	0.5%	12.1%	0.6%	13.5%
Accomm., cafes and restaurants	1.5%	2.5%	1.3%	1.9%	1.3%	2.1%
Transport	4.0%	4.9%	3.5%	3.6%	3.6%	4.0%
Communication services	6.0%	31.4%	5.2%	23.1%	5.4%	25.9%
Finance and insurance	1.6%	31.1%	1.4%	22.9%	1.5%	25.6%
Property and business services	2.3%	22.4%	2.0%	16.5%	2.1%	18.5%
Government admin. and defence	4.6%	37.2%	4.0%	27.5%	4.2%	30.7%
Education	2.3%	11.4%	2.0%	8.4%	2.1%	9.4%
Health and community services	0.5%	15.7%	0.4%	11.6%	0.4%	13.0%
Cultural and recreational services	1.8%	7.9%	1.6%	5.8%	1.6%	6.5%
Personal and other services	2.1%	7.7%	1.8%	5.7%	1.9%	6.3%
Ownership of dwellings	0.0%	0.0%	n/c	n/c	n/c	n/c
Total	**1.7%**	**9.9%**	**1.5%**	**7.4%**	**1.6%**	**8.2%**

Source: KPMG (2012), Table 6, p. 32

The cost shares of ICT in terms of operational and capital expenditure in sectors such as agriculture, forestry, fishing and ownership of dwelling are forecast to not change (n/c) with the take up of cloud computing.

In this thesis, we have adopted the cost shares of ICT with 50% take-up of public cloud services. That is, the percentage cost savings resulting from the uptake of cloud computing within each industry group were derived as the difference between the percentages shown in the base case and the 50% take up columns for operational and capital expenditure shown in Table 5.12.

To allocate the cost shares of ICT to the industry groups in the economic model database, we had to map the industry groups in the economic model database to the industry sectors shown in Table 5.12. The mapped industries are shown in Table 5.13.

Table 5.13: Industry groups in the economic model database mapped to industry sectors

Industry sector	Economic model industry group
Agriculture, forestry and fishing	Agriculture, forestry and fishing
Mining	Mining

Industry sector	Economic model industry group
	Textiles, clothing and footwear
	Miscellaneous manufacturing
	Wood and wood products
	Paper and printing
	Chemicals and coal products
	Non-metallic mineral products
	Metal products
	Transport equipment
Manufacturing	Other machinery and equipment
Electricity, gas and water	Electricity, gas and water
Construction	Construction
Wholesale trade	Wholesale trade
Retail trade	Retail Trade
Accomm., cafes and restaurants	Food, beverages and tobacco
Transport	Transport and storage
	Postal services
Communication services	Telecommunication services
Finance and insurance	Finance and business services
Property and business services	Finance and business services
Government admin. and defence	Public admin. and defence
Education	Education
Health and community services	Health, welfare and community services
Cultural and recreational services	Health, welfare and community services
Personal and other services	Health, welfare and community services
Ownership of dwellings	Finance and business services

For economic model industry groups mapped to one industry sector, we have assumed the same ICT cost shares. The average cost shares of ICT were used for one economic model industry group mapped to multiple industry sectors. For example, the ICT cost shares in the base case for Finance and business services is 19.1%. It is estimated as the average of the ICT operating and capital expenditure cost shares of the Finance and insurance (1.6%+31.1%), Property and business services (2.3%+22.4%), and Ownership of dwellings (0%) sectors. The resulting estimates of ICT cost shares for each economic model industry group in the base case and 50% public cloud take-up scenario are summarised in Table 5.14.

Table 5.14: Cost shares of ICT by industry group

Economic model industry group	Base Case	50% take up
Agriculture, forestry and fishing	1.5%	1.5%
Mining	3.6%	3.0%
Food, beverages and tobacco	4.0%	3.4%
Textiles, clothing and footwear	10.4%	8.7%
Miscellaneous manufacturing	10.4%	8.7%
Wood and wood products	10.4%	8.7%
Paper and printing	10.4%	8.7%
Chemicals and coal products	10.4%	8.7%

Non-metallic mineral products	10.4%	8.7%
Metal products	10.4%	8.7%
Transport equipment	10.4%	8.7%
Other machinery and equipment	10.4%	8.7%
Electricity, gas and water	8.5%	7.1%
Construction	11.0%	9.2%
Wholesale trade	19.5%	16.2%
Retail trade	17.0%	14.1%
Recreation and personal services	4.0%	3.4%
Transport and storage	8.9%	7.6%
Postal services	37.4%	31.3%
Telecommunication services	37.4%	31.3%
Finance and business services	19.1%	15.9%
Public admin. and defence	41.8%	34.9%
Education	13.7%	11.5%
Health, welfare and community services	11.9%	9.9%

We have then derived the percentage change through cloud implementation in traditional ICT expenditure as follows:

$$\Delta\%(\text{savings})\text{ICT Expenditure}_{\text{Industry}} = \%\text{ICT Cost Shares Base Case}_{\text{Industry}} - \begin{matrix}\%\text{ICT Cost Shares}\\ \text{Cloud (50\% take up)}\end{matrix}_{\text{Industry}} \qquad (1)$$

where

$\Delta\%(\text{savings})\text{ICT Expenditure}_{\text{Industry}}$ is estimated percentage change in traditional ICT expenditure by industry;

$\%\text{ICT Cost Shares Base Case}_{\text{Industry}}$ is businesses' operational and capital ICT expenditures without cloud implementation as a proportion of total expenditure by industry, from Table 5.14; and

$\begin{matrix}\%\text{ICT Cost Shares}\\ \text{Cloud (50\% take up)}\end{matrix}_{\text{Industry}}$ is businesses' operational and capital ICT expenditure after cloud implementation in 50% of firms as a proportion of total expenditure by industry, from Table 5.14.

On the right hand side of equation (1), we have subtracted the industry cost shares of ICT in the future without cloud implementation from the industry cost shares of ICT in the future with public cloud services implemented in 50% of small and medium businesses. Table 5.15 shows the resulting estimates of the savings in traditional ICT expenditure for each industry.

Table 5.15: Savings in traditional ICT expenditure by industry

Economic model industry group	ICT savings (%)
Agriculture, forestry and fishing	0.0%

Economic model industry group	ICT savings (%)
Mining	0.6%
Food, beverages and tobacco	0.6%
Textiles, clothing and footwear	1.7%
Miscellaneous manufacturing	1.7%
Wood and wood products	1.7%
Paper and printing	1.7%
Chemicals and coal products	1.7%
Non-metallic mineral products	1.7%
Metal products	1.7%
Transport equipment	1.7%
Other machinery and equipment	1.7%
Electricity, gas and water	1.4%
Construction	1.8%
Wholesale trade	3.3%
Retail trade	2.9%
Recreation and personal services	0.6%
Transport and storage	1.3%
Postal services	6.1%
Telecommunication services	6.1%
Finance and business services	3.2%
Public admin. and defence	6.9%
Education	2.2%
Health, welfare and community services	2.0%

Electronic commerce

For an estimate of the economic benefits of electronic commerce, we have adopted the results from studies conducted by Atrostic and Nguyen (2006), and Rincon-Aznar et al. (2005) summarised in Table 5.16.

Table 5.16: Study results on the impact of productivity of electronic commerce on firm productivity

Industrial Sector	Study	E Business Impact on Firm Productivity	Share of Informational activities that involve external parties
Manufacturing	Atrostic and Nguyen (2006)	~5%	~25%
Services	Rincón-Aznar *et al.* (2006)	~10%	~50%
Information	Fornefeld *et al.* (2008)	~20%	100%

Source: ITU (2012), Table 5, p. 16

In Accordance with findings from Atrostic and Nguyen (2006) and Rincon-Aznar et al. (2005), we have assumed 5% productivity improvement in the manufacturing industries and 10% productivity improvement in the service industries. Table 5.17 shows the assumed improvements in the productivity of labour inputs for each industry.

Table 5.17: Productivity improvement of electronic commerce by industry

Industry	Industrial sector / economy's activity	Productivity improvement
1 AgriForFish	Extraction of raw materials (primary)	0%
2 Mining	Extraction of raw materials (primary)	0%
3 FoodDrinkTob	Manufacturing (secondary)	5%
4 TCFs	Manufacturing (secondary)	5%
5 MiscManuf	Manufacturing (secondary)	5%
6 WoodProds	Manufacturing (secondary)	5%
7 PaperPrint	Manufacturing (secondary)	5%
8 ChemCoalPrds	Manufacturing (secondary)	5%
9 NonMetMinPrd	Manufacturing (secondary)	5%
10 MetalPrds	Manufacturing (secondary)	5%
11 TransEqp	Manufacturing (secondary)	5%
12 OthMachEqp	Manufacturing (secondary)	5%
13 EGW	Services (tertiary)	10%
14 Construction	Services (tertiary)	10%
15 WholesalTrad	Services (tertiary)	10%
16 RetailTrade	Services (tertiary)	10%
17 RecPersSrvc	Services (tertiary)	10%
18 Transport	Services (tertiary)	10%
19 PostalSrvcs	Services (tertiary)	10%
20 Telecomms	Services (tertiary)	10%
21 FinBusSrvces	Services (tertiary)	10%
22 PubAdmDef	Services (tertiary)	10%
23 Education	Services (tertiary)	10%
24 Community	Services (tertiary)	10%

Online higher education

We have adopted estimates from Bowen et al. (2012) suggesting that a hybrid form in large introductory courses at public universities in which primary instruction is delivered to the students online (now commonly called "MOOCs") but with some physically face-to-face supervision "requires 67 percent to 75 percent less classroom use than the traditional course" (Bowen et al., 2012, p. 27). We have assumed that no additional classroom space, such as additional computer labs, is required in the hybrid course and derived the average space savings as follows:

$$\Delta\%(\text{savings})\text{Space} = \frac{\sum_{i=1}^{2} \Delta\%(\text{savings})\text{Space}_i}{2} \quad (2)$$

where

$\Delta\%(\text{savings})\text{Space}$ is percentage change of lecture space at universities;

$\Delta\%(\text{savings})\text{Space}_i$ is percentage change in classroom use of 67% and 75%, sourced from Bowen et al. (2012).

We have used the average space savings of 71% as an input to the economic model and treated as capital cost savings in tertiary education.

Telehealth practice

We have accounted for economic benefits resulting from the following four types of telehealth applications:

- telehealth intervention into existing aged care programs;
- health provider-to-provider teleconsulting;
- private patient communications with clinicians; and
- teleconsultation in broadband-enabled medical offices (microclinics) in remote areas between patients, general practitioners and specialists at a nearby hospital.

The economic benefits of telehealth interventions into existing aged care programs were based on estimates of the reduction in the cost of traditional health expenditure by Access Economics (2010a). We have adopted the assumptions made in the study conducted by Access Economics for telehealth interventions into existing aged care programs in a selection of sites with early access to the NBN. We then extrapolated the potential reduction in traditional health expenditure on a national scale ($\Delta\$(\text{savings})\text{Aged Care}$) as follows:

$$\Delta\$(\text{savings})\text{Aged Care} = \sum_{i=1}^{3}\{\#\text{Elderly Residents} \times \%\text{CD Prevalence}_i \times \left(\sum_{j=4}^{4} \%\text{Telehealth Effect}_j \times \$\text{CD Aged Care Expenditure}_{i,j} + \%\text{Telehealth Effect} \times \$\text{CD Informal Carer Cost}_i + \$\text{CD RAC Expenditure} - \sum_{k=1}^{3} \$\text{Intervention Cost}_k \right)\} \quad (3)$$

where

$\Delta\$(\text{savings})\text{Aged Care}$ is reduction in traditional healthcare expenditure through telehealth intervention in aged care, in $AU;

$\#\text{Elderly Residents}$ is number of persons usually resident aged 65 and older, sourced from the ABS;

$\%\text{CD Prevalence}$ is occurrence of chronic disease, such as cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD) and diabetes, in persons aged 65 and older in percent, sourced from Australian Institute of Health and Welfare (Begg et al., 2007);

$\%\text{Telehealth Effect}_j$ is percentage change in hospital, medical services, pharmaceuticals and other health system expenditure for aged care associated with CVD, COPD and diabetes, sourced from Access Economics (2010a);

$\$\text{CD Aged Care Expenditure}_{i,j}$ is annual health system expenditure for aged care associated with CVD, COPD and diabetes, such as hospitals, medical services and pharmaceuticals, per capita;

$\%\text{Telehealth Effect}$ is reduction in carer hours per week in percent, sourced from Access Economics (2010a);

$\$\text{CD Informal Carer Cost}_\text{i}$ is annual cost of informal care for people aged 65 and older with CVD, COPD or diabetes per person in $AU, sourced from Access Economics (2010a);

$\$\text{CD RAC Expenditure}$ is reduction in residential aged care (RAC) and formal sector community care services expenditure for people aged 65 and older with CVD, COPD or diabetes per capita in $AU, sourced from Access Economics (2010a); and

$\$\text{Intervention Cost}_\text{k}$ is cost of the care coordinator, telehealth equipment and data transmission associated with telehealth interventions into existing aged care programs per capita in $AU, sourced from Access Economics (2010a).

We have excluded the impact of telehealth on transport costs because this was estimated for all Australians separately. The estimated reduction in traditional healthcare expenditure through telehealth intervention in aged care in Australia excluding the impact on transport is then approximately $AU 8.2 billion.

The economic benefits of health provider-to-provider teleconsulting were previously estimated by Cusack et al. (2007) in the United States. We have assumed that the economic benefits of health provider-to-provider teleconsulting are similar in Australia. Based on this assumption, we have derived the potential reduction in the cost of traditional health expenditure that is replaced with provider-to-provider tele-consulting ($\Delta\$(\text{savings})\text{Provider}$) as follows:

$$\Delta\$(\text{savings})\text{Provider} = \Delta\$\text{US}(\text{savings})\text{US Provider} \times \frac{\#\text{Population AU}}{\#\text{Population US}} \times \text{PPP} \times \text{Inflation} \quad (4)$$

where

$\Delta\$(\text{savings})\text{Provider}$ is reduction in traditional healthcare expenditure through provider-to-provider teleconsulting, in $AU;

$\Delta\$\text{US}(\text{savings})\text{US Provider}$ is reduction in the cost of traditional healthcare expenditure that is replaced with provider-to-provider teleconsulting in the United States of approximately $US 4.3 billion, sourced from Cusack et al. (2007);

$\#\text{Population US}$ is residential population in the United States as of 2011, approximately 312 million, sourced from U.S. Census Bureau (a);

$\#\text{Population AU}$ is estimated residential population in Australia as of 2011, approximately 21.5 million, sourced from the ABS (2011b);

PPP is purchasing power parity for Australia as of 2011, 1.51, sourced from the OECD (a); and

Inflation is inflation rate multiplier 1.09 (2008-2011), sourced from the website www.rateinflation.com.

The estimated reduction in traditional healthcare expenditure through provider-to-provider teleconsulting in Australia is then approximately $AU 487 million.

Secure, private communications with clinicians will enable more effective participation in disease management programs and avoid unnecessary visits to a clinic (Bartlett et al., 2010). We have estimated the economic benefits of secure, private communications with clinicians as follows:

$$\Delta\$(\text{savings})\text{Private} = \frac{\Delta\$(\text{savings})\text{Private}}{\Delta\$(\text{savings})\text{Patient SM}} \times \Delta\$(\text{savings})\text{Patient SM} \tag{5}$$

where

$\Delta\$(\text{savings})\text{Private}$ is reduction in traditional healthcare expenditure through secure, private communications with clinicians, in $AU;

$\frac{\Delta\$(\text{savings})\text{Private}}{\Delta\$(\text{savings})\text{Patient SM}}$ is ratio of reduction in traditional healthcare expenditure through secure, private communications with clinicians, in $AU, to reduction in traditional healthcare expenditure through patient self-management, in $AU, which we have assumed to be 0.5;

$\Delta\$(\text{savings})\text{Patient SM}$ is $AU 900 million annual value through patient self-management, including secure, private communications with clinicians, sourced from Bartlett et al. (2010).

The estimated reduction in traditional healthcare expenditure through secure, private communications with clinicians is then $AU 450 million.

For teleconsultation in broadband-enabled microclinics between patients, general practitioners and specialists at a nearby hospital, we have derived the economic benefits as follows:

$$\Delta\%(\text{savings})\text{Microclinics} = 50\% \tag{6}$$

where

$\Delta\%(\text{savings})\text{Microclinics}$ is percentage change of per-patient cost of a full hospital through the use of telehealth in broadband-enabled microclinics in remote areas, sourced from Capps (2009).

In accordance with the results of the trial conducted by Kaiser Permanente in regional areas in the United States reported by Capps (2009), we have assumed that the per-patient cost at a broadband-enabled microclinic or, alternatively, a telehealth kiosk[19] outside metropolitan and inner regional Australia, is half that of acute care institutions. Acute care institutions refer to acute care hospitals, free-standing hospices, alcohol and drug treatment centres, and same-day establishments except activities involving health research and formal health education (ABS, 2010c). In other words, the reduction in traditional health expenditure for acute care institutions outside metropolitan and inner regional Australia was assumed to be 50%, subject to service availability.

[19] See for example American Well's virtual healthcare kiosk described on the website under the following link (last accessed 2 June 2016): https://www.americanwell.com/telemedicine-kiosk/.

Transport

We have estimated the potential reduction in household spending on transport services through secure, private patient communications with clinicians replacing in-person physician visits. We have adopted findings from Yamamoto (2014) in terms of the success rate of telehealth and alternative sites of care for patients choosing telehealth, and estimates of private transport expenditure from Deloitte Access Economics (2013). We then used our estimates of number of persons usually resident by region and statistical remoteness area that benefit from the NBN as shown in Tables 5.18 and 5.19 to derive the reduction in the cost of traditional transport expenditure ($\Delta\$(\text{savings})\text{PrivateTeleconsultation}_{\text{Region}}$) as follows:

$$\Delta\$(\text{savings})\text{Private Teleconsultation}_{\text{Region}} = \sum_{\text{Remoteness Area}=1}^{5}\Big(\#\text{Residents}(\text{NBN impact on service delivery})_{\text{Region,Remoteness Area}} \times \#\text{Telehealth Visits} \times \%\text{Resolved} \times \%\text{Alternative site of care} \times \$\text{Single Car Trip}_{\text{Remoteness Area}} \times 2\Big) \quad (4)$$

where

$\Delta\$(\text{savings})\text{Private Teleconsultation}_{\text{Region}}$ is reduction in household spending on transport services, in $AU;

$\#\text{Residents}(\text{NBN impact on service delivery})_{\text{Region,Remoteness Area}}$ is number of persons usually resident by region and statistical remoteness area that reduce consumption of transport services with the NBN from Tables 5.18 and 5.19;

$\#\text{Telehealth Visits}$ is average number of telehealth visits in a year, 1.3 per patient, sourced from Yamamoto (2014);

$\%\text{Resolved}$ is proportion of patients whose health condition was resolved during the telehealth visit, 83%, sourced from Yamamoto (2014);

$\%\text{Alternative site of care}$ is proportion of patients choosing telehealth who would otherwise have travelled to an alternative site of care, 87.7%, less the standard deviation of 3.7% related to the proportion of people who are doing nothing, which accounts for a conservative estimate, sourced from Yamamoto (2014); and

$\$\text{Single Car Trip}_{\text{Remoteness Area}}$ is out-of-pocket costs per one-way car trip by statistical remoteness area, in $AU, from Table 5.20; we have assumed that 2 one-way trips have been avoided by teleconsultation.

Table 5.18: Persons usually resident that benefit from secure, private patient communications with clinicians with the NBN in the modest service-requirements scenario by region and remoteness area

Region	Major Cities of Australia	Inner Regional Australia	Outer Regional Australia	Remote Australia	Very Remote Australia
Greater Sydney	49,154	2,970	0	0	0

Rest of NSW	5,588	41,146	27,739	1,094	0
Greater Melbourne	75,925	10,100	0	0	0
Rest of Vic.	1,453	36,007	13,653	22	0
Greater Brisbane	26,174	7,595	606	246	0
Rest of Qld	1,189	19,399	17,173	5,501	964
Greater Adelaide	5,110	1,052	0	0	0
Rest of SA	0	8,990	6,540	1,528	705
Greater Perth	4,122	2,364	0	0	0
Rest of WA	0	8,022	6,240	1,067	5,576
Tasmania	0	23,500	20,502	535	0
Northern Territory	0	0	219	2,220	2,485
Australian Capital Territory	14	0	0	0	0
Total	168,729	161,146	92,673	12,213	9,730

Table 5.19: Persons usually resident that benefit from secure, private patient communications with clinicians with the NBN in the high service-requirements scenario by region and remoteness area

Region	Major Cities of Australia	Inner Regional Australia	Outer Regional Australia	Remote Australia	Very Remote Australia
Greater Sydney	1,937,817	76,115	0	0	0
Rest of NSW	771,310	1,154,160	304,193	18,114	2,227
Greater Melbourne	2,003,740	110,043	0	0	0
Rest of Vic.	169,522	790,188	180,190	1,118	0
Greater Brisbane	1,163,129	98,542	4,158	1,273	0
Rest of Qld	335,011	703,155	551,910	49,146	13,498
Greater Adelaide	769,963	20,446	0	0	0
Rest of SA	0	92,512	159,324	29,224	4,716
Greater Perth	1,480,697	27,767	0	0	0
Rest of WA	0	156,326	148,812	73,002	20,277
Tasmania	0	322,055	130,447	6,104	0
Northern Territory	0	0	120,086	35,491	5,767
Australian Capital Territory	576	36	0	0	0
Total	8,631,766	3,551,346	1,599,121	213,471	46,485

Table 5.20: Out-of-pocket costs per car trip ($AU, one way)

Destination	Metropolitan	Inner Regional	Outer Regional	Remote
Doctor/ Department of Human Services	5.20	9.40	19.20	29.00

Source: Deloitte Access Economics (2013), p. 55

The resulting estimates of the potential reduction in household spending on transport services through secure, private patient communications with clinicians replacing in-person physician visits are shown in Table 5.21.

Table 5.21: Reduction in travel costs and household spending on transport

Region	Avoided travel costs (million $AU)
Greater Sydney	17.4
Rest of NSW	34.3
Greater Melbourne	18.5
Rest of Vic.	19.0
Greater Brisbane	11.4
Rest of Qld	33.5
Greater Adelaide	6.8
Rest of SA	7.9
Greater Perth	12.8
Rest of WA	11.3
Tasmania	9.2
Northern Territory	5.6
Australian Capital Territory	0
Total	**187.7**

The total reduction in household spending on transport services through secure, private patient communications with clinicians replacing in-person physician visits is then approximately $AU 187.7 million.

Teleworking

Our estimates of the economic benefits of telework were based on two impacts: the first is the improvement in the productivity of labour inputs; the second is greater labour-force participation.

For the first change, we have combined the increased productivity of teleworkers compared to non-teleworkers found in a study by Bentley et al. (2013) with the costs and benefits of telework implementation at organisations suggested by England (2012). We have assumed that the sample data published by England (2012) for a three-year business telework implementation project are representative of the averages across all organisations and industries. We have estimated the benefits of telework implementation as follows:

Recruitment savings

$$\Delta\%(\text{savings})\text{Recruitment}_{\text{Industry}} = \Delta\%(\text{average})\text{Recruitment savings} \times \Delta\%(\text{savings})\text{Turnover} \times \left(1 - \%\text{Home ICT policy}_{\text{Industry}}\right) \times \%\text{Employer flexibility} \quad (5)$$

where

$\Delta\%(\text{savings})\text{Recruitment}$ is reduction in recruitment costs by industry, in percent;

$\Delta\%(\text{average})\text{Recruitment savings}$ is average recruitment costs including recruitment, training and retention of approximately 36.7%, sourced from England (2012);

$\Delta\%(\text{savings})\text{Turnover}$ is reduction in recruitment costs assuming 10% turnover saved company-wide, sourced from England (2012);

$\%\text{Home ICT policy}_{\text{Industry}}$ is businesses allowing their employees to use ICT so that they can work from home by industry, in percent, from Table 5.22;

$\%\text{Employer flexibility}$ is businesses that will definitely (6%), or are likely to (15%), change their employment model because of the NBN, in percent, sourced from Deloitte Access Economics and Colmar Brunton (2012).

Table 5.22 shows the mapping of businesses allowing their employees to use ICT so that they can work from home to the industries in the economic model database. We have used averages of respective Australian and New Zealand Standard Industrial Classification (ANZSIC) industry subdivisions.

Table 5.22: Mapped industries and the percentages of businesses allowing their employees to use ICT so that they can work from home

Industry	ANZSIC Industry Division/Subdivision	Businesses allowing their employees to use ICT so that they can work from home
1 AgriForFish	A - Agriculture, Forestry and Fishing (01, 02, 03, 04, 05)	21%
2 Mining	B – Mining (06, 07, 08, 09, 10)	46%
3 FoodDrinkTob	45 - Food and Beverage Services	20%
4 TCFs	13 - Textile, Leather, Clothing and Footwear Manufacturing	27%
5 MiscManuf	11 - Food Product Manufacturing; 12 - Beverage and Tobacco Product Manufacturing; 19 - Polymer Product and Rubber Product Manufacturing	40%
6 WoodProds	14 - Wood Product Manufacturing	25%
7 PaperPrint	16 - Printing (including the Reproduction of Recorded Media); 54 - Publishing (except Internet and Music Publishing)	29%
8 ChemCoalPrds	11 - Food Product Manufacturing; 12 - Beverage and Tobacco Product Manufacturing; 19 - Polymer Product and Rubber Product Manufacturing; 14 - Wood Product Manufacturing; 16 - Printing (including the Reproduction of Recorded Media); 54 - Publishing (except Internet and Music Publishing); 20 - Non-Metallic Mineral Product Manufacturing; 20 - Non-Metallic Mineral Product Manufacturing; 21 - Primary Metal and Metal Product Manufacturing; 22 - Fabricated Metal Product Manufacturing; 23 - Transport Equipment Manufacturing; 24 - Machinery and Equipment Manufacturing; 25 - Furniture and Other Manufacturing	32%
9 NonMetMinPrd	20 - Non-Metallic Mineral Product Manufacturing	19%

10 MetalPrds	21 - Primary Metal and Metal Product Manufacturing; 22 - Fabricated Metal Product Manufacturing	32%
11 TransEqp	23 - Transport Equipment Manufacturing	50%
12 OthMachEqp	24 - Machinery and Equipment Manufacturing; 25 - Furniture and Other Manufacturing	30%
13 EGW	D - Electricity, Gas, Water and Waste Services (26, 27, 28, 29)	45%
14 Construction	E – Construction (30, 31, 32)	27%
15 WholesalTrad	F - Wholesale Trade (33, 34, 35, 36, 37, 38)	39%
16 RetailTrade	G - Retail Trade (39, 40, 41, 42, 43); 94 - Repair and Maintenance	18%
17 RecPersSrvc	44 – Accommodation; R - Arts and Recreation Services (89, 90, 91, 92); 95 - Personal and Other Services	29%
18 Transport	46 - Road Transport; 47 - Rail Transport; 48 - Water Transport; 49 - Air and Space Transport; 50 - Other Transport	47%
19 PostalSrvcs	51 - Postal and Courier Pick-up and Delivery Services	13%
20 Telecomms	58 - Telecommunications Services	58%
21 FinBusSrvces	K - Financial and Insurance Services (62, 63, 64); M - Professional, Scientific and Technical Services (69, 70)	62%
22 PubAdmDef	N - Administrative and Support Services (72, 73)	39%
23 Education	69 - Professional, Scientific and Technical Services (Except Computer System Design and Related Services)	49%
24 Community	Q - Health Care and Social Assistance (84, 85, 86, 87)	31%

The resulting recruitment savings are shown in Table 5.23.

Table 5.23: Recruitment savings by industry

Industry	Recruitment savings
1 AgriForFish	0.61%
2 Mining	0.42%
3 FoodDrinkTob	0.62%
4 TCFs	0.56%
5 MiscManuf	0.46%
6 WoodProds	0.58%
7 PaperPrint	0.55%
8 ChemCoalPrds	0.52%
9 NonMetMinPrd	0.62%
10 MetalPrds	0.53%
11 TransEqp	0.38%
12 OthMachEqp	0.54%
13 EGW	0.42%
14 Construction	0.56%
15 WholesalTrad	0.47%
16 RetailTrade	0.63%
17 RecPersSrvc	0.55%
18 Transport	0.41%
19 PostalSrvcs	0.67%
20 Telecomms	0.32%

21 FinBusSrvces	0.29%
22 PubAdmDef	0.47%
23 Education	0.39%
24 Community	0.53%

Operational benefits

$$\Delta\%(\text{savings})\text{Operational benefits}_{\text{Industry}} = \frac{\sum_{i=1}^{3} \Delta\%(\text{savings})\text{Operational benefits}_i}{3} \times \left(1 - \%\text{Home ICT policy}_{\text{Industry}}\right) \times \%\text{Employer flexibility} \quad (7)$$

where

$\Delta\%(\text{savings})\text{Operational benefits}_{\text{Industry}}$ is reduction in operational expenditure by industry, in percent;

$\Delta\%(\text{savings})\text{Operational benefits}_i$ is operational benefits of 0% in the first year of the telework implementation project and 4% in subsequent years, sourced from England (2012);

$\%\text{Home ICT policy}_{\text{Industry}}$ is businesses allowing their employees to use ICT so that they can work from home by industry, in percent, from Table 5.22;

$\%\text{Employer flexibility}$ is businesses that will definitely (6%), or are likely to (15%), change their employment model because of the NBN, in percent, sourced from Deloitte Access Economics and Colmar Brunton (2012).

The resulting operational benefits are shown in Table 5.24.

Table 5.24: Operational benefits by industry

Industry	Operational benefits
1 AgriForFish	0.44%
2 Mining	0.30%
3 FoodDrinkTob	0.45%
4 TCFs	0.41%
5 MiscManuf	0.34%
6 WoodProds	0.42%
7 PaperPrint	0.40%
8 ChemCoalPrds	0.38%
9 NonMetMinPrd	0.45%
10 MetalPrds	0.38%
11 TransEqp	0.28%
12 OthMachEqp	0.39%
13 EGW	0.31%
14 Construction	0.41%
15 WholesalTrad	0.34%
16 RetailTrade	0.46%
17 RecPersSrvc	0.40%

18 Transport	0.30%
19 PostalSrvcs	0.49%
20 Telecomms	0.23%
21 FinBusSrvces	0.21%
22 PubAdmDef	0.34%
23 Education	0.28%
24 Community	0.39%

Potential productivity gain

$$\Delta\%(\text{savings})\text{Labour} = \Delta\%(\text{increase})\text{Efficieny} \times (\%\text{Teleworkers Y2020} - \%\text{Teleworkers Y2006}) \quad (6)$$

where

$\Delta\%(\text{savings})\text{Labour}$ is improvement in the productivity of labour inputs;

$\Delta\%(\text{increase})\text{Efficieny}$ is average productivity advantage for teleworking employees of 9%, sourced from Bentley et al. (2013);

$\%\text{Teleworkers Y2020}$ is employees with telework arrangements by 2020 in percent according to the Government's telework target; and

$\%\text{Teleworkers Y2006}$ is employees with telework arrangements in percent, sourced from Deloitte Access Economics and Colmar Brunton (2012);

The resulting improvement in the productivity of labour inputs is 0.54%.

Absenteeism saved

$$\Delta\%(\text{savings})\text{Absenteeism} = \frac{\$(\text{savings})\text{Absenteeism}}{\$\text{Salary}} \quad (8)$$

where

$\Delta\%(\text{savings})\text{Absenteeism}$ is reduction in an employee's intentional or habitual absence from work compared to a non-teleworking employee, in percent;

$\$(\text{savings})\text{Absenteeism}$ is \$AU 3,000 reduction in an employee's intentional or habitual absence from work compared to a non-teleworking employee, sourced from England (2012);

$\$\text{Salary}$ is average salary of \$AU 50,000 per employee, sourced from England (2012);

The resulting absenteeism saved for a teleworking employee compared to a non-teleworking employee is 6%.

We have estimated the costs of telework implementation as follows:

Shortfall of non-teleworkers

$$\Delta\%(\text{costs})\text{Shortfall}_{\text{Industry}} = \frac{\sum_{i=1}^{3} \Delta\%(\text{costs})\text{Shortfall}_i}{3} \times (1 - \%\text{Home ICT policy}_{\text{Industry}}) \times \%\text{Employer flexibility} \quad (9)$$

where

$\Delta\%(\text{costs})\text{Shortfall}_{\text{Industry}}$ is shortfall of non-teleworkers by industry, in percent;

$\Delta\%(\text{costs})\text{Shortfall}_i$ is shortfall of non-teleworkers of 5% in the first year of the telework implementation project and 3% in subsequent years, sourced from England (2012);

$\%\text{Home ICT policy}_{\text{Industry}}$ is businesses allowing their employees to use ICT so that they can work from home by industry, in percent, from Table 5.22;

$\%\text{Employer flexibility}$ is businesses that will definitely (6%), or are likely to (15%), change their employment model because of the NBN, in percent, sourced from Deloitte Access Economics and Colmar Brunton (2012).

The resulting shortfall of non-teleworkers is shown in Table 5.25.

Table 5.25: Shortfall of non-teleworkers

Industry	Shortfall
1 AgriForFish	0.61%
2 Mining	0.42%
3 FoodDrinkTob	0.62%
4 TCFs	0.56%
5 MiscManuf	0.46%
6 WoodProds	0.58%
7 PaperPrint	0.55%
8 ChemCoalPrds	0.52%
9 NonMetMinPrd	0.62%
10 MetalPrds	0.53%
11 TransEqp	0.38%
12 OthMachEqp	0.54%
13 EGW	0.42%
14 Construction	0.56%
15 WholesalTrad	0.47%
16 RetailTrade	0.63%
17 RecPersSrvc	0.55%
18 Transport	0.41%
19 PostalSrvcs	0.67%
20 Telecomms	0.32%
21 FinBusSrvces	0.29%
22 PubAdmDef	0.47%
23 Education	0.39%

24 Community	0.53%

Additional ICT costs for teleworker

$$\Delta\%(\text{costs})\text{Fitout} = \frac{\$(\text{costs})\text{ICT}}{\$\text{Salary}} \tag{10}$$

where

$\Delta\%(\text{costs})\text{Fitout}$ is additional ICT costs for teleworkers;

$\$(\text{costs})\text{ICT}$ is additional ICT costs of $AU 587 annually for people who telework once or twice per week, sourced from Access Economics (2010b);

$\$\text{Salary}$ is average salary of $AU 50,000 per employee, sourced from England (2012);

The resulting fit out for teleworkers is approximately 1.2%.

Consulting and training

$$\Delta\%(\text{costs})\text{Training} = \frac{\frac{\sum_{i=1}^{3} \$(\text{costs})\text{Training}_i}{3}}{(\$\text{Salary} \times \#\text{Teleworkers})} \tag{11}$$

where

$\Delta\%(\text{costs})\text{Training}$ is additional consulting and training costs for teleworkers, in percent;

$\$(\text{costs})\text{Training}_i$ is additional consulting and training costs for teleworkers of $AU 6,000 in the first year of the telework implementation project sample and $AU 2,000 in subsequent years, sourced from England (2012);

$\$\text{Salary}$ is average salary of $AU 50,000 per employee, sourced from England (2012); and

$\#\text{Teleworkers}$ is number of teleworkers in the telework implementation project sample provided by England (2012).

The resulting consulting and training costs for teleworkers is approximately 0.3%.

Work place changes (Churn)

$$\Delta\%(\text{costs})\text{Churn} = \frac{\sum_{i=1}^{3} \Delta\%(\text{costs})\text{Churn}_i}{3} \tag{12}$$

where

$\Delta\%(\text{costs})\text{Churn}$ is churn factor which refers the impact of work place changes on corporate productivity, in percent; and

$\Delta\%(\text{costs})\text{Churn}_i$ is churn factor of 20% in the first year of the telework implementation project sample and 0% in subsequent years, sourced from England (2012).

The resulting churn factor is approximately 6.7%.

To derive estimates of greater labour force participation, the second change we have modelled for telework, we have adopted projections from Deloitte Access Economics and Colmar Brunton (2012). We have derived the labour supply increase as follows:

$$\Delta\#\mathrm{FTE} = \sum_{i=1}^{3}(\#\mathrm{POP}_i \times \Delta\%\mathrm{Participation}_i \times \%\mathrm{FTE}_i) \tag{13}$$

where

> $\Delta\#\mathrm{FTE}$ is number of potential workers who increase participation in the labour force in full-time equivalent (FTE) terms;
>
> $\#\mathrm{POP}_i$ is more than 2.9 million mature workers, 3.2 million part-time workers and less than 3.7 million people outside the labour force of working age who would be likely to enter the labour force if they could telework, sourced from Deloitte Access Economics and Colmar Brunton (2012); and
>
> $\Delta\%\mathrm{Participation}_i$ is 6% of mature workers, 3% of part-time workers and 1% of those who are not in the labour force who have identified working from home as a labour force enabler without prompting, sourced from Deloitte Access Economics and Colmar Brunton (2012); and
>
> $\%\mathrm{FTE}_i$ is the labour supply increase of FTE equivalent mature workers (45%), part-time workers (23%) and those who are not in the labour force who have identified working from home as a labour force enabler without prompting (56%), sourced from Deloitte Access Economics and Colmar Brunton (2012).

The resulting number of workers who are willing to increase participation in the labour force is less than 310,000 or 122,037 FTEs. The projected telework opportunities are accompanied by the Government's telework target of doubling the telework rate from 6% to 12% by 2020 (Deloitte Access Economics and Colmar Brunton, 2012) providing three times more telework opportunities. The results from the employer flexibility survey in terms of changes to the employment model because of the NBN suggests that almost half of the employees are not sure or unlikely to change their employment model because of the NBN (Access Economics, 2010b). We think that there is a good argument for strong government support to overcome cultural and organisational resistance to change of the employment model with respect to telework arrangements. Given that the projections are well within the Government's telework target to have at least doubled telework by 2020, we have assumed that the projected labour supply increase will occur in its entirety when the service is available.

Online entertainment

Our estimates of the economic implications of greater access to online services were based on projections of increased cost of households' entertainment expenditure by 2020 from Deloitte Access Economics (2013). We have estimated the increased cost of households' entertainment expenditure as follows:

$$\Delta\$(\text{increase})\text{Online Services}_{\text{Region}} = (\$\text{HH EX Entertainment 2020} - \$\text{HH EX Entertainment 2010} \times 52) \times \#\text{HH 2010} \times \frac{\#\text{Residents}_{\text{Region}}}{\#\text{All Residents}} \quad (14)$$

where

$\Delta\$(\text{increase})\text{Online Services}_{\text{Region}}$ is estimated increase in the cost of households' entertainment expenditure through greater access to online services by region;

$\$\text{HH EX Entertainment 2020}$ is projected average household expenditure on entertainment in 2020 of $AU 1,522, sourced from Deloitte Access Economics (2013);

$\$\text{HH EX Entertainment 2010}$ is average household expenditure on entertainment in 2010 of $AU 22 per week, in $AU, sourced from Deloitte Access Economics (2013);

$\#\text{HH 2010}$ is projected total number of 8,555,475 households in 2011, which assumes a low rate of change in propensities (Series II), sourced from the ABS (2010d); and

$\frac{\#\text{Residents}_{\text{Region}}}{\#\text{All Residents}}$ are ratios from the third column in Table 5.26.

Table 5.26 shows the regional population and ratios required in equation (14).

Table 5.26: Regional population in 2011

Region	Residents	Residents (%)
Greater Sydney	4,391,674	20%
Rest of NSW	2,512,949	12%
Greater Melbourne	3,999,982	19%
Rest of Vic.	1,345,715	6%
Greater Brisbane	2,065,996	10%
Rest of Qld	2,253,725	11%
Greater Adelaide	1,225,235	6%
Rest of SA	368,261	2%
Greater Perth	1,728,867	8%
Rest of WA	502,594	2%
Tasmania	494,164	2%
Northern Territory	209,963	1%
Australian Capital Territory	357,332	2%
Total	**21,456,457**	**100%**

Source: Australian Bureau of Statistics (2011b)

The resulting increases in household spending on online services are shown in Table 5.27.

Table 5.27: Increases in entertainment expenditure and household spending on online services

Region	Additional entertainment costs (million $AU)
Greater Sydney	612.3
Rest of NSW	350.4
Greater Melbourne	557.7
Rest of Vic.	187.6
Greater Brisbane	288.1
Rest of Qld	314.2
Greater Adelaide	170.8
Rest of SA	51.3
Greater Perth	241.0
Rest of WA	70.1
Tasmania	68.9
Northern Territory	29.3
Australian Capital Territory	49.8
Total	**2,992**

Our estimate of increases in household spending on online services is about $AU 3 billion.

5.5 Economic Cost of the NBN

Our estimates of the economic cost of financing the NBN are based on the assumption that, with the NBN in place, it is necessary for Australia to have a balance of trade surplus to pay for the NBN. The trade surplus can be thought of as a payment arising from foreign investment in the NBN. That is, we have assumed foreign participation in the NBN will have no effect on foreign ownership or loans in some other project. An alternative approach might be to assume that the government adopts fiscal and monetary policy consistent with a given target for external liabilities. In this case, the government adjusts its macro policies so that expenditure on NBN construction crowds out private and/or public consumption. This assumption of zero effect on the balance of trade implies that any foreign participation in the NBN has crowded out foreign participation in some other project. With the NBN originally announced in large part to be funded by debt through the issuing of Australian Government Bonds (Minister for Broadband, Communications and the Digital Economy, 2009), and the trade balance assumed to be exogenous in the long-run model simulation, modelling the trade surplus is the more straightforward approach. We have estimated the required debt-servicing payments as amortised loan or mortgage payments according to Kohn (1990) as follows:

$$\Delta\$(\text{increase})\text{BoT} = \frac{\$\text{Peak Funding}\times(1+\%\text{Interest})^{\#\text{Payments}}}{(1+\%\text{Interest})^{\#\text{Payments}}-1} \tag{15}$$

where

$\Delta\$(\text{increase})\text{BoT}$ is estimated increase in the balance of trade in a typical long-run year in $AU (2010 prices);

$\$\text{Peak Funding}$ is NBN’s peak funding requirement of $AU 40.4 billion, sourced from the NBN Company (2013a);

$\%\mathrm{Interest}$ is long term interest rate paid on debt of 6.9%, sourced from the NBN Company (2013a); and

$\#\mathrm{Payments}$ is number of payments over an assumed period of 16 years.

With NBN peak funding of $AU 40.4 billion and an interest rate of 6.9%, equation (15) gives a required annual trade surplus of approximately $AU 4.2 billion than otherwise would have been required. Due to the uncertainty involved with regards to peak funding, interest rates and repayment period, the actual required annual trade surplus may vary, of course. Given our belief that the above assumptions reflect a conservative view on the costs involved in deploying and operating the NBN, we are of the view that our estimate of the required annual trade surplus provides a reasonable approximation of the NBN's likely economic costs.

5.6 Concluding Remarks

Studies from Department of Communications and the Arts (2014a) and Access Economics (2009) have derived benefits from the use of high-speed broadband that have little relation to services and their access-speed requirements. There is no published broadband impact study of the NBN that considers service requirements and the long-term benefits that arise from how it is put to use properly.

In this chapter, we have described our approach of considering the economic benefits arising from new services or new ways of working that are enabled by broadband and the NBN. We have only included services for which there is well-attested, published evidence of economic benefit. Our main contribution in this chapter is to derive estimates of the NBN incremental impact on service delivery using the results from our spatial analysis described in the previous chapter. That is, we have clearly distinguished between the economic situation in Australia in the long run without the NBN and with the NBN with the aim to elaborate the incremental impact of the NBN. In doing so, we have explored two broad scenarios for the future with respect to service requirements. In one, the services considered require only modest access speeds. In this case, an evolved broadband environment of the future without the NBN would be able to satisfy most service needs and the NBN will have only a marginal impact on service delivery. In the other arguably more likely scenario, the services require higher access speeds and the NBN has a significant impact on their delivery.

In the chapter that follows, we will derive the inputs to the economic model using the estimates of the economic benefit of the services and the NBN impact on service delivery considering both modest and high access-speed scenarios.

CHAPTER 6
THE ECONOMIC MODEL

6.1 Introduction

The framework we have adopted for estimating the economic impact of the NBN on Australian regions is TERM (The Enormous Regional Model) (Wittwer, 2012). TERM was originally developed for comparative-static analyses of Australian issues and builds on the ORANI model (Dixon et al., 1982). Both models belong to the Walras-Johansen (Walras, 1954) class of economy-wide models. General equilibrium models such as TERM and ORANI account for all the linkages between sectors and agents of an economy. These models link neo-classical production functions and price-responsive demand functions to an input-output or social accounting matrix. Quantities and prices are determined endogenously. The neoclassical production functions display constant elasticity of substitution (Solow, 1956) which implies that any change in the input factors results in the constant change in the output. Producers choose a combination of primary factor and intermediate inputs of goods and services that minimises cost. The intermediate input aggregate is a CES composite of different composite commodities. The composite commodities are a CES composite of imported and domestically produced commodities. The primary factors and intermediate inputs aggregates are each demanded in fixed proportions to industry output (Leontief assumption) similar to the example described in Allen (1967). Commodity outputs are derived from industry outputs according to the production possibilities of the firm as a function of different combination of supply activities. The constant elasticity of transformation (CET) production-possibility frontier (Powell and Gruen, 1968) mechanism follows the notion of the CES function and is calibrated by the multiproduction matrix in the database which shows the value of output of each commodity by each industry in each region. A more detailed description of the production structure and system of demand sourcing in TERM was published in Wittwer (2012).

Similar to the ORANI model (Dixon et al., 1982), there is a separate production function for capital in each industry. Units of fixed capital for industries are created by combining effective units of intermediate inputs according to a Leontief production function. The amount of commodities demanded by investment industries in a region is proportional to the industry investment level and varies across industries. For example, a given dollar increase in investment in agriculture will result in a greater increase in demand for tractors than a similar dollar increase in investment in the chemical industry. The actual composition is derived from the values given in the economic model database.

TERM provides industry-level disaggregation in a quantitative description of the whole economy. What distinguishes TERM from other CGE models is that it can handle a relatively large number of regions or sectors. This makes it a useful tool for examining the regional impacts of policy changes, particularly changes to the supply- or production-side of the economy that may be region-specific, such as the NBN, for example.

The non-linear equations and relationships in TERM are linearised following Johansen (1960), which greatly simplifies the implementation of the model. The variables in the linearised equations are written in terms of changes or percentage changes, as described in detail by Dixon and Rimmer (2002). A software package (Harrison et al., 2014) is then used to solve the linearised system of equations by matrix manipulations.

As noted earlier, TERM requires actual economic data to produce meaningful quantitative results. The input-output data is part of the Australian national accounts and provides the structure of the model database. In the input-output table, an industry's column shows its cost structure and a commodity's row shows its sales structure. The complete database depicts the economy's initial situation representing a particular year, which we will refer to as the base year. That is, the initial solution to the set of equations representing the theory of the model is embedded in the database.

In detailed CGE models, such as TERM, the number of equations (m) and variables (n) is quite large with many more variables than equations. To close the model and compute a solution, the number of endogenous variables must equal the number of equations. In other words, (n-m) variables must be treated as exogenous for the model closure to be valid (that is, the model has a unique solution). Model computations or simulations generate deviations away from an initial solution of the model equations. The choice of variables that are determined exogenously in the model closure specifies the economic environment, i.e. time horizon, under which a model simulation is run. We have specified the (n-m) exogenous variables in a typical short-run and long-run closure for the model to compute potential changes to the structure of the economy in a typical short-run and long-run year due to the NBN. The new values in the updated database are the results of the effects on the (m) endogenous variables due to changes in the (n-m) exogenous variables.

The basic tasks of a CGE-based analysis were discussed by Adams (2005). The derivation of the TERM model's theoretical structure and calibration, i.e. the construction of a balanced database and evaluation of the model coefficients, was done previously, documented in Wittwer (2012), and is not a subject of this study. In this chapter, we provide only a high-level overview of the framework of the economic model we have adopted and a brief discussion of the model's theoretical structure where necessary. Our emphasis in this chapter is on the TERM model modifications we have made for the purpose of this study. First, we have chosen the sectoral aggregation in the database at a size that can be easily managed by TERM, which would be slow to solve if a fully disaggregated sectoral and regional database were used (Wittwer, 2012). Second, we have included two new NBN "industries" and two corresponding commodities in the TERM database. Third, we ran a 'historical' model simulation with the original database of the 2005/2006 base year to approximate the structure of the economy in the financial year 2010/2011. We have chosen the base year for our thesis based on a representative or typical year prior to NBN deployment and the temporary mining boom. Fourth, we have added three variables to the set of equations in order to close the model and compute a solution in the historical simulation.

The four TERM model modifications are discussed in detail in the Appendix B. In the section that follows, we give a brief overview of the type of inputs that are required in the economic model and our approach to develop these inputs. In the remaining sections of this chapter, we describe which model variables we choose to set (exogenous) in the model closure rather than being determined by the model equations (endogenous), and the detailed inputs we have developed to describe the effects of the NBN.

6.2 Model Computations

The model equations describe the changes to the cells in the database in response to imposed changes in the values of the model's exogenous variables, which can be illustrated as follows:

$$New\ solution = (1 + \Delta\%) \times Initial\ solution \tag{1}$$

where

$New\ solution$ is deviations away from an initial solution of the set of model equations representing the theory of the model embedded in the database;

$\Delta\%$ is percentage change of at least one exogenous variable; and

$Initial\ solution$ is initial solution to the model equations in accordance with the base year data.

For the economic model to process deviations away from the initial solution, TERM requires entries in the form of a percentage change of at least one exogenous variable. The new solution in the form of an updated database represents the structure of the economy in a typical future year with the particular project or policy under consideration. Therefore, we need terms of the following form:

$$\Delta\% = \frac{\text{Change in value}}{\text{Initial value}} \times 100. \tag{2}$$

To modify the estimated percentage change into a form that represents the impact of the NBN, we have derived ratios including but not limited to the following:

- $\frac{\text{Regional}}{\text{National}}$ to estimate the change in value in a region from a national value, e.g. $\frac{\text{\#Premises passed 2015}_{\text{SydneyNSW}}}{\text{\#All Premises passed 2015}}$ as ratio of number of premises where work on the NBN is either planned or expected to commence by 30 Jun 2015 in Greater Sydney to total number of premises where work on the NBN is either planned or expected to commence by 30 Jun 2015, used in equation (7);

- $\frac{\text{Sub industry}}{\text{Industry}}$ to estimate the change in value for an industry from a sub-industry, e.g. $\frac{\text{\$Government OPEX on Tertiary Education}_{\text{Rest of NSW}}}{\text{\$Government OPEX on Education}_{\text{Rest of NSW}}}$ as ratio of government operating expenses on tertiary education in the rest of NSW to government operating expenses on education in the rest of NSW, in \$AU, used in equation (15);

- $\frac{\text{Commodity}}{\text{All comodities}}$ to estimate the change in value for a commodity from many commodities, e.g. $\frac{\text{\$ICT Production of ICT specialist industries}_{\text{Telecommunications}}}{\text{\$All ICT Production}}$ as ratio of ICT production of the "ICT specialist" industry Telecommunications to total ICT production of the "ICT specialist" industries, in \$AU, used in equation (10); and

- $\frac{\text{NBN impact indicator}}{\text{Total indicator}}$ to estimate the change of a value resulting from a new broadband-enabled service made more widely available through the NBN compared to the business as usual, e.g. $\frac{\#\text{Students(NBN impact on service delivery)}_{\text{Tasmania}}}{\#\text{Students}_{\text{Tasmania}}}$ as ratio of number of students subject to the NBN impact on service delivery in Tasmania to all students in Tasmania, used in equation (15).

To derive the percentage changes that represent the impact of the NBN in a form that is required by the economic model database, we needed to include a combination of the above ratios. Where the required ratio was not available from a publicly available source, we have used an approximate value in the form of ratios we have derived from a publicly available source.

In the following section, we briefly describe the changes we made to the TERM model and its database which we have adopted for the purpose of this thesis such as adding the NBN 'industries' and additional minor changes to the model equations.

6.3 Preparing the TERM model and its database

The master database developed by the Centre of Policy Studies (CoPS) includes hundreds of industries, commodities, regions, *et cetera*. In order to keep the solution time for the model to a reasonable value, we have chosen a sectoral aggregation and adopted the regional aggregation with the aim to retain sufficient detail for the impact analysis of the NBN on the economy. The regional aggregations were provided to us by CoPS and are shown in Table 4.2. The sectoral aggregations in the database adopted for this study are shown in Appendix B in Table B.1. For the impact analysis of the NBN on the economy in the short term, we have added two NBN-related industries, an 'NBN retail service' industry and an 'NBN wholesale service' industry to the TERM data structure, which we have described in more detail in Appendix B in sections B.1 and B.2.

The base year adopted for the present study is the financial year 2010/2011. It reflects the structure of the Australian economy in a typical year without the unusually steep increase in private capital expenditure in the Australian mining sector during subsequent years. More importantly, the economy was still largely unaffected by the roll-out of the NBN. Our approach to the historical simulation is described in more detail in Appendix B in section B.3.

We describe the model closure and the percentage changes that represent the impact of the NBN in a typical short-run and long-run year in the following two sections.

6.4 Model closures for the NBN impact simulations

In this section, we describe our approach to "close the model" and run NBN impact simulations by treating (n-m) variables as exogenous. Which of the (n-m) variables are treated as exogenous in the model closure determines the economic environment under which a model simulation is run. To be able to better relate to the resulting economic environment, we describe the main macroeconomic relationships in TERM using a stylised 'back-of-the-envelope' version of a typical CGE model as reference, following the approach of Dixon and Rimmer (2002): "Stylised models assist in identifying the principal theoretical mechanisms that underlie the projections from the full model" (Adams, 2005, p. 941). The stylised model we have adopted in this thesis is based on the simplified version of the BOTE-M model developed by Bohlmann (2011). Because of its simplicity, it captures the main macroeconomic relationships that apply equally in TERM and is useful in producing high-level results that are easily interpretable without losing any broad detail. It is also useful as a quick reference to the full model, without getting distracted by the details of the equations system, and providing insight for the interpretation of simulation results in the next chapter. To understand all features in TERM that might lead to results that are different to those suggested by the stylised model, it remains necessary to consider aspects of the full model's database and model theory.

According to the stylised model we have adopted, the value of real gross domestic product (GDP) from the expenditure side is defined as follows:

$$\mathrm{GPD} = \mathrm{C} + \mathrm{I} + \mathrm{G} + (\mathrm{X} - \mathrm{M}) \tag{3}$$

where

GPD is real gross domestic product, in \$AU;

C is private household consumption, in \$AU;

I is investment, in \$AU;

G is government expenditure, in \$AU;

X is exports, in \$AU; and

M is imports, in \$AU.

Total output in the economy or real GDP is related to inputs of capital (K) and labour (L), and a primary-factor productivity or technical change term (A) as shown in equation (4).

$$\mathrm{GPD} = \mathrm{A} \times \mathrm{f}_1(\mathrm{K}, \mathrm{L}) \tag{4}$$

where

GPD is real gross domestic product, in \$AU;

A is primary-factor productivity or technical change;

K is capital, in \$AU;

L is labour, in \$AU; and

$\mathrm{f}_1(\ldots)$ is a function of the variables in parentheses.

The rate of return on capital (RoR) is the ratio of the annual income from an investment to the original investment. We assume that the RoR can be expressed as follows:

$$\mathrm{RoR} = \frac{\mathrm{Q}}{\mathrm{PI}} \tag{5}$$

where

RoR is rate of return on capital;

Q is factor payment to capital; and

PI is price index for new investment.

Bohlmann (2011) assumes that the factor payment to capital (Q) in the form of an interest rate is determined by the value of the marginal product of capital as follows:

$$\mathrm{Q} = \mathrm{MPK} \times \mathrm{PY} \tag{6}$$

where

Q is factor payment to capital;

MPK is marginal product of capital; and

PY is price of economy-wide output.

PY may be interpreted as the GDP deflator, which measures the average price level of GDP. MPK represents the change in output per unit change in capital. Marginal product functions are homogenous of degree zero assuming that the production function in equation (4) is constant returns to scale. MPK can then be expressed as a function of the capital-labour ($\mathrm{K/L}$) ratio (negatively correlated) and technical change. $\mathrm{PY/PI}$ is a function of the terms of trade (TofT), that is the foreign-currency price of domestically produced exports relative to the price of imports. The above relationship can be summarised in the stylised model through the following equation:

$$\mathrm{RoR} = \mathrm{f_2}(\frac{\mathrm{K}}{\mathrm{L}}, \mathrm{TofT}, \mathrm{A}) \tag{7}$$

where

RoR is rate of return on capital;

K is capital, in \$AU;

L is labour, in \$AU;

TofT is terms of trade;

A is a technical change term; and

$\mathrm{f_2}(\dots)$ is a function of the variables in parentheses.

Bohlmann (2011) assumes that the before-tax real wage of consumers (RW) is determined as follows:

$$\mathrm{RW} = \frac{\mathrm{W}}{\mathrm{CPI}} \quad (8)$$

where

RW is before-tax real wage of consumers;

W is factor payment to labour; and

CPI is consumer price index.

Bohlmann (2011) assumes that the factor payment to labour (W) is determined by the value of the marginal product of labour as follows:

$$\mathrm{W} = \mathrm{MPL} \times \mathrm{PY} \quad (9)$$

where

W is factor payment to capital;

MPL is marginal product of labour; and

PY is price of economy-wide output.

MPL represents the change in output per unit change in labour and is homogenous of degree zero. MPL can be expressed as a function of the capital-labour ($\mathrm{K/L}$) ratio (positively correlated) and technical change. $\mathrm{PY/PI}$ is a function of the terms of trade (TofT). The above relationship can be summarised in the stylised model through the following equation:

$$\mathrm{RW} = \mathrm{f}_3(\frac{\mathrm{K}}{\mathrm{L}}, \mathrm{TofT}, \mathrm{A}) \quad (10)$$

where

RW is before-tax real wage of consumers;

K is capital, in $AU;

L is labour, in $AU;

TofT is terms of trade;

A is a technical change term; and

$\mathrm{f}_3(\ldots)$ is a function of the variables in parentheses.

In the remaining section, we will refer to the stylised model equations described above.

The short-run closure

The period from the base year to a typical short-run year during the construction phase of the NBN is long enough for price changes to be transmitted throughout the economy, and for price-induced substitution to take place. We have assumed that the time horizon does not allow for investment decisions to greatly affect the useful size of industries' capital stocks in form of new buildings and equipment which takes longer to produce and install. While fluctuations in the aggregate labour (L) are likely to occur in the short term, remuneration packages may not be renegotiated and are 'sticky'; that is resistant to change. With aggregate capital stock (K) treated as exogenous, we allow rates of return (RoR) to adjust. Hence, L and RoR might change as a result of the relatively large investment in the NBN during the construction phase.

The use of the NBN has no or negligible economic impact in the short term. Thus, we have not modelled any service usage. The only substantial economic impact in the short term is the construction of the NBN itself. To model the construction of the NBN in a typical short-run year, we have adopted the approach suggested by Dixon et al. (1992) that the construction of a major project crowds out neither public nor private consumption. Instead, it will result in a deterioration of the trade balance; that is the value of exports (X) less the value of imports (M). Private consumption (C) and aggregate investment (I) are treated as exogenous. Real government spending demand follows real household demand. The distribution of investment between industries is subject to movements in the industries' rates-of-return schedule.[20]

To impose a percentage change on investment in the NBN Company wholesale services industry, we have treated the NBN Company wholesale services industry investment variable as exogenous. To close the model, we have swapped the newly exogenous percentage change variable for investment in the NBN Company wholesale services industry with the previously exogenous investment shift variable of the same industry. Shifter or shift variables are initially equal to zero. They are used to turn an equation off in which shift variables are used if the user does not wish to use the equation. The reason for not using the equation could be that the user decides to make the dependent variable exogenous.

A complete list of the exogenous (n-m) variables in the short-run closure is provided in Appendix B.4. Table 6.1 lists those variables in the short-run closure that are treated differently in the long-run model closure.

Table 6.1: Selected variables treated either as exogenous or endogenous in the short-run closure

Variable	Short-run closure
Real wage	Exogenous
Employment	Endogenous
Rate of return	Endogenous
Capital	Exogenous
Private household consumption	Exogenous
Government expenditure	Exogenous
Aggregate investment	Exogenous
NBNCoSrvcs industry investment	Exogenous

[20] The interested reader will find a detailed description of the allocation of investment across industries in Dixon et al. (1982), chapter 3, section 19.

Trade balance	Endogenous

The long-run closure

We conducted model simulations using a typical long-term closure to estimate the economic impact of the NBN in the mature phase for debt-servicing repayments and the following service groups:

- cloud computing;
- electronic commerce;
- telehealth practice;
- telehealth practice (microclinics);
- transport;
- online higher education;
- telework; and
- online entertainment.

The results of the simulations for the above service groups were interpreted separately before being added together for the total long-run impact of the NBN. Due to the non-linear equations of the economic model, the results of a combined single simulation for all service groups varies slightly, as shown by the residual in Figure 7.2 in chapter 7.

The aim of the model closure we have adopted for the model long-run simulations was to reflect the economic environment of the Australian economy in a typical year in the mid-2020s after NBN construction is completed (currently scheduled for end of 2019). By that time, investment decisions have affected the useful size of industries' capital stocks. That is, capital stock (K) is determined by the model equations and subject to changes in net investment. Labour (L) in the long-term is determined by population and labour force growth trends and treated as exogenous in the long-run closure. The labour market is allowed to clear by absorbing any demand-side pressure via changes in real wages as remuneration packages are periodically renegotiated. Technical change affecting the marginal product of labour will thus be reflected in a change to the real wage.

Rates of return on capital investments (RoR) and many factors that influence RoR, such as interest rates and risk premiums, are relatively stable over time and unlikely to be affected by the NBN in the long term and therefore treated as exogenous in the long-run closure. Thus, Investment (I) is bound to the gross capital growth trend in the base year data for 2010/2011 (I_{base}/K_{base}). Also, any technical change affecting the marginal product of capital will be absorbed through a change to the capital stock (K).

The trade balance (X-M) is treated as exogenous while the variables that determine the value of real gross domestic product (GDP) from the expenditure side (see equation (3)) are determined by the model equations. Real government spending demand follows real household demand. The sum of private (C) and public (G) consumption is equal to the product of the average propensity to consume and GDP.

A complete list of the exogenous (n-m) variables in the long-run closure is shown in Appendix B.5. Table 6.2 lists those variables in the long-run closure that are treated differently in the short-run closure.

Table 6.2: Selected variables treated either as exogenous or endogenous in the long-run closure

Variable	Long-run closure
Real wage	Endogenous
Employment	Exogenous
Rate of return	Exogenous
Capital	Endogenous
Private consumption	Endogenous
Government consumption	Endogenous
Aggregate investment	Endogenous
NBNCoSrvcs industry investment	Endogenous
Trade balance	Exogenous

6.5 Changes imposed on the exogenous model variables

The model short-run simulation

NBN Company wholesale service industry investment

We have assumed that NBN deployment in the short run affects investment in the newly added NBN wholesale service industry, and that the investment occurs in the regions where work on the network is underway. To allocate the estimated increases in investment to regions, we have used forecasts of the number of premises where work on the network is planned in a region. Table 6.3 shows the latest forecast from NBN Company (2012a) which was available to us at the time of our analysis in this thesis.

Table 6.3: Total premises where the NBN is either planned to be built or work commenced by 30 June 2015

Region	Premises	Premises (%)
SydneyNSW	616,600	17%
RoNSW	394,100	11%
MelbourneVic	488,400	14%
RoVic	203,200	6%
BrisbaneQld	301,900	9%
RoQld	376,700	11%
AdelaideSA	210,700	6%
RoSA	116,600	3%
PerthWA	231,300	7%
RoWA	197,900	6%
Tas	209,100	6%
NT	65,200	2%
ACT	135,300	4%
Total	**3,547,000**	**100%**

Source: NBN Company (2012a)

For expenditure, we have chosen FY 2016 as a typical year in the short run. NBN Company has forecast capital and operational expenditures of $AU 4.9 and $AU 3.6 billion, respectively, that is, a total of $AU 8.5 billion. The percentage changes to investment in the NBN wholesale service industry were derived as follows:

$$\text{xinvitot}_{\text{"NBNCoSrvcs", Region}} = \left(\text{\$NBN expenditure FY2016} \times \frac{\text{\#Premises passed 2015}_{\text{Region}}}{\text{\#All Premises passed 2015}} \times \frac{1}{\text{\$Investment}_{\text{"NBNCoSrvcs", Region}}}\right) \times 100 \tag{11}$$

where

$\text{xinvitot}_{\text{"NBNCoSrvcs", Region}}$ is percentage change of investment in the NBN Company wholesale service industry by region;

$\text{\$NBN expenditure FY2016}$ is forecast of total expenditure in the financial year 2016 of approximately $AU 8.5 billion, sourced from NBN Company (2012b);

$\frac{\text{\#Premises passed 2015}_{\text{Region}}}{\text{\#All Premises passed 2015}}$ is ratios of number of premises passed from Table 6.3;

$\text{\$Investment}_{\text{"NBNCoSrvcs", Region}}$ is investment of the NBN wholesale service industry by region in $AU, from Table 6.4.

We have allocated the estimated increased investment in the NBN wholesale service industry to regions in proportion to the number of premises planned to be connected to the NBN by mid-2015 shown in Table 6.3. We have then divided our estimates of the regional NBN expenditure by the regional investment of the NBN wholesale service industry from the economic model database with the estimated base year data for 2010/2011 to derive the percentage change values of NBN wholesale service industry investment in each region.

Table 6.4: Initial values for investment of the NBN wholesale services industry in 2010/2011 (million $AU)

Region	Investment (NBNCoSrvcs) (million $AU)
1 SydneyNSW	7.428088E-0014
2 RoNSW	2.960120E-0014
3 MelbourneVic	6.146991E-0014
4 RoVic	1.811712E-0014
5 BrisbaneQld	2.876887E-0014
6 RoQld	2.319042E-0014
7 AdelaideSA	2.316715E-0014
8 RoSA	6.854676E-0015
9 PerthWA	2.031315E-0014
10 RoWA	9.553664E-0015
11 Tas	2.158389E-0014
12 NT	5.085430E-0015
13 ACT	1.752473E-0014
Total	3.395111E-0013

The percentage change values we have estimated in equation (11) are shown in Appendix C.

Aggregate investment

The approach we have adopted to evaluate the percentage change in aggregate investment is as follows: investment in all industries is endogenous except for the NBN wholesale service industry, which we have set exogenous and increased in the model short-run simulation. With aggregate investment assumed exogenous in the short run, we have increased aggregate investment in order to avoid the crowding-out of investment in the industries where investment is endogenous. We have derived the percentage change in aggregate investment as follows:

$$\mathrm{NatMacro}(\text{"RealInv"}) = \left(\frac{\$\mathrm{NBN\ expenditure\ FY2016}}{\$\mathrm{Aggregate\ investment}}\right) \times 100 \quad (12)$$

where

$\mathrm{NatMacro}(\text{"RealInv"})$ is percentage change in aggregate investment;

$\$\mathrm{NBN\ expenditure\ in\ FY2016}$ is forecast of total NBN wholesale service industry expenditure in the financial year 2016 of approximately $AU 8.5 billion, sourced from NBN Company (2012b); and

$\$\mathrm{Aggregate\ investment}$ is aggregate investment of approximately $AU 500 billion from the economic model database with the base year data for 2010/2011.

We have divided total investment in the NBN wholesale service industry in the financial year 2016 by the aggregated investment from the economic model database with the base year data for 2010/2011 to derive the percentage change of aggregate investment, which is approximately 1.7%.

The model long-run simulations

The NBN produces economic impact through the services that use it. In chapter 5.5, we have summarised the economic impact we have adopted for selected services and our estimates of the NBN incremental impact on service delivery. From this composition, we have derived the inputs to the economic model in the form of percentage changes of selected exogenous variables in the model long-run simulations as described below. We have also taken into consideration the economic costs of NBN deployment as a payment arising from foreign investment in the NBN, which we have assumed to be in the form of a balance of trade surplus in a typical long-run year.

Debt-servicing repayments

To analyse the economic impact of a required annual trade surplus of approximately $AU 4.2 billion greater than otherwise would have been required in a typical long-run year with the NBN, we have made the following assumption: On a regional level, each region was assumed to contribute to the debt-servicing repayments according to overall economic activity, or real GDP. That is, in the model long-run simulation, we have adjusted regional propensity to consume from labour income to accommodate the debt-servicing repayments with respect to the overall economic activity in each region. First, we have conducted a model long-run simulation with an increase in the trade balance estimated as follows:

$$\mathrm{shrBOT} = \frac{\Delta\$(\mathrm{increase})\mathrm{BoT}}{\$\mathrm{GDP}} \times 100 \tag{13}$$

where

shrBoT is change in national real balance of trade as percentage of real GDP;

$\Delta\$(\mathrm{increase})\mathrm{BoT}$ is estimated increase in the national real balance of trade of $AU 4.2 billion calculated in section 5.5; and

$\$\mathrm{GDP}$ is real GDP from Table 6.6 in $AU.

The percentage change value of shrBoT we have estimated in equation (13) is approximately 0.38%. Second, we have estimated the percentage change values of regional propensity to consume from labour income as follows:

$$\mathrm{fhou}_{\mathrm{Region}} = \%\mathrm{houslack} \times \$\mathrm{All\ Nom\ HH\ Cons} \times \frac{\$\mathrm{GDP}_{\mathrm{Region}}}{\$\mathrm{GDP}} \times \frac{1}{\$\mathrm{Nom\ HH\ Cons}_{\mathrm{Region}}} \tag{14}$$

where

$\mathrm{fhou}_{\mathrm{Region}}$ is percentage change in propensity to consume from labour income by region;

$\%\mathrm{houslack}$ is national shift in average propensity to consume from labour income, −0.34779%, sourced from the results of the model long-run simulation with the estimated value of shrBoT from equation (13);

$\$\mathrm{All\ Nom\ HH\ Cons}$ is sum of nominal household consumption from Table 6.5 in $AU;

$\$\mathrm{GDP}_{\mathrm{Region}}$ is real GDP by region from Table 6.6 in $AU;

$\$\mathrm{GDP}$ is real GDP from Table 6.6 in $AU; and

$\$\mathrm{Nom\ HH\ Cons}_{\mathrm{Region}}$is nominal household consumption by region from Table 6.5 in $AU.

In equation (14), we estimate the percentage change in regional propensity to consume from labour income with respect to real GDP by region as a proportion of real GDP, and the percentage change in national propensity to consume from labour income as a result of the imposed trade surplus estimated in equation (13).

Table 6.5 shows estimated nominal household consumption by region from the economic model database with the base year data for 2010/2011.

Table 6.5: Estimated nominal household consumption by region in 2010/2011 (million $AU)

Region	Nominal household consumption (million $AU)
1 SydneyNSW	214,050
2 RoNSW	115,935
3 MelbourneVic	181,370
4 RoVic	63,081

5 BrisbaneQld	127,707
6 RoQld	66,227
7 AdelaideSA	52,882
8 RoSA	18,394
9 PerthWA	74,980
10 RoWA	25,020
11 Tas	22,740
12 NT	9,645
13 ACT	18,423
Total	**990,455**

Table 6.6 shows estimated real GDP by region from the economic model database with the base year data for 2010/2011.

Table 6.6: Estimated GDP by region in 2010/2011 (million $AU)

Region	GDP (million $AU)
1 SydneyNSW	228,151
2 RoNSW	120,174
3 MelbourneVic	196,632
4 RoVic	66,640
5 BrisbaneQld	141,141
6 RoQld	84,435
7 AdelaideSA	58,752
8 RoSA	21,880
9 PerthWA	96,136
10 RoWA	38,603
11 Tas	23,649
12 NT	10,422
13 ACT	17,365
Total	**1,103,979**

The percentage change values we have estimated in equation (14) are shown in Appendix C.

Cloud computing – ICT related activities of ICT specialist industries

We have quantified the change in ICT expenditure (Operating and capital expenditure) with cloud implementation in the economic model as technical change of ICT inputs to production in various industries. Productivity benefits associated with cloud services that allow staff to take on additional tasks might occur in larger organisations (KPMG, 2012). This assessment would suggest changes to the values of the labour-augmenting technical change variable in the model long-run simulation. Without sufficient evidence in this regard, however, we have focused on changes to the values of the intermediate technical change variable for composite (imported and domestic) commodities by industry and region of use ($\mathrm{bint\_s}_{\mathrm{Commodity,Industry,Region}}$). To identify ICT related activities that are affected by cloud implementation, we have made reference to the ABS ICT Satellite Account (ABS, 2006) Statistics. Table 6.7 shows the market value of ICT goods and services produced within Australia.

Table 6.7: ICT related activity in 2002/2003

Industry	ICT related output (million $AU)
1. ICT specialist industries	
1.1. Manufacturing	1,813
1.2. Wholesale trade	8,861
1.3. Telecommunication services	32,650
1.4. Computer services	15,528
2. Other industries	6,227
Total	**65,079**

Source: ABS (2006)

First, we have mapped the ICT specialist industries to their equivalent industries in the economic model database as shown in Table 6.8.

Table 6.8: Mapping of ICT specialist industries to the industries in the economic model database

ICT specialist industry	Mapped TERM industry
1.1. Manufacturing	Other machinery and equipment
1.2. Wholesale trade	Wholesale trade
1.3. Telecommunication services	Telecommunication
1.4. Computer services	Finance and business services

The great majority of ICT output is produced by a small number of industries and is used domestically. We have therefore assumed that the technical change resulting from cloud implementation has an effect on the use of ICT goods and services in each industry in proportion of ICT related output shown in Table 6.7. For example, approximately 3% (1,813/65,079) of the technical change applies to the use of other machinery and equipment in each industry.

In equation (14), we have used the notation "Subset 1" for the mapped ICT specialist industries shown in the second column in Table 6.8 and their commodities. We have derived the percentage change values of the intermediate technical change variable of ICT specialist industries' commodities as follows:

$$\mathrm{bint\_s}_{\mathrm{Subset\ 1\ Commodity,Industry,Region}} = -\Delta\%(\mathrm{savings})\mathrm{ICT\ Expenditure}_{\mathrm{Industry}} \times \%\mathrm{ICT\ Output\ Reconciliation} \times \frac{\$\mathrm{ICT\ Output}_{\mathrm{Subset\ 1\ Industry}}}{\$\mathrm{All\ ICT\ Output}} \times \frac{\$\mathrm{ICT\ Expenditure(NBN\ impact\ on\ service\ delivery)}_{\mathrm{Industry,Region}}}{\$\mathrm{ICT\ Expenditure}_{\mathrm{Industry,Region}}} \quad (14)$$

where

$\mathrm{bint\_s}_{\mathrm{Commodity,Industry,Region}}$ is percentage change of intermediate technical change of composite (imported and domestic) commodities by industry and region of use;

$\Delta\%(\mathrm{savings})\mathrm{ICT\ Expenditure}_{\mathrm{Industry}}$ is estimated percentage change in the cost of traditional ICT expenditure by industry, as described in section 5.4;

$\%\mathrm{ICT\ Output\ Reconciliation}$ is a ratio described below;

$\$\text{ICT Output}_{\text{Subset 1 Industry}}$ is output of ICT specialist industries (1.1 to 1.4) from Table 6.7, in $AU;

$\$\text{All ICT Output}$ is total ICT related output, in $AU, from Table 6.7;

$\$\text{ICT Expenditure(NBN impact on service delivery)}_{\text{Industry,Region}}$ is expenditures on ICT by industry and region of use subject to the NBN impact on service delivery, in $AU;

$\$\text{ICT Expenditure}_{\text{Industry,Region}}$ is expenditure on ICT by industry and region of use, in $AU.

The first term on the right hand side of the equations (14) describes the effect of cloud implementation which we have derived in equation (1) of section 5.4. We have assumed that the estimated percentage savings apply on the national as well as on all regional levels. However, we need to reconcile the savings with the ABS data for total ICT expenditure. This is the purpose of the term $\%\text{ICT Output Reconciliation}$.

If we apply the ratios of businesses' operational and capital ICT expenditures without cloud implementation as a proportion of total expenditure from equation (1) of section 5.4 to the values of industry demand for imported and domestically produced commodities, in $AU, sourced from the model base-year data for 2010/2011 (as described in chapter 6), we obtain a total of $AU 174,563 million for total ICT expenditure. Total ICT production in 2002/2003 was estimated to be $AU 81,229 million (2010 prices).[21] To obtain the correct proportionate change in savings, therefore, we scale the values by 81,229/174,563, that is, 0.4653, which is the value of $\%\text{ICT Output Reconciliation}$.

While it is more than likely that the cost shares of ICT in all industries increase over time, our estimates of the economic benefits of public cloud services should be considered conservative. Since the economic benefit of public cloud services is comparatively small, the effect of including this constant on our results is marginal.

The purpose of the second term is to estimate the proportion of technical change in the mapped industries by commodity. The last term accounts for the NBN impact on service delivery in terms of businesses' expenditure on ICT. The ratios of the last term were not available to us. Instead, we have used ratios of businesses' turnover subject to the NBN impact on service delivery as an approximation of businesses' expenditure on ICT as shown in equation (15).

$$\frac{\$\text{ICT Expenditure(NBN impact on service delivery)}_{\text{Industry,Region}}}{\$\text{ICT Expenditure}_{\text{Industry,Region}}} \approx \frac{\text{MB area(NBN impact on service delivery)}_{\text{Industry Land Use,SA2}}}{\text{MB area}_{\text{Industry Land Use,Region}}} \times \frac{\$\text{Turnover}_{\text{Industry,SA2}}}{\$\text{Turnover}_{\text{Industry,Region}}} \tag{15}$$

where

$\frac{\$\text{ICT Expenditure(NBN impact on service delivery)}_{\text{Industry,Region}}}{\$\text{ICT Expenditure}_{\text{Industry,Region}}}$ are the ratios we require in equation (14);

[21] As described in this chapter, the economic model had a base year 2002/2003. We updated it to 2010/2011, with prices in 2010 values.

$\frac{\text{MB area(NBN impact on service delivery)}_{\text{Industry Land Use,SA2}}}{\text{MB area}_{\text{Industry Land Use,Region}}} \times \frac{\$\text{Turnover}_{\text{Industry,SA2}}}{\$\text{Turnover}_{\text{Industry,Region}}}$ are the ratios of the NBN impact on service delivery in terms of SME turnover by industry and region of use estimated for cloud computing from Table 5.7 for modest access speeds and Table 5.8 for high access speeds.

Our assumption of using businesses' turnover as an approximation for expenditure on ICT is consistent with the general assumption that "Intermediate input usage with CGE models typically follows a "Leontief" structure - that is, the physical quantity of intermediate inputs used per unit of output is, at a given technology, constant and independent of price" (Horridge et al., 2005, p. 304).

The percentage change values we have estimated in equation (14) are shown in Appendix C.

Cloud computing – ICT related activities of industries other than ICT specialist industries

In equation (16), we have used the notation "Subset 2" for industries and their commodities other than the ICT specialist industries mapped to equivalent TERM industries in the second column in Table 6.8. We have derived the percentage change values of the intermediate technical change variable of the subset 2 commodities as follows:

$$\text{bint\_s}_{\text{Subset 2 Commodity,Industry,Region}} = -\Delta\%(\text{savings})\text{ICT Expenditure}_{\text{Industry}} \times \%\text{ICT Output Reconciliation} \times \frac{\$\text{ICT Output}}{\$\text{All ICT Output}} \times \frac{\$\text{Subset 2 Commodities Used}_{\text{Subset 2 Commodity,Industry}}}{\$\text{All Subset 2 Commodities Used}_{\text{Industry}}} \times \frac{\$\text{ICT Expenditure(NBN impact on service delivery)}_{\text{Industry,Region}}}{\$\text{ICT Expenditure}_{\text{Industry,Region}}} \quad (16)$$

where

$\text{bint\_s}_{\text{Subset 2 Commodity,Industry,Region}}$ is percentage change of intermediate technical change of composite (imported and domestic) subset 2 commodities by industry and region of use;

$\Delta\%(\text{savings})\text{ICT Expenditure}_{\text{Industry}}$ is estimated percentage change in traditional ICT expenditure by industry, as described in section 5.4;

$\%\text{ICT Output Reconciliation}$ is the ratio required in equation (14);

$\$\text{ICT Output}$ is output of non-ICT specialist industries (2. Other industries), in $AU, from Table 6.7;

$\$\text{All ICT Output}$ is total ICT output, in $AU, from Table 6.7;

$\$\text{Subset 2 Commodities Used}_{\text{Subset 2 Commodity,Industry}}$ is use of subset 2 commodities by commodity and industry, in $AU, from Table 6.9;

$\$\text{All Subset 2 Commodities Used}_{\text{Industry}}$ is total use of subset 2 commodities by industry, in $AU, from Table 6.9;

$\$\text{ICT Expenditure(NBN impact on service delivery)}_{\text{Industry,Region}}$ is expenditures on ICT by industry and region of use subject to the NBN impact on service delivery, in $AU;

$\$\text{ICT Expenditure}_{\text{Industry,Region}}$ is expenditure on ICT by industry and region of use, in $AU.

Our approach is similar to the one shown in equation (14). We have included the fourth term on the right hand side of equation (16) to estimate the technical change resulting from cloud implementation equi-proportionate to the use of subset 2 commodities in each industry. For example, approximately 3% (1,813/65,079) of the technical change applies to the use of other machinery and equipment in each industry.

Table 6.9 shows the use of imported and domestic subset 2 commodities in each industry from the economic model base year data for 2010/2011.

Table 6.9: Use of (subset 2) commodities by industry in 2010/2011 (million $AU)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	13,155	85	37,979	2,046	405	405	22	946	6	48	11	47	11	410	827	1,110	4,784	118	1	12	891	277	19	34
2 Mining	57	18,954	1,048	133	235	334	45	30,316	4,093	39,799	123	368	6,347	2,689	275	879	1,028	119	45	333	844	183	128	229
3 FoodDrinkTob	2,946	82	19,278	115	655	18	33	1,210	11	33	34	43	28	240	1,172	10,549	21,496	120	31	227	1,399	533	398	162
4 TCFs	176	161	310	4,520	466	2,476	206	204	79	889	271	260	76	11,896	1,413	952	1,433	605	24	176	1,643	749	476	688
5 MiscManuf	208	440	3,020	371	1,401	588	1,204	1,556	123	641	744	1,032	383	6,646	2,150	958	1,776	1,453	230	1,713	1,336	1,556	429	343
6 WoodProds	103	156	2,908	210	222	1,722	3,076	837	207	351	282	219	41	1,753	1,468	845	1,423	293	51	381	1,138	1,300	707	511
7 PaperPrint	78	157	371	125	189	337	2,258	287	80	312	136	358	101	1,377	2,942	4,827	3,330	476	289	2,152	6,295	2,497	2,608	294
8 ChemCoalPrds	7,918	8,198	903	913	3,822	1,268	1,193	12,603	1,248	1,993	733	1,106	2,254	11,601	3,956	2,519	5,247	14,346	39	1,336	6,208	1,357	299	3,196
9 NonMetMinPrd	42	189	711	109	121	87	16	224	3,889	804	330	349	366	20,123	875	376	336	24	0	4	1,439	137	28	52
10 MetalPrds	429	3,197	1,666	776	1,335	1,268	161	814	651	25,431	3,552	9,358	802	25,379	2,076	1,111	1,573	1,538	141	1,073	3,684	1,425	445	204
11 TransEqp	195	595	53	30	109	99	26	33	70	108	6,713	391	24	1,869	1,313	8,613	397	8,797	95	709	791	4,337	151	16
13 EGW	885	1,962	963	249	269	338	193	624	487	2,464	329	634	25,205	2,647	953	1,753	2,802	2,242	108	807	6,133	834	1,452	534
14 Construction	671	4,896	254	129	73	41	61	1,177	37	320	58	196	3,358	101,521	3,556	1,207	1,881	2,483	445	3,312	8,377	5,740	32	57
16 RetailTrade	638	537	616	134	114	166	456	303	54	140	39	130	323	2,499	3,104	3,964	3,230	7,323	196	1,457	5,310	763	324	462
17 RecPersSrvc	523	1,137	2,364	239	194	226	900	1,275	245	768	524	516	563	2,490	3,065	3,461	14,855	2,020	174	1,644	22,283	2,874	2,306	1,838
18 Transport	692	5,099	2,463	851	494	762	1,136	1,568	697	2,354	499	959	381	5,228	17,750	1,866	2,137	13,900	164	2,460	11,296	4,767	1,052	492
19 PostalSrvcs	34	32	125	32	45	24	260	38	39	93	35	135	41	298	471	988	1,369	297	74	550	2,223	634	340	358
22 PubAdmDef	57	403	199	30	31	66	305	294	29	148	122	54	84	1,585	306	554	304	2,007	16	717	2,943	4,419	565	243
23 Education	29	229	247	79	47	39	89	210	75	176	97	189	303	250	101	345	1,272	628	13	98	5,055	644	1,532	173
24 Community	77	2	95	40	4	8	87	203	2	4	54	7	6	29	42	59	225	165	4	173	144	232	89	873
Total	**28,912**	**46,510**	**75,574**	**11,132**	**10,231**	**10,271**	**11,728**	**54,721**	**12,120**	**76,878**	**14,686**	**16,353**	**40,696**	**200,528**	**47,812**	**46,935**	**70,897**	**58,953**	**2,140**	**19,334**	**89,433**	**35,259**	**13,379**	**10,759**

The percentage change values we have estimated in equation (16) are shown in Appendix C.

Electronic commerce – Labour productivity

We have treated the estimated productivity improvements through electronic commerce as technical change in the use of labour in all industries. To analyse the long-run effects of the estimated productivity improvements in the economic model, we have changed the values of the labour-augmenting technical change variable over all occupations by industry and region of use ($\text{alab\_o}_{\text{Industry,Region}}$) in the economic model. We have derived the percentage change values that we have applied to the exogenous variable as follows:

$$\text{alab\_o}_{\text{Industry,Region}} = -\Delta\%(\text{improvement})\text{Productivity}_{\text{Industry}} \times \frac{\$\text{LAB}(\text{NBN impact on service delivery})_{\text{Industry,Region}}}{\$\text{LAB}_{\text{Industry,Region}}} \qquad (17)$$

where

$\text{alab\_o}_{\text{Industry,Region}}$ is percentage change of labour-augmenting technical change by industry and region of use;

$\Delta\%(\text{improvement})\text{Productivity}_{\text{Industry}}$ is percentage change of productivity of labour by industry taken from Table 5.15;

$\$\text{LAB}(\text{NBN impact on service delivery})_{\text{Industry,Region}}$ is payments awarded to the suppliers of labour (return to labour) by industry and region of use subject to the NBN incremental impact on service delivery, in $AU; and

$\$\text{LAB}_{\text{Industry,Region}}$ is industry return to labour by industry and region of use, in $AU.

The productivity improvements are indicated by the first term on the right hand side of equation (17) above. We have assumed that the estimated productivity improvements apply on the national as well as on all regional levels. The second and last term accounts for the NBN impact on service delivery in terms of industry return to labour. The ratios required in the second term were not available to us. The only businesses related data on the required regional level available to us were number of businesses by employment and turnover size. Similar to the approximation used in equation (15), we have used ratios of businesses' turnover as an approximation for the return-to-labour ratios required in the second and last term of the right hand side of equation (17). This approximation is consistent with the general assumption in the model theory that the industry demands for the aggregate primary factor are proportional to total output and technological terms as shown in equation (B.2) in Appendix B.3. Therefore, we have replaced the second and last term on the right hand side of equation (17) with the same ratios as calculated for cloud computing in the previous subsection as shown in equation (18).

$$\frac{\$\text{LAB}(\text{NBN impact on service delivery})_{\text{Industry,Region}}}{\$\text{LAB}_{\text{Industry,Region}}} \approx \frac{\text{MB area}(\text{NBN impact on service delivery})_{\text{Industry Land Use,SA2}}}{\text{MB area}_{\text{Industry Land Use,Region}}} \times \frac{\$\text{Turnover}_{\text{Industry,SA2}}}{\$\text{Turnover}_{\text{Industry,Region}}} \qquad (18)$$

where

$$\frac{\$\mathrm{LAB}(\text{NBN impact on service delivery})_{\text{Industry,Region}}}{\$\mathrm{LAB}_{\text{Industry,Region}}}$$ are the ratios we require in equation (17);

$$\frac{\text{MB area}(\text{NBN impact on service delivery})_{\text{Industry Land Use,SA2}}}{\text{MB area}_{\text{Industry Land Use,Region}}} \times \frac{\$\text{Turnover}_{\text{Industry,SA2}}}{\$\text{Turnover}_{\text{Industry,Region}}}$$ are the ratios of the NBN impact on service delivery in terms of SME turnover by industry and region of use estimated for Electronic Commerce from Table 5.9 for modest access speeds and Table 5.10 for high access speeds.

The resulting percentage change values we have estimated in equation (17) are shown in Appendix C.

Online higher education – Capital productivity

We have treated the estimated lecture space savings through interactive learning online courses with some physically face-to-face instruction as technical change in the use of capital in the education industry. To analyse the long-run effects of the space savings in the tertiary sector with the NBN, we have changed the values of the capital-augmenting technical change variable for the education industry by region of use ($\mathrm{acap}_{\text{"}Education\text{",Region}}$) in the economic model. The Education industry in the economic model database covers schools, colleges, universities, museums, libraries, art galleries, and historical theme parks. Hence, we had to reduce the values of the capital-augmenting technical change in education according to the proportion of the tertiary education quantities in the Education industry. We have used government operating expenses on tertiary education as a ratio of government operating expenses on education from the ABS (2012b) by State and Territory and local Governments as an approximation of the proportion of the tertiary education quantities in the Education industry in the economic model database. Table 6.10 shows operating expenses on education by purpose and State and Local Governments.

Table 6.10: Operating expenses on education in 2010/2011 (million $AU)

State and Local Government	Primary and secondary education (million $AU)	Tertiary education (million $AU)	Total (million $AU)
New South Wales	11,567	1,800	15,228
Victoria	8,873	2,297	12,299
Queensland	7,855	780	9,776
South Australia	3,086	567	3,796
Western Australia	4,678	569	5,702
Tasmania	1,031	153	1,285
Northern Territory	770	149	993
Australian Capital Territory	689	112	852

Source: ABS (2012b)

For want of more detailed regional data, we have assumed that the ratios of operating expenses on tertiary education to total operating expenses on education by state and local government are similar in capital cities and the rest of a state or territory. For example, the New South Wales State and Local Government operating expenses on tertiary education in Sydney and Rest of New South Wales are 11.8% ($AU 1,800 million/$AU 15,228 million). Table 6.11 shows our assumptions of State and Local Governments operating expenses on tertiary education by region.

Table 6.11: Assumed State and local government operating expenses on tertiary education by region

Region	Operating expenses on tertiary education 2010/2011 (%)
Greater Sydney	11.8%
Rest of NSW	11.8%
Greater Melbourne	18.7%
Rest of Vic.	18.7%
Greater Brisbane	8.0%
Rest of Qld	8.0%
Greater Adelaide	14.9%
Rest of SA	14.9%
Greater Perth	10.0%
Rest of WA	10.0%
Tasmania	11.9%
Northern Territory	15.0%
Australian Capital Territory	13.1%

We have derived the percentage change values that we have applied to the exogenous variable as follows:

$$\mathrm{acap}_{"\mathit{Education}",\mathrm{Region}} = -\Delta\%(\mathrm{savings})\mathrm{Space} \times \frac{\$\mathrm{Government\ OPEX\ on\ Tertiary\ Education}_{\mathrm{Region}}}{\$\mathrm{Government\ OPEX\ on\ Education}_{\mathrm{Region}}} \times \frac{\#\mathrm{Students(NBN\ impact\ on\ service\ delivery)}_{\mathrm{Region}}}{\#\mathrm{Students}_{\mathrm{Region}}} \qquad (19)$$

where

$\mathrm{acap}_{"\mathit{Education}",\mathrm{Region}}$ is percentage change capital-augmenting technical change in the Education industry by region of use;

$\Delta\%(\mathrm{savings})\mathrm{Space}$ is average lecture space savings of 71% from section 5.4;

$\frac{\$\mathrm{Government\ OPEX\ on\ Tertiary\ Education}_{\mathrm{Region}}}{\$\mathrm{Government\ OPEX\ on\ Education}_{\mathrm{Region}}}$ is government operating expenses on tertiary education as a ratio of the government operating expenses on education by region from Table 6.11;

$\#\mathrm{Students(NBN\ impact\ on\ service\ delivery)}_{\mathrm{Region}}$ is number of students by region of residence subject to the NBN impact on service delivery; and

$\#\mathrm{Students}_{\mathrm{Region}}$ is number of students by region of residence.

The first term indicates our estimates of space savings through interactive learning online courses with some physically face-to-face instruction, as described in chapter 5.4. We have assumed that the space savings apply on a national as well as on a regional level. The purpose of the second term is to reduce the percentage change of the technical change variable in the Education industry reflecting space savings through online higher education assumed in tertiary education only. We have used government operational expenditure as an approximation for the use of capital in education. The last term accounts for the NBN impact on service delivery in terms of students usually resident. However, the required ratios were not available to us. To derive a reasonable approximation of the last term, we have assumed that access to interactive learning online courses would lead to similar ratios of students to persons by region of residence. Hence, we have replaced the last term in equation (19) with the term on the right hand side of the following equation:

$$\frac{\#\text{Students(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Students}_{\text{Region}}} \approx \frac{\#\text{Residents(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Residents}_{\text{Region}}} \tag{20}$$

where

$\frac{\#\text{Students(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Students}_{\text{Region}}}$ are ratios we require in equation (19); and

$\frac{\#\text{Residents(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Residents}_{\text{Region}}}$ are ratios of the NBN impact on service delivery in terms of persons by region of residence estimated for Online Higher Education from Table 5.3 for modest access speeds and Table 5.4 for high access speeds.

The percentage change values we have estimated in equation (19) are shown in Appendix C.

Telehealth practice

We have treated the estimated reduction in traditional healthcare expenditure through four different types of telehealth interventions as technical change in the appropriate industry's use of all imported and domestically produced inputs. The Community industry in the economic model database covers health, welfare and community services. To analyse the long-run effects of the technical change through the telehealth interventions, we have changed the values of the all-input-augmenting technical change variable of the Community industry by region of use ($\text{atot}_{\text{"}Community\text{"},\text{Region}}$) in the economic model.

Telehealth practice – Aged care

For telehealth interventions into existing aged care programs, we have derived the percentage change values to the exogenous variable as follows:

$$\text{atot}_{\text{"}Community\text{"},\text{Region}} = \left(-\Delta\$(\text{savings})\text{Aged Care} \times \frac{\#\text{Elderly Residents}_{\text{Region}}}{\#\text{All Elderly Residents}} \times \frac{1}{\$\text{Community}_{\text{Region}}} \times \frac{\#\text{Elderly Residents(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Elderly Residents}_{\text{Region}}}\right) \times 100 \tag{21}$$

where

$\text{atot}_{\text{"Community"},\text{Region}}$ is percentage change of all-input augmenting technical change in the Community industry by region of use;

$\Delta\$(\mathrm{savings})\mathrm{Aged\ Care}$ is estimated reduction in traditional healthcare expenditure through telehealth interventions in aged care, i.e. $AU 8,200 million, as estimated in chapter 5.4;

$\$\mathrm{Community}_{\mathrm{Region}}$ is industry demand of imported and domestically produced Community commodities by region of use, in $AU, from Table 6.12;

$\#\mathrm{Elderly\ Residents}_{\mathrm{Region}}$ is number of persons aged 65 and older by region of residence, sourced from the 2011 ABS Census data;

$\#\mathrm{All\ Elderly\ Residents}$ is number of all persons aged 65 and older, sourced from the 2011 ABS Census data; and

$\frac{\#\mathrm{Elderly\ Residents(NBN\ impact\ on\ service\ delivery)}_{\mathrm{Region}}}{\#\mathrm{Elderly\ Residents}_{\mathrm{Region}}}$ are ratios of the NBN impact on service delivery in terms of elderly persons by region of residence estimated for telehealth interventions into existing aged care programs from Table 5.5 for modest and high access speeds.

The first term of the right hand side of equation (21) indicates our estimates of the reduction in traditional healthcare expenditure through the implementation of telehealth interventions in aged care. The purpose of the second term is to allocate the estimated cost savings to regions according to the number of persons aged 65 and older as a proportion of all persons aged 65 and older. The third term turns the estimated cost savings in a region into a proportion of the Community industry expenditures in the region. The last term accounts for the NBN impact on service delivery in terms of persons aged 65 and older.

Table 6.12 shows the industry demand of composite (imported and domestic) Community services from the economic model base year data for 2010/2011.

Table 6.12: Industry demand of imported and domestically produced Community commodities in 2010/2011 (million $AU)

Region	Industry demand of Community services (million $AU)
Greater Sydney	30,222
Rest of NSW	16,426
Greater Melbourne	26,477
Rest of Vic.	8,788
Greater Brisbane	18,570
Rest of Qld	9,016
Greater Adelaide	8,266
Rest of SA	2,450
Greater Perth	10,908
Rest of WA	3,037
Tasmania	3,204
Northern Territory	1,331
Australian Capital Territory	2,309
Total	**141,006**

The percentage change values we have estimated in equation (21) are shown in Appendix C.

Telehealth practice - provider-to-provider tele-consulting

To account for the estimated impact of provider-to-provider tele-consulting with the NBN, we have derived the percentage change values that we have applied to the exogenous variable as follows:

$$\text{atot}_{\textit{"Community"},\text{Region}} = \left(-\Delta\$(\text{savings})\text{Provider} \times \frac{\#\text{GP Services}_{\text{Region}}}{\#\text{All GP Services}} \times \frac{1}{\$\text{Community}_{\text{Region}}} \times \frac{\#\text{GP Services(NBN impact on service delivery)}_{\text{Region}}}{\#\text{GP Services}_{\text{Region}}} \right) \times 100 \tag{22}$$

where

$\text{atot}_{\textit{"Community"},\text{Region}}$ is all-input augmenting technical change in the Community industry by region of use in per cent;

$\Delta\$(\text{savings})\text{Provider}$ is estimated reduction in traditional healthcare expenditure through provider-to-provider tele-consulting, i.e. $AU 487 million, as estimated in chapter 5.4;

$\frac{\#\text{GP Services}_{\text{Region}}}{\#\text{All GP Services}}$ is ratio of health services provided by general practitioners (GPs) from Table 6.13; and

$\$\text{Community}_{\text{Region}}$ is industry demand of imported and domestically produced Community commodities by region of use, in $AU, from Table 6.12;

$\frac{\#\text{GP Services(NBN impact on service delivery)}_{\text{Region}}}{\#\text{GP Services}_{\text{Region}}}$ are ratios of the NBN impact on service delivery in terms of GP services by region of use estimated for provider-to-provider tele-consulting from Table 5.6 for modest and high access speeds.

The first term indicates the estimated reduction in traditional healthcare expenditure through provider-to-provider tele-consulting. With the second term, we have allocated the estimated cost savings to regions according to the number of GP services in a region as a proportion of all GP services shown in Table 6.13. The third term turns the estimated cost savings in a region into a proportion of the Community industry expenditures in the region. The last term accounts for the NBN impact on service delivery in terms of GP services.

Table 6.13: GP services in 2009/2010

Region	GP services	GP services (%)
Greater Sydney	27,833,666	26%
Rest of NSW	14,439,385	13%
Greater Melbourne	22,913,772	21%
Rest of Vic.	7,289,728	7%
Greater Brisbane	8,290,271	8%
Rest of Qld	4,405,971	4%
Greater Adelaide	7,155,642	7%
Rest of SA	2,235,875	2%
Greater Perth	8,107,566	7%
Rest of WA	1,710,370	2%
Tasmania	2,729,510	3%
Northern Territory	522,205	0%

Australian Capital Territory	1,477,547	1%
Total	**109,111,508**	**100%**

The percentage change values we have estimated in equation (22) are shown in Appendix C.

Telehealth practice – Secure, private communications with clinicians

For the impact of broadband-enabled secure, private communications with clinicians with the NBN, we have derived the percentage change values that we have applied to the exogenous all-input-augmenting technical change variable as follows:

$$\mathrm{atot}_{\textit{"Community"},\mathrm{Region}} = \left(-\Delta\$(\mathrm{savings})\mathrm{Private} \times \frac{\#\mathrm{Residents}_{\mathrm{Region}}}{\#\mathrm{All\ Residents}} \times \frac{1}{\$\mathrm{Community}_{\mathrm{Region}}} \times \frac{\#\mathrm{Residents(NBN\ impact\ on\ service\ delivery)}_{\mathrm{Region}}}{\#\mathrm{Residents}_{\mathrm{Region}}}\right) \times 100 \quad (23)$$

where

$\mathrm{atot}_{\textit{"Community"},\mathrm{Region}}$ is all-input augmenting technical change in the aggregated industry group Community by region of use, in percent;

$\Delta\$(\mathrm{savings})\mathrm{Private}$ is estimated reduction in traditional healthcare expenditure through broadband-enabled secure, private communications with clinicians, $AU 450 million, as estimated in chapter 5.4;

$\#\mathrm{Residents}_{\mathrm{Region}}$ is number of persons by region of residence, sourced from the 2011 ABS Census data;

$\#\mathrm{All\ Residents}$ is number of all persons usually resident, sourced from the 2011 ABS Census data;

$\$\mathrm{Community}_{\mathrm{Region}}$ is industry use of imported and domestically produced community commodities by region of use, in $AU, from Table 6.12; and

$\frac{\#\mathrm{Residents(NBN\ impact\ on\ service\ delivery)}_{\mathrm{Region}}}{\#\mathrm{Residents}_{\mathrm{Region}}}$ are ratios of the NBN impact on service delivery in terms of persons by region of residence estimated for broadband-enabled secure, private communications with clinicians from Table 5.3 for modest access speeds and Table 5.4 for high access speeds.

The first term indicates the estimated reduction in traditional healthcare expenditure through secure, private communications with clinicians. The second term is to estimate the cost savings by region according to number of persons usually resident in a region as a proportion of all persons usually resident. The third term turns the estimated cost savings in a region into a proportion of the Community industry expenditures in the region. The last term accounts for the NBN impact on service delivery in terms of persons usually resident.

The percentage change values we have estimated in equation (23) are shown in Appendix C.

Telehealth practice – Microclinics

For the use of telehealth in broadband-enabled microclinics in remote areas, we have derived the percentage change values that we have applied to the exogenous all-input-augmenting technical change variable as follows:

$$\text{atot}_{\textit{"Community"},\text{Region}} = -\Delta\%(\text{savings})\text{Microclinics} \times \frac{\$\text{Acute care}_{\text{S/T}}}{\$\text{Government expenses}_{\text{S/T}}} \times \frac{\#\text{Residents(NBN impact on service delivery)}_{\text{Region(Outer Regional,Remote,Very Remote Australia)}}}{\#\text{Residents}_{\text{Region(Outer Regional,Remote,Very Remote Australia)}}} \quad (24)$$

where

$\text{atot}_{\textit{"Community"},\text{Region}}$ is percentage change of all-input augmenting technical change in the Community industry by region of use;

$\Delta\%(\text{savings})\text{Microclinics}$ is percentage change of traditional healthcare expenditure through the use of telehealth in broadband-enabled microclinics in remote areas, as described in chapter 5.4;

$\$\text{Acute care}_{\text{S/T}}$ is government expenses on acute care institutions by State or Territory, in $AU, from Table 6.15;

$\$\text{Government expenses}_{\text{S/T}}$ is general government expenses by State or Territory, in $AU, from Table 6.15; and

$\frac{\#\text{Residents(NBN impact on service delivery)}_{\text{Region(Outer Regional,Remote,Very Remote Australia)}}}{\#\text{Residents}_{\text{Region(Outer Regional,Remote,Very Remote Australia)}}}$ are ratios of the NBN impact on service delivery in terms of persons by region of residence in outer regional, remote and very remote Australia, estimated for microclinics from Table 5.3 for modest access speeds and Table 5.4 for high access speeds.

The first term on the right hand side of equation (24) is the average per-patient savings or reduction in traditional healthcare expenditure in remote areas through the use of telehealth in broadband-enabled microclinics. As an approximation for remote areas, we have assumed that the cost savings occur predominantly in outer regional, remote and very remote Australia based on the ASGC Remoteness Areas. The third term accounts for the proportion of acute care institutions in general government expenses related to the Community industry. The last term accounts for the NBN impact on service delivery in outer regional, remote and very remote Australia in terms of persons usually resident. By definition, the results are zero for regions of major cities and inner regional Australia.

General government expenses published by the ABS (2011d) are related to health (36.1%), social security and welfare (50.6%), housing and community amenities (8.5%), recreation and culture (4.8%). Disaggregated general government expenses were available by federal (Commonwealth) and State or Territory as shown in Table 6.14.

Table 6.14: General government expenses in 2009/2010

Region	Acute care institutions (million $AU)	Total (Health, social security and welfare, housing and community amenities, recreation and culture) (million $AU)
Commonwealth	13,120	173,119
New South Wales	10,794	23,619
Victoria	8,831	18,670
Queensland	7,088	14,956
South Australia	3,771	7,482
Western Australia	3,271	8,889
Tasmania	885	1,920
Northern Territory	574	1,749
Australian Capital Territory	10,794	1,451

Source: ABS (2011d)

We have allocated Commonwealth expenses to States or Territories equi-proportionate to the number of residents. For example, 32% of the population are usually resident in NSW. We have therefore assumed that 32% of Commonwealth expenses are allocated to NSW. Our estimates of general government expenses by State or Territory are summarised in Table 6.15.

Table 6.15: Estimates of general Government Expenses in 2009/2010

Region	Population	Population (%)	Acute care institutions (million $AU)	Total (Health, social security and welfare, housing and community amenities, recreation and culture) (million $AU)
NSW	6,904,623	32%	15,034	79,565
Vic	5,345,697	25%	12,084	61,590
Qld	4,319,721	20%	9,718	49,653
SA	1,593,496	7%	4,734	20,190
WA	2,231,461	10%	4,653	27,129
Tas	494,164	2%	1,185	5,884
NT	209,963	1%	710	3,542
ACT	357,332	2%	864	4,303

Due to the limited regional statistics available to us, we have assumed that general government expenses related to acute care institutions as a proportion of total general government expenses in a State or Territory are similar in regions within the same State or Territory. For example, 19% ($AU 15,034 million/$AU 79,565 million) of general government expenses estimated for NSW are related to acute care institutions in Sydney and Rest of NSW.

The percentage change values we have estimated in equation (24) are shown in Appendix C.

Transport – Household preferences

We have treated the estimated reduction in household spending on transport through secure, private patient communications with clinicians as changes to private consumption of transport commodities. To analyse the long-run effects of the estimated transport savings, we have changed the values of the subsistence taste shift variable for imported and domestic composite transport services by region of use ($\text{ahou\_s}_{\textit{"Transport"},\text{Region}}$) in the economic model. The treatment of changes in preferences ("tastes") closely parallels that of changes in technology. The subsistence taste shift variable allows for changes in tastes in the economic model's equation system. The value of the variable increases (decreases) if there is an increase (decrease) in the subsistence demand, i.e. an upward (downward) movement in the demand curve. That is, the effects of a 1 percent quantity-augmenting change in tastes for a commodity could be simulated by an exogenously imposed 1 percent reduction in the subsistence shift variable.

We have derived the percentage change values that we have applied to the exogenous variable as follows:

$$\text{ahou\_s}_{\text{"Transport"},\text{Region}} = \left(-\Delta\$(\text{savings})\text{Private Teleconsultation}_{\text{Region}} \times \frac{1}{\$\text{Transport}_{\text{Region}}}\right) \times 100 \tag{25}$$

where

$\text{ahou\_s}_{\textit{"Transport"},\text{Region}}$ is taste change variable for transport services over all sources by region of use and household, in percent;

$\Delta\$(\text{savings})\text{Private Teleconsultation}_{\text{Region}}$ is estimated travel savings through the use of broadband-enabled secure, private communications with clinicians, in $AU, as described in chapter 5.4;

$\$\text{Transport}_{\text{Region}}$ is household demand for transport commodities by region of use, in $AU, from Table 6.16.

The first term on the right hand side of equation (25) is the estimated travel savings described in chapter 5.4, which accounts for the NBN impact on service delivery in terms of persons by region of residence. The purpose of the second term is to estimate the percentage changes of private consumption of transport services in a region. Table 6.16 shows private consumption of composite (imported and domestic) Transport services from the economic model base year data for 2010/2011.

Table 6.16: Private consumption of Transport services in 2010/2011 (million $AU)

Region	Private consumption of Transport (million $AU)
Greater Sydney	5,586
Rest of NSW	3,305
Greater Melbourne	4,687
Rest of Vic.	1,744
Greater Brisbane	3,633
Rest of Qld	1,589
Greater Adelaide	1,405
Rest of SA	554
Greater Perth	1,925
Rest of WA	727
Tasmania	641
Northern Territory	272
Australian Capital Territory	432

Total	26,499

Subsistence demand in the model's equation system refers to (imported and domestic) composite commodities. We have therefore used (the sum of) imported and domestic transport services from Table 6.16. The percentage change values we have estimated in equation (25) are shown in Appendix C.

Telework – Labour productivity

We have treated the estimated net savings resulting from the costs and benefits of telework implementation described in chapter 5.4 as improvements in the productivity of labour inputs. We have estimated the benefits of telework implementation in terms of cost savings for each industry as follows:

$$\Delta\$(\text{savings})\text{Workplace}_{\text{Industry}} = \big(\Delta\%(\text{savings})\text{Recruitment}_{\text{Industry}} + \Delta\%(\text{savings})\text{Operational benefits}_{\text{Industry}}\big) \times \$\text{LAB}_{\text{Industry}} + (\Delta\%(\text{savings})\text{Labour} + \Delta\%(\text{savings})\text{Absenteeism}) \times \$\text{LAB New Teleworkers}_{\text{Industry}} \quad (26)$$

where

$\Delta\$(\text{savings})\text{Workplace}_{\text{Industry}}$ is cost savings through telework implementation in businesses by industry, in $AU;

$\Delta\%(\text{savings})\text{Recruitment}$ is reduction in recruitment costs by industry, in percent, from chapter 5.4;

$\Delta\%(\text{savings})\text{Operational benefits}_{\text{Industry}}$ is reduction in operational expenditure by industry, in percent, from chapter 5.4;

$\$\text{LAB}_{\text{Industry}}$ is industry return to labour by industry, in $AU, from Table 6.18;

$\Delta\%(\text{savings})\text{Labour}$ is improvement in the productivity of labour inputs, in percent, from chapter 5.4;

$\Delta\%(\text{savings})\text{Absenteeism}$ is reduction in an employee's intentional or habitual absence from work compared to a non-teleworking employee, in percent, from chapter 5.4; and

$\$\text{LAB New Teleworkers}_{\text{Industry}}$ is industry return to labour of additional teleworkers by 2020 described below.

We have derived the industry return to labour of additional teleworkers by 2020 in each industry ($\$\text{LAB New Teleworkers}_{\text{Industry}}$) as follows:

$$\$\text{LAB New Teleworkers}_{\text{Industry}} = (\%\text{Teleworkers Y2020} - \%\text{Teleworkers Y2006}) \times \%\text{Teleworkers}_{\text{Industry}} \times \$\text{LAB}_{\text{Industry}} \quad (27)$$

where

$\$\mathrm{LAB\ New\ Teleworkers}_{\mathrm{Industry}}$ is industry return to labour of previously non-teleworkers with telework arrangements by 2020, in $AU;

$\%\mathrm{Teleworkers\ Y2020}$ is employees with telework arrangements in percent in accordance with the Government's telework target of 12% by 2020 (Deloitte Access Economics and Colmar Brunton, 2012); and

$\%\mathrm{Teleworkers\ Y2006}$ is employees with telework arrangements in percent, i.e. 6%, sourced from Deloitte Access Economics and Colmar Brunton (2012);

$\%\mathrm{Teleworkers}_{\mathrm{Industry}}$ is persons who worked any hours at home in main or second job by industry, in percent, from Table 6.18.

$\$\mathrm{LAB}_{\mathrm{Industry}}$ is industry return to labour by industry, in $AU, from Table 6.18.

The first term on the right hand side of equation (27) estimates the percentage change of teleworkers from 2006 to 2020. The second term allocates the estimated net additions of teleworkers in percent to industries equi-proportionate to actual numbers of teleworkers. The percentages were derived from statistics on number of persons who worked any hours at home in main or second job by industry, sourced from ABS (2009a). The last term is the total industry return to labour in each industry.

To derive the ratios required in equation (27), we have mapped the number of persons who worked any hours at home in main or second job by ANZSIC industry to the industries in the economic model database. Table 6.17 shows our mapping of industries in the economic model database to ANZSIC industries of job worked at home to.

Table 6.17: Mapping of ANZSIC industries of job worked at home

ANZSIC industry	Persons ('000)	Persons (%)	TERM Industry
Other services	104.3	4.3%	Not mapped
Arts and recreation services	47.4	2.0%	17 RecPersSrvc
Health care and social assistance	154.6	6.4%	24 Community
Education and training	372.3	15.5%	23 Education
Public administration and safety	79	3.3%	22 PubAdmDef
Administrative and support services	75.4	3.1%	21 FinBusSrvces
Professional, scientific and technical services	316.8	13.1%	21 FinBusSrvces
Rental, hiring and real estate services	67.1	2.8%	21 FinBusSrvces
Financial and insurance services	82.6	3.4%	21 FinBusSrvces
Information media and telecommunications	50.9	2.1%	20 Telecomms
Transport, postal and warehousing	94.5	3.9%	18 Transport; 19 PostalSrvcs
Accommodation and food services	66.5	2.8%	3 FoodDrinkTob
Retail trade	142	5.9%	16 RetailTrade
Wholesale trade	85.7	3.6%	15 WholesalTrad
Construction	276.7	11.5%	14 Construction
Electricity, gas, water and waste services	18.3	0.8%	13 EGW

Manufacturing	132.3	5.5%	4 TCFs; 5 MiscManuf; 6 WoodProds; 7 PaperPrint; 8 ChemCoalPrds; 9 NonMetMinPrd; 10 MetalPrds; 11 TransEqp; 12 OthMachEqp
Mining	12.9	0.5%	2 Mining
Agriculture, forestry and fishing	230.1	9.6%	1 AgriForFish
Total	**2409.2**	**100%**	

We have mapped all industries except 'other services' accounting for 4.3% of persons who worked any hours at home in main or second job. In cases where we have mapped more than one TERM industry to an ANZSIC industry division, industry return to labour from the economic model base year data for 2010/2011 was used to allocate the industry data equi-proportionate to the respective TERM industry. Our estimates of persons who worked any hours at home in main or second job by TERM industry are shown in Table 6.18.

Table 6.18: Mapping of industry of job worked at home

TERM Industry	Industry return to labour (million $AU)	Persons who worked any hours at home in main or second job by industry (%)
1 AgriForFish	25,233.8	9.6%
2 Mining	21,657.3	0.5%
3 FoodDrinkTob	19,969.7	2.8%
4 TCFs	7,088.6	0.4%
5 MiscManuf	5,807.0	0.3%
6 WoodProds	5,299.1	0.3%
7 PaperPrint	11,955.5	0.7%
8 ChemCoalPrds	9,038.3	0.5%
9 NonMetMinPrd	5,944.7	0.3%
10 MetalPrds	23,361.0	1.3%
11 TransEqp	7,857.1	0.7%
12 OthMachEqp	15,482.8	0.9%
13 EGW	10,700.0	0.8%
14 Construction	114,961.6	11.5%
15 WholesalTrad	58,209.4	3.6%
16 RetailTrade	92,586.4	5.9%
17 RecPersSrvc	72,520.8	2.0%
18 Transport	49,174.7	3.8%
19 PostalSrvcs	1,844.4	0.1%
20 telecoms	13,731.0	2.1%
21 FinBusSrvces	230,970.0	22.5%
22 PubAdmDef	66,015.6	3.3%
23 Education	78,956.9	15.5%

24 Community	103,453.1	6.4%

Our estimates of industry return to labour of previously non-teleworkers with telework arrangements by 2020 calculated in equation (27) is shown in Table 6.19.

Table 6.19: Estimated industry return to labour of additional teleworkers in 2020

Industry	Additional teleworkers (million $AU)
1 AgriForFish	145
2 Mining	7
3 FoodDrinkTob	33
4 TCFs	2
5 MiscManuf	1
6 WoodProds	1
7 PaperPrint	5
8 ChemCoalPrds	3
9 NonMetMinPrd	1
10 MetalPrds	20
11 TransEqp	2
12 OthMachEqp	9
13 EGW	5
14 Construction	792
15 WholesalTrad	124
16 RetailTrade	327
17 RecPersSrvc	86
18 Transport	112
19 PostalSrvcs	0
20 Telecomms	17
21 FinBusSrvces	3,117
22 PubAdmDef	130
23 Education	732
24 Community	398

Our estimated cost savings of telework implementation in businesses by industry calculated in equation (26) are shown in the second column in Table 6.20.

We have estimated the costs of telework implementation for each industry as follows:

$$\Delta\$(\text{costs})\text{Workplace}_{\text{Industry}} = (1 + \Delta\%(\text{costs})\text{Churn}) \times \Big(\big(\Delta\%(\text{costs})\text{Shortfall}_{\text{Industry}} + \Delta\%(\text{costs})\text{Training}\big) \times \$\text{LAB}_{\text{Industry}} + \Delta\%(\text{costs})\text{Fitout} \times \$\text{LAB New Teleworkers}_{\text{Industry}}\Big) \quad (28)$$

where

$\Delta\$(\text{costs})\text{Workplace}_{\text{Industry}}$ is telework implementation costs in organisations by industry in $AU;

$\Delta\%(\text{costs})\text{Churn}$ is churn factor which refers the impact of work place changes on corporate productivity, in percent, from chapter 5.4;

$\Delta\%(\text{costs})\text{Shortfall}_{\text{Industry}}$ is shortfall of non-teleworkers by industry, in percent, from chapter 5.4;

$\Delta\%(\text{costs})\text{Training}$ is additional consulting and training costs for teleworkers, in percent, from chapter 5.4;

$\$\text{LAB}_{\text{Industry}}$ is industry return to labour by industry, in $AU, from Table 6.18;

$\Delta\%(\text{costs})\text{Fitout}$ is additional ICT costs for teleworkers, in percent, from chapter 5.4; and

$\$\text{LAB New Teleworkers}_{\text{Industry}}$ is industry return to labour of previously non-teleworkers with telework arrangements by 2020 from Table 6.19.

Our estimated costs of telework implementation in businesses by industry are shown in the third column in Table 6.20.

We have derived the net benefits of telework implementation in businesses by 2020 for each industry as follows:

$$\Delta\$(\text{savings})\text{LAB}_{\text{Industry}} = \Delta\$(\text{savings})\text{Workplace}_{\text{Industry}} - \Delta\$(\text{costs})\text{Workplace}_{\text{Industry}} \quad (29)$$

Where

$\Delta\$(\text{savings})\text{LAB}_{\text{Industry}}$ is net savings of industry return to labour, in $AU;

$\Delta\$(\text{savings})\text{Workplace}_{\text{Industry}}$ is savings through telework implementation in businesses by industry, in $AU, from Table 6.20; and

$\Delta\$(\text{costs})\text{Workplace}_{\text{Industry}}$ is telework implementation costs in businesses by industry in $AU, from Table 6.20.

Table 6.20 shows the estimated costs, cost savings, and net savings of telework implementation in businesses by 2020 for each industry, calculated in equations (26), (28) and (29).

Table 6.20: Industry costs and benefits of telework implementation in businesses

Industry	Savings (million $AU) (2)	Costs (million $AU) (3)	Net savings (million $AU) (4)=(2)-(3)
1 AgriForFish	286	180	106
2 Mining	157	105	52
3 FoodDrinkTob	218	144	74
4 TCFs	69	46	23

5 MiscManuf	47	31	15
6 WoodProds	53	36	17
7 PaperPrint	114	76	38
8 ChemCoalPrds	82	55	27
9 NonMetMinPrd	64	43	21
10 MetalPrds	216	144	72
11 TransEqp	52	35	17
12 OthMachEqp	146	97	48
13 EGW	79	53	26
14 Construction	1,231	759	472
15 WholesalTrad	490	319	171
16 RetailTrade	1,060	685	375
17 RecPersSrvc	696	461	235
18 Transport	364	236	129
19 PostalSrvcs	21	14	7
20 Telecomms	79	52	27
21 FinBusSrvces	1,628	821	807
22 PubAdmDef	554	362	192
23 Education	641	367	274
24 Community	1,011	646	365

To analyse the long-run effects of people telework more with the NBN, we have changed the values of the labour-augmenting technical change variable over all occupations by industry and region of employment ($\text{alab\_o}_{\text{Industry,Region}}$) in the economic model. We have derived the percentage change values that we have applied to the exogenous variable as follows:

$$\text{alab\_o}_{\text{Industry,Region}} = \left(-\Delta\$(\text{savings})\text{LAB}_{\text{Industry}} \times \frac{1}{\$\text{LAB}_{\text{Industry}}} \times \frac{\#\text{Teleworkers}(\text{NBN impact on service delivery})_{\text{Region}}}{\#\text{Teleworkers}_{\text{Region}}}\right) \times 100 \tag{30}$$

where

$\text{alab\_o}_{\text{Industry,Region}}$ is percentage change of labour-augmenting technical change by industry and region of use;

$\Delta\$(\text{savings})\text{LAB}_{\text{Industry}}$ is net savings of the industry return to labour, in \$AU, from Table 6.20;

$\$\text{LAB}_{\text{Industry}}$ is industry return to labour by industry, in \$AU, from Table 6.18;

$\#\text{Teleworkers}(\text{NBN impact on service delivery})_{\text{Region}}$ is number of teleworkers by region of residence subject to the NBN impact on service delivery; and

$\#\text{Teleworkers}_{\text{Region}}$ is number of teleworkers by region of residence.

The first term on the right hand side of equation (30) is the estimated reduction in the industry return to labour. The purpose of the second term is to estimate the technical change in each industry, in percent. The last term accounts for the NBN impact on service delivery in terms of number of teleworkers in each region. The required ratios were not available to us. Instead, we have used the ratios of the term on the right hand side of the following equation as a reasonable approximation.

$$\frac{\#\text{Teleworkers(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Teleworkers}_{\text{Region}}} \approx \frac{\#\text{Residents(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Residents}_{\text{Region}}} \tag{31}$$

where

$\frac{\#\text{Teleworkers(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Teleworkers}_{\text{Region}}}$ are ratios we require in equation (30); and

$\frac{\#\text{Residents(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Residents}_{\text{Region}}}$ are ratios of the NBN impact on service delivery in terms of persons by region of residence estimated for Telework from Table 5.3 for modest access speeds and Table 5.4 for high access speeds.

We note that most teleworkers are not teleworking every day of their working week, but less (Bentley et al., 2013; Deloitte Access Economics and Colmar Brunton, 2012). Most persons who work any hours at home may therefore commute to some extent. Research has shown that people tend to gradually adjust the location of their homes relative to their workplace when telecommuting (Zhu, 2012). However, the constant travel-time budget suggested by Marchetti (1994) limits people's commute time, activity time, and the subsequently induced non-work travel. We have therefore assumed that the ratio of additional teleworkers to persons usually resident in a region is similar.

The percentage change values we have estimated in equation (30) are shown in Appendix C.

Telework – Aggregate employment

To analyse the long-run effects of increased labour participation due to people telework more with the NBN, we have changed the values of the aggregate (national) employment percentage change variable ($NatMacro(\text{"}AggEmploy\text{"})$) in the model long-run simulation. First, we have estimated the number of additional teleworkers by 2020 in each region as follows:

$$\Delta\#\text{FTE}_{\text{Region}} = \Delta\#\text{FTE} \times \sum_{\text{Industry}=1}^{24}\left(\frac{\$\text{LAB}_{\text{Industry,Region}}}{\$\text{LAB}_{\text{Industry}}} \times \%\text{Teleworkers}_{\text{Industry}}\right) \tag{32}$$

where

$\Delta\#\text{FTE}_{\text{Region}}$ is number of potential workers who increase participation in the labour force in full-time equivalent (FTE) terms by region;

$\Delta\#\text{FTE}$ is number of potential FTEs who increase participation in the labour force from chapter 5.4;

$\$\mathrm{LAB}_{\mathrm{Industry,Region}}$ is industry return to labour by industry and region of employment, in $AU, from Table 6.21;

$\$\mathrm{LAB}_{\mathrm{Industry}}$ is industry return to labour by industry, in $AU, from Table 6.18; and

$\%\mathrm{Teleworkers}_{\mathrm{Industry}}$ is persons who worked any hours at home in main or second job by industry, in percent, from Table 6.18.

The first term on the right hand side of equation (32) is the number of potential FTEs increasing labour force participation with telework by 2020. The purpose of the second term is to estimate the location of work for teleworkers in a region subject to the proportion of industry return to labour in a region and persons who worked any hours at home in main or second job by industry. In other words, the increased labour force participation will occur according to the share of persons employed and teleworkers in each industry. For want of more detailed regional data, we have made two assumptions. First, the proportions of persons who worked any hours at home in main or second job by industry are similar across regions. Second, the FTEs increasing labour force participation are teleworking in the same region as their place of employment. While these assumptions may not be true in all cases, they are reasonable assumptions for the majority of teleworkers who are not teleworking every day of their working week, but less (Bentley et al., 2013; Deloitte Access Economics and Colmar Brunton, 2012). We have then aggregated our regional estimates to national estimates taking into consideration the NBN impact of service delivery in a region.

Table 6.21 shows industry return or payments to labour by industry and region of employment from the economic model base year data for 2010/2011 required in equation (32).

Table 6.21: Industry return (payments) to labour in 2010/2011 (million $AU)

	Greater Sydney	Rest of NSW	Greater Mel-bourne	Rest of Vic.	Greater Brisbane	Rest of Qld	Greater Adelaide	Rest of SA	Greater Perth	Rest of WA	Tasmania	Northern Territory	Australian Capital Territory
1 AgriForFish	558	5,680	695	4,654	941	5,514	257	2,366	401	2,720	1,229	187	30
2 Mining	563	3,498	544	819	1,215	5,158	661	620	4,604	3,366	288	311	12
3 FoodDrinkTob	3,260	2,469	3,626	2,256	2,111	2,341	971	807	977	415	641	41	56
4 TCFs	1,240	817	1,547	728	849	438	355	216	374	157	302	17	47
5 MiscManuf	1,250	366	1,804	274	794	215	443	61	427	70	60	19	23
6 WoodProds	1,201	298	1,441	377	733	129	332	112	367	47	230	12	20
7 PaperPrint	4,034	810	2,765	557	1,397	395	550	122	768	114	207	68	167
8 ChemCoalPrds	2,278	743	2,116	555	1,072	404	412	109	930	248	123	26	22
9 NonMetMinPrd	1,263	609	1,133	375	898	343	338	88	595	123	110	32	38
10 MetalPrds	3,408	3,094	3,694	1,342	3,159	2,232	1,217	568	2,245	1,363	533	423	83
11 TransEqp	780	457	2,752	564	1,052	379	1,195	90	400	63	78	29	17
12 OthMachEqp	3,906	1,358	3,431	728	1,958	666	1,324	219	1,286	226	233	54	95
13 EGW	1,880	1,515	1,446	861	1,287	1,071	589	254	852	384	344	74	143
14 Construction	22,017	12,564	19,598	7,642	18,291	8,462	5,342	1,949	10,589	3,759	2,189	1,018	1,542
15 WholesalTrad	16,005	4,337	13,635	2,664	7,858	2,785	2,794	733	4,720	934	1,039	349	356
16 RetailTrade	19,585	10,491	17,438	5,812	12,054	6,377	4,962	1,660	7,258	2,363	2,056	895	1,635
17 RecPersSrvc	16,464	8,038	13,520	3,844	10,249	4,246	3,837	1,254	5,589	1,550	1,540	854	1,537
18 Transport	11,822	5,101	8,914	2,571	7,130	3,807	2,416	710	3,334	1,081	1,140	516	632
19 PostalSrvcs	443	181	398	108	237	103	99	29	138	35	38	10	26
20 Telecomms	3,513	1,164	3,000	678	1,814	668	738	167	1,047	243	278	117	304
21 FinBusSrvces	65,225	18,875	47,037	9,613	32,685	10,051	11,744	2,838	19,219	4,298	3,953	1,662	3,771
22 PubAdmDef	12,385	7,066	9,690	3,505	9,092	4,300	3,990	994	5,382	1,547	2,070	1,557	4,438
23 Education	16,608	9,702	14,908	5,192	9,971	4,946	4,541	1,409	5,708	1,625	1,738	769	1,839
24 Community	22,685	11,509	19,524	5,977	14,062	5,645	7,069	1,550	8,612	1,742	2,337	947	1,794

We have derived the percentage change values that we have applied to the exogenous variable as follows:

$$NatMacro("AggEmploy") = \left(\sum_{\text{Region}=1}^{13}\left(\Delta\#\text{FTE}_{\text{Region}} \times \frac{\#\text{Teleworkers(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Teleworkers}_{\text{Region}}}\right) \times \frac{1}{\#\text{LAB 2020}}\right) \times 100 \tag{33}$$

where

$NatMacro("AggEmploy")$ is percentage change of aggregate employment;

$\Delta\#\text{FTE}_{\text{Region}}$ is number of FTEs increasing labour force participation by region from equation (32);

$\frac{\#\text{Teleworkers(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Teleworkers}_{\text{Region}}}$ are ratios identical to the ones we require in equation (30);

$\#\text{LAB 2020}$ is labour force by 2020 of about 12.9 million, sourced from Deloitte Access Economics and Colmar Brunton (2012).

The first term on the right hand side of equation ((33) reflects the estimated number of FTEs increasing participation in the labour force with telework in a region. The second term accounts for the NBN impact on service delivery in terms of teleworkers usually resident, which was not available to us. Similar to equation (30), we have replaced the ratios of teleworkers subject to the NBN impact on service delivery with the right hand side of equation (31). The purpose of the last term is to estimate the percentage change of labour force participation by 2020.

The increases in aggregate employment with the NBN when services require modest access-speeds we have estimated in equation (33) are approximately 0.02%, and approximately 0.62% when services require high access-speeds.

Online entertainment – Household preferences

We have quantified the impact of online services as a change to households' subsistence demand for Recreation and Personal Services. In the model long-run simulation, we have changed the values of the subsistence taste shift variable for Recreation and Personal Services by region of use ($\text{ahou\_s}_{\textit{"RecPersSrvc"},\text{Region}}$). The percentage change values of the exogenous variable were derived as follows:

$$\text{ahou\_s}_{\textit{"RecPersSrvc"},\text{Region}} = \left(\Delta\$\text{(increase)Online Services}_{\text{Region}} \times \frac{1}{\$\mathit{RecPersSrvc}\ \text{HH Use}_{\text{Region}}} \times \frac{\#\text{Residents(NBN impact on service delivery)}_{\text{Region}}}{\#\text{Residents}_{\text{Region}}}\right) \times 100 \tag{34}$$

where

$ahou\_s_{"RecPersSrvc",\mathrm{Region}}$ is percentage change of the taste change variable for Recreation and Personal Services over all sources and households by region of use;

$\Delta\$(\mathrm{increase})\mathrm{Online\ Services}_{\mathrm{Region}}$ is estimated increase in the cost of households' entertainment expenditure through greater access to online services of $AU 350 per household or $AU 2,992 million in total by 2020, from chapter 5.4;

$\$RecPersSrvc\ \mathrm{HH\ Use}_{\mathrm{Region}}$ is households' spending on Recreation and Personal Services by region of use, in $AU, from Table 6.22; and

$\frac{\#\mathrm{Residents(NBN\ impact\ on\ service\ delivery)}_{\mathrm{Region}}}{\#\mathrm{Residents}_{\mathrm{Region}}}$ are ratios of the NBN impact on service delivery in terms of persons by region of residence estimated for online services from Table 5.3 for modest access speeds and Table 5.4 for high access speeds in chapter 5.3.

The first term on the right hand side of equation (34) is the estimated increase in the cost of households' entertainment expenditure through greater access to online services from chapter 5.4. The purpose of the second term is to derive the percentage changes of the estimated household subsistence demand change for Recreation and Personal Services. The last term accounts for the NBN impact on service delivery in terms of persons usually resident.

Table 6.22 shows the private consumption of Recreation and Personal Services from the economic model base year data for 2010/2011.

Table 6.22: Private consumption of Recreation and Personal Services in 2010/2011 (million $AU)

Region	Private consumption of Recreation and Personal Services (million $AU)
Greater Sydney	25,342
Rest of NSW	14,757
Greater Melbourne	19,937
Rest of Vic.	7,290
Greater Brisbane	16,751
Rest of Qld	8,779
Greater Adelaide	6,115
Rest of SA	2,269
Greater Perth	8,698
Rest of WA	3,080
Tasmania	2,907
Northern Territory	1,278
Australian Capital Territory	2,096
Total	**119,300**

The percentage change values we have estimated in equation (34) are shown in Appendix C.

6.6 Concluding Remarks

Most methodologies that forecast or observe impacts of the use of the internet at the whole-of-economy level employ a 'top-down' approach. For example, studies by the OECD (2003) and Simon and Wardrop (2002) relied on the growth accounting framework. That is, they have identified the residual of the growth that cannot be explained by changes to the various inputs of an economy or a sector over a given time period in the national accounts and assumed respective growth in productivity. With a few exceptions (ACIL Tasman, 2004; Matsumoto et al., 2007; Access Economics, 2009), studies focusing on the impact of ubiquitous network technologies have not extrapolated evidences of service benefits to a whole-of-economy level.

In this chapter, we have described in detail the use of a 'bottom-up' approach by extrapolating evidences from studies focusing on new services enabled by broadband to a whole-of-economy level. We have described in brief TERM, which we have adopted for the whole-of-economy level general equilibrium analysis. We have added the NBN into the TERM database and estimated the base year data for 2010/2011 in a historical simulation. We have described the economic environment under which a model simulation is run specified in each model closure in terms of the variables that are treated as exogenous. Our main contribution in this chapter is to estimate a variety of changes to the exogenous variables in the model by combining evidences of service benefits and our estimates of the NBN impact on service delivery summarised in the previous chapter.

In the comparative-static model framework, we have not considered broadband and new services adoption over time. Rather, in considering the state of the economy in a typical long-run year, we have assumed final service adoption levels in the economic sectors that, if supported by accompanied policies, are likely to be conservative.

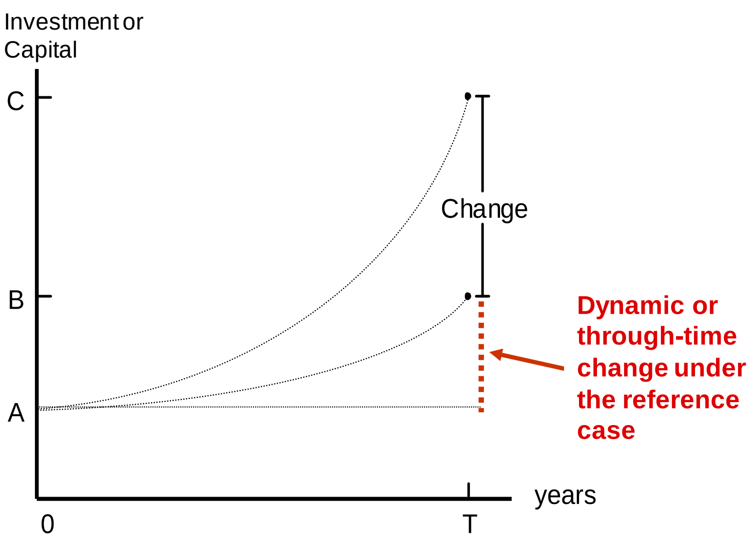
In the chapter that follows, we will run the model simulations with the inputs derived in this chapter. Based on the model output, we provide simulation-specific interpretations by focusing first on macroeconomic variables, then on structural variables such as industry output.

CHAPTER 7
Economic Impact of the NBN

7.1 Introduction

As a result of the inputs to TERM derived in the previous chapter, we have estimated the potential impact of the NBN on the Australian economy. We have relied on a comparative-static general equilibrium analysis in TERM to explore and investigate the impact of the NBN in the short and in the long run post NBN deployment. The model simulation results are of the form: given the NBN, then in the macroeconomic environment under which a simulation is run, variable *X* will differ in the short run by *x* percent from the value it would have had in the absence of the NBN, while in the long run it will differ by *y* percent. Figure 7.1 illustrates the typical result for investment or capital in *T* years.

Figure 7.1 Comparative-static interpretation of results in TERM



Source: Centre of policy studies, presentation from 2010

In Figure 7.1, *A* is the value of investment or capital parameter in the base year (at year *T* = 0) and represents the initial solution of the equation system in TERM. The value *B* corresponds to the reference case (no-NBN) value of the investment or capital parameter after *T* years. *T* can be interpreted as a typical short- or long-run year depending on the choice of exogenous variables in the model closure, which we have described in chapter 6. The through-time change or evolution over *T* years under the reference case in the absence of the NBN is illustrated by the lower trace from *A* to *B*. The upper trace from *A* to *C* represents the through time change or evolution over *T* years of the parameter with the NBN built. The difference between *A* and *B* represents the result of the reference case and is not subject of this study, which relies on a comparative-static version of TERM. The difference between *B* and *C* represents the impact of the NBN scenario relative to the reference case of no NBN and is the main focus of this study. The comparative-static model evaluates deviations away from the initial solution which can be interpreted as the (percentage) change of the investment or capital parameter from *B* to *C* in *T* years from the base year resulting from implementing the NBN.

We briefly describe the reference case and its relevance in a comparative-static CGE model in the next section. We then describe our approach in running the model short-run and long-run simulations. In the remainder of the chapter, we provide quantitative estimates of the national, industry and regional effects of the NBN on the economy and describe in broad terms how these results arise from the relationships in the economic model. We use a back-of-the-envelope (BOTE) analysis for the description of the macroeconomic results, where appropriate. The BOTE analysis is based on a stylised or simplified version of TERM and captures its main macroeconomic relationships. This approach is generally useful when evaluating and interpreting the simulation results derived using the full model. The industry-level results can be typically explained by the macro results.

7.2 The Reference Case

The inputs to TERM in the form of changes in the values of selected exogenous variables are relative to a reference case. Changes imposed to the exogenous variables are measures of the incremental impact over and above changes of these variables in the reference case. The choice of reference case can affect the model simulation results and is therefore critical when modelling the economic impact of the NBN. In this section, we outline the reference case, which we have developed in the previous chapters.

In the reference case, broadband access technologies are available in the mid- to long-term future with no NBN. We have considered actual network deployments and assumed some development of broadband technologies within the footprint of existing networks. The changes of access speeds and broadband services availability based on these assumptions are described in more detail in chapter 4.

End users in the reference case have access to the same set of applications subject to the same access-speed requirements as in a typical long-run year with the NBN. It takes the conservative view implicitly that ubiquity does not bring additional benefits in terms of the type of applications.

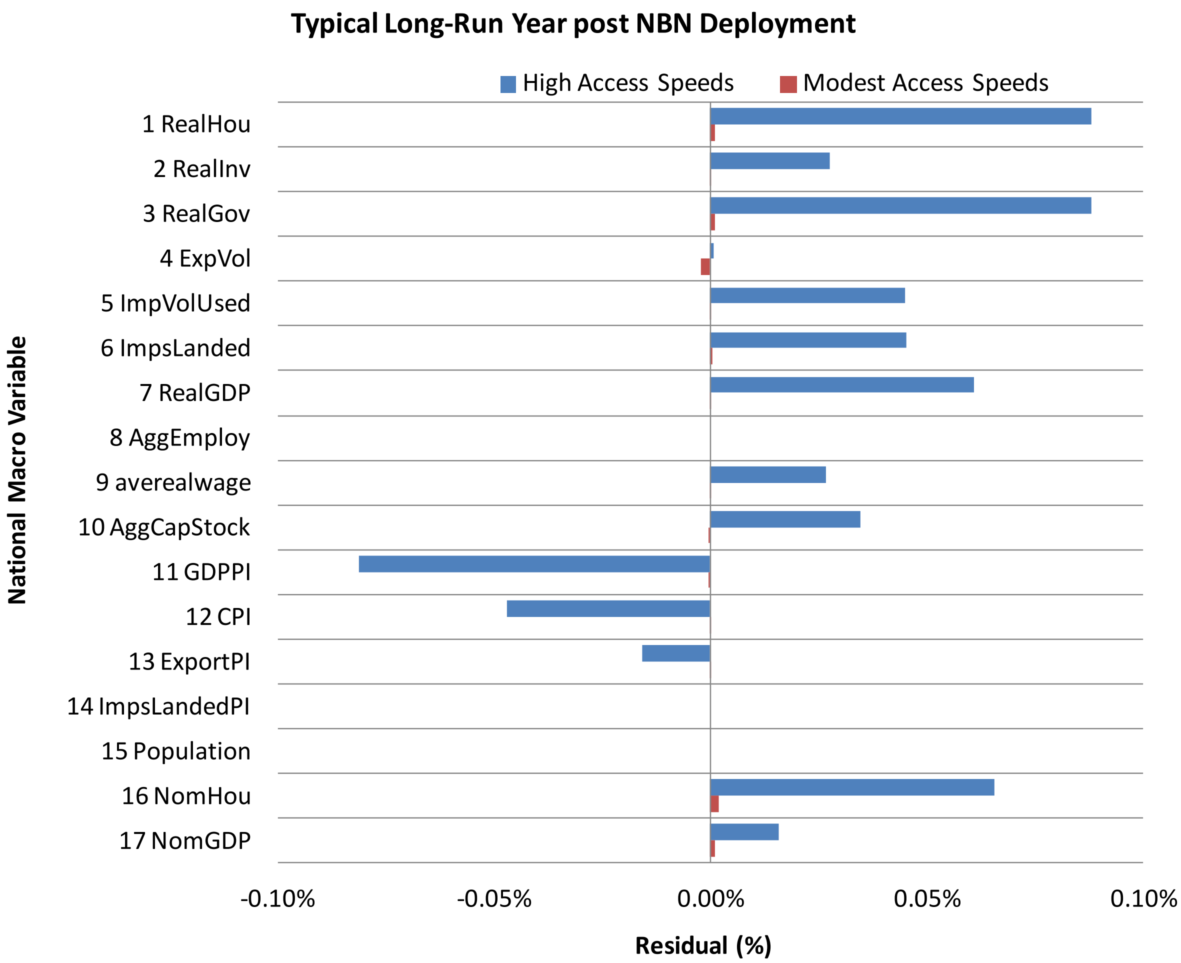
7.3 Solution method and linearisation error

The non-linear equations and relationships in TERM are linearised following Johansen (1960). Johansen results are not exact, except for small shocks. The linearisation error occurs because the computation does not exactly account for the changes in the model coefficients, derivatives or elasticities, when departing from the initial values of the variables (Dixon and Rimmer, 2010).

To minimise the linearisation error and produce close to exact solutions, Dixon et al. (1982) have developed a multi-step version of Johansen's one-step solution method. The multi-step Johansen/Euler method breaks large changes in the exogenous variables into a user specified number of equal components. For each sub-change in the exogenous variables, then, the consequent sub-change in the endogenous variables that are dependent on the exogenous variables is derived using a linear approximation. Results for the first sub-change are calculated and the database is updated accordingly. Using the new database, results are calculated for the second sub-change and so forth. Errors are super-proportional to the size of the shock. That is, halving the percentage change in the exogenous variables leads to errors at each step that are less than half the size of the error produced by the computation of the whole percentage change. Thus, the more steps that are applied, increasing the number of equal components, the closer the results get to the actual solution. An extrapolated solution is the best way to obtain an accurate solution (Harrison et al., 2014). That is, "[...] to carry out 2 or 3 different multi-step calculations with different numbers of steps and to then calculate the solution as an appropriate weighted average of these." (Harrison et al., 2014, p. 47 and 48).

The simulation results presented in this chapter are extrapolated (Euler) solutions with 3 multi-step calculations using 4, 6, and 8 steps. For presentation purposes of the model long-run simulation results described in section 7.5, we have quantified the impact of each service group separately by running multiple long-run simulations. Each simulation is run with only those percentage changes imposed on the selected exogenous variables that we have estimated for the respective service group described in chapter 6. The sum of results computed for each service group differs marginally from the results of one simulation with the percentage changes for all service groups included because of the linearisation error described above. Assuming that the impact of all services groups will occur over the same period, we have treated the results of one long-run simulation with all percentage changes included as the true result. Figure 7.2 shows the residual for selected national macroeconomic variables resulting from the difference between the two solutions expressed in absolute terms. We have subtracted the single shock solution as percentage change in the national macro variables relative to the reference case from the multiple sub-shock solution.

Figure 7.2: Absolute difference in solutions for national macroeconomic variables with the NBN relative to the reference case



The residuals shown in Figure 7.2 are smaller in the model long-run simulation with the NBN when the percentage changes in the exogenous variables are relatively small as is the case in the modest access-speed requirements scenario. Since the residuals in both scenarios are negligible, the multiple sub-shock solution we are referring to in this chapter provide a reasonable approximation of the true result, that is, the single shock solution.

In the section that follows, we describe the effects of the NBN in the construction phase.

7.4 Short-run simulation results

Our focus in this section is on the effects of NBN deployment. We have assumed that the use of the NBN in the short term has no or negligible economic impact. Thus, we have not imposed changes in the exogenous variables in terms of any service usage. That is, the only economic impact in the model short-run simulation is the construction of the NBN itself. The results are largely driven by the increased investment particularly in the newly added NBN wholesale service industry.

First, we will focus on the national macroeconomic results, then on the sectoral results with the NBN in the short term.

National macroeconomic results

Figure 7.3 shows the results of the model short-run simulation for selected macroeconomic variables. The percentage changes compared with the reference case indicate whether the value of the economic variables in a typical short-run year might be greater (positive), smaller (negative) or the same (0) as it otherwise would have been in the absence of the NBN, that is, in the reference case.

Figure 7.3: National macroeconomic variables with the NBN in the short term

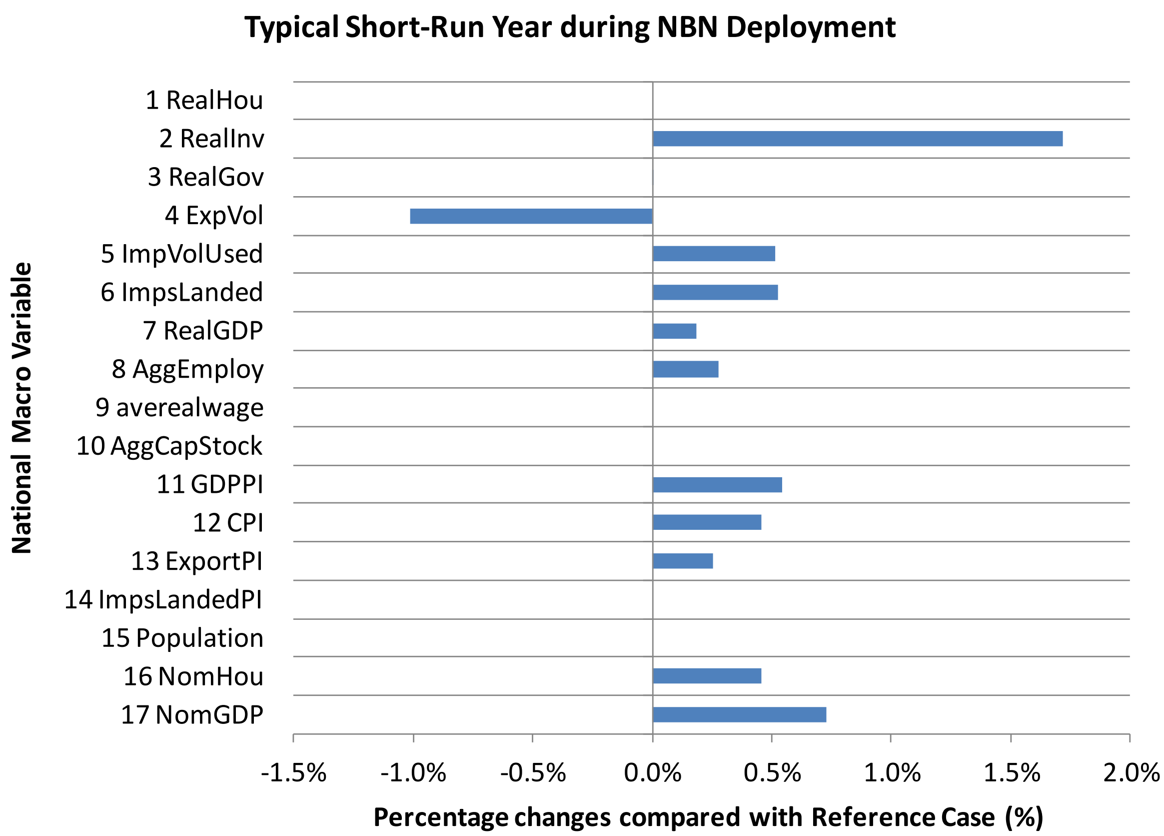


Table 7.1: lists the national results in a typical short-run year as shown in Figure 7.3. National macroeconomic variables that are exogenous are shown in italics and highlighted in yellow.

Table 7.1 National macroeconomic variables with the NBN in the short term

National Macroeconomic Variable	Long Name	Percentage change compared with Reference Case
1 RealHou	*Real Household Consumption*	*0%*
2 RealInv	*Real Investment*	*1.72%*
3 RealGov	Real Government Consumption	0.001%
4 ExpVol	Export Volume	-1.01%
5 ImpVolUsed	Import Volume (Used)	0.51%
6 ImpsLanded	Import Volume (Landed)	0.53%
7 RealGDP	Real GDP	0.18%
8 AggEmploy	Aggregate Employment	0.28%
9 averealwage	*Average Real Wage*	*0%*
10 AggCapStock	*Aggregate Capital Stock*	*0%*

National Macroeconomic Variable	Long Name	Percentage change compared with Reference Case
11 GDPPI	GDP Price Index	0.55%
12 CPI	Consumer Price Index	0.46%
13 ExportPI	Export Price Index	0.25%
14 ImpsLandedPI	*Imports Landed Price Index*	*0%*
15 Population	*Population Size*	*0%*
16 NomHou	Nominal Household Consumption	0.46%
17 NomGDP	Nominal GDP	0.73%

In the remainder of this section, we will refer to the national macroeconomic variables by their code and long name as shown in the first and second column of Table 7.1, respectively, e.g. Imports Landed Price Index {14}.

As described in chapter 6.3, we have treated Real Household Consumption {1}, Real Investment {2} and Real Government Consumption {3} as exogenous in the short-run closure. Due to the imposed changes to investment in the NBN, gross national expenditure or domestic absorption (sum of Real Household Consumption {1}, Real Investment {2} and Real Government Consumption {3}) increases more than GDP which will push the trade balance towards deficit. From this it follows that the resources needed in NBN construction become available mainly from reductions in activity in the traded-goods sectors (export-oriented agriculture and mining, and import-competing manufacturing). The comparatively large appreciation of the real exchange rate[22] reduces exports (Export Volume {4}, accompanied by an increase in the Export Price Index {13}) and increases imports (Import Volume (Used) {5}).

Aggregate Employment {8} increases, reflecting improvement in the terms of trade (ratio of Export Price Index {13} to Imports Landed Price Index {14}). With the Average Real Wage {9} and Aggregate Capital Stock {10} assumed to be unchanging in the short-run closure, by definition Real GDP {7} increases due to the increase in Aggregate Employment {8}.

Next, we will give an interpretation of the sectoral results with the NBN in the short term.

Sectoral results

Figure 7.4 shows the results of the national industry activity level or output for all industry groups in TERM. For the aggregation of regional to national industry output, the economic model uses value added weights; for each industry group, the regional share of primary factors (labour, capital, land) is multiplied with the percentage change in the regional output and aggregated to derive the national industry output. Similar to Figure 7.3, the result in the form of percentage changes suggests whether the actual value of the industry output in a typical short-run year might be higher, lower or the same as it otherwise would have been in the absence of the NBN.

[22] The real exchange rate is exogenous. With foreign-currency prices fixed on the import side, real appreciation (devaluation) is derived from a decrease (increase) in the GDP price index {11}.

Figure 7.4: National industry output effects of the NBN in the short term

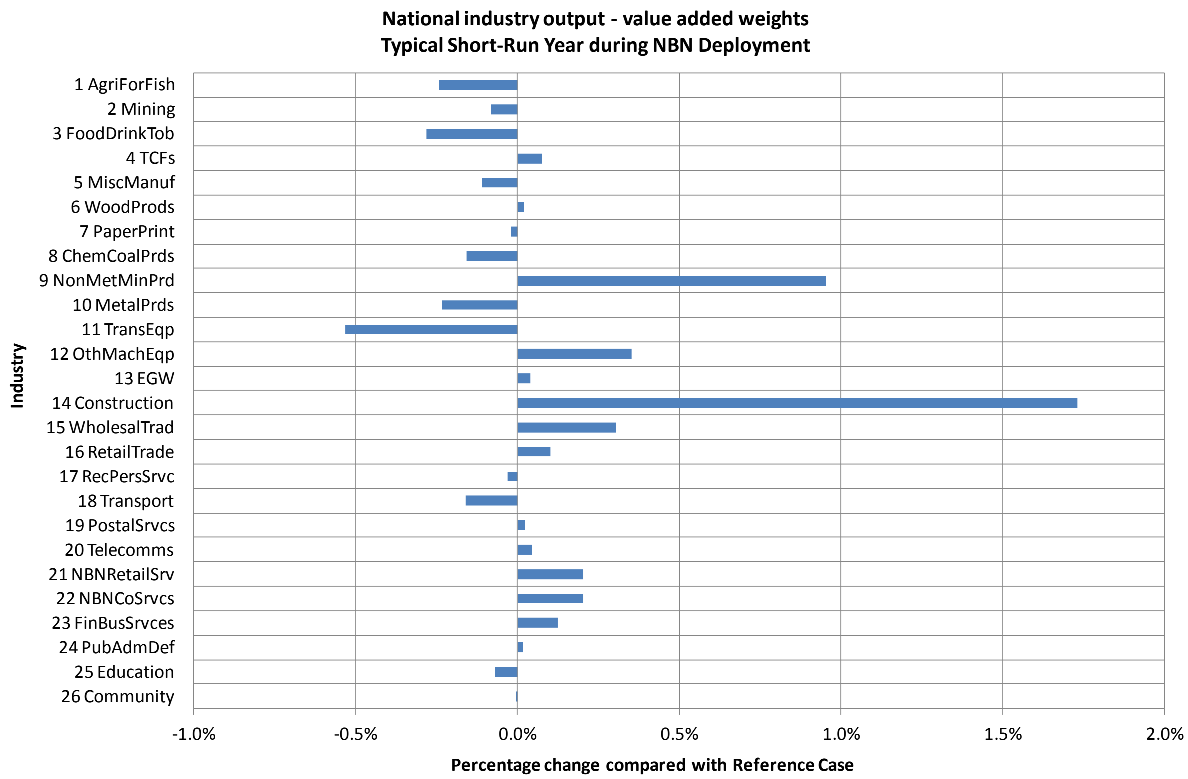


Table 7.2 lists the national sectoral results in a typical short-run year as shown in Figure 7.4.

Table 7.2: Summary of national industry output effects of the NBN in the short term

Industry Name	Long Name	National industry output - value added weights
1 AgriForFish	Agriculture, Forestry and Fishing	-0.24%
2 Mining	Mining	-0.08%
3 FoodDrinkTob	Food, Beverages and Tobacco	-0.28%
4 TCFs	Textiles, Clothing and Footwear	0.08%
5 MiscManuf	Miscellaneous Manufacturing	-0.11%
6 WoodProds	Wood and Wood Products	0.02%
7 PaperPrint	Paper and Printing	-0.02%
8 ChemCoalPrds	Chemicals and Coal Products	-0.16%
9 NonMetMinPrd	Non-Metallic Mineral Products	0.95%
10 MetalPrds	Metal Products	-0.23%
11 TransEqp	Transport Equipment	-0.53%
12 OthMachEqp	Other Machinery and Equipment	0.35%
13 EGW	Electricity, Gas and Water	0.04%
14 Construction	Construction	1.73%
15 WholesalTrad	Wholesale Trade	0.31%
16 RetailTrade	Retail Trade	0.10%
17 RecPersSrvc	Recreation and Personal Services	-0.03%
18 Transport	Transport and Storage	-0.16%

Industry Name	Long Name	National industry output - value added weights
19 PostalSrvcs	Postal Services	0.02%
20 Telecomms	Telecommunication Services	0.05%
21 NBNRetailSrv	NBN Retail Services	0.20%
22 NBNCoSrvcs	NBN Wholesale Services	0.20%
23 FinBusSrvces	Finance and Business Services	0.12%
24 PubAdmDef	Public Administration and Defence	0.02%
25 Education	Education	-0.07%
26 Community	Community Services	-0.004%

The industry-level results can be explained by the macro results. Similar to the previous section, we will refer to the industries in the remainder of the section by their code and long name as shown in the first and second column of Table 7.2, respectively, e.g. Community Services {26}.

About two-thirds of the Construction {14} industry's output is used as an input for creating capital for various industries.[23] The imposed increase of investment in the NBN Wholesale Services {22} benefits producers of capital, e.g. Construction {14}, and Other Machinery and Equipment {12}. This also explains the expansion in industries providing inputs to Construction {14}, such as Non-Metallic Mineral Products {9}, for example. Export-oriented industries, such as Agriculture, Forestry and Fishing {1}, Mining {2}, Metal Products {10}, Food, Beverages and Tobacco {3}, Transport and Storage {18}, and import-competing manufacturing, such as Transport Equipment {11}, are affected negatively by real appreciation of the real exchange rate associated with the increased investment-to-GDP ratio. Wholesale {15} and Retail Trade {16} industries gain from increased imports and related freight and insurance costs. Consumption-oriented industries such as health and social services (included in the Community Services {26} industry group) are relatively unaffected because of our assumptions that Real Household Consumption is unaffected by NBN deployment in the short term and regional real government spending demand follows regional real household demand.

In the section that follows, we give an interpretation of the model long-run simulations results.

7.5 Long-run simulation results

In this section, we give a quantitative description and interpretation of the results in a typical long-run year computed for each service group separately. The economic benefits of the NBN in the long term arise from how it is put to use. It permits people to telework more and to benefit from other new broadband services made more widely available through the NBN. Through changes in business processes, it should lead to improvements in productivity and encourage labour-force participation. To identify the multiple economic impacts of each service group, we will emphasise the model long-run simulation results for each service group in the modest and high access-speed scenarios. Alongside the economic benefits of the NBN in the long term, we have taken into consideration the NBN's economic cost in the form of a trade surplus greater than otherwise would have been required in the absence of the NBN.

[23] Capital creation requires no inputs of primary factors but heavy inputs of construction. Construction industries use primary inputs and pay production taxes for the costs of holding liquidity and inventories associated with the creation of capital.

First, we will focus on the national macroeconomic results, then on the industry level results, and finally on the regional results for some of the macroeconomic variables.

National macroeconomic results

We have explored two broad scenarios for the future post NBN deployment. In one, the services considered require only modest access speeds (both down to the customer and up to the network). In this case, an evolved broadband environment of the future without the NBN would be able to satisfy most service needs and the NBN will have only a marginal impact. In the other scenario, the services require higher access speeds and the NBN has a significant impact on their delivery and the consequent economic benefit. Figure 7.5 compares the impact of the NBN on national real GDP under both future scenarios.

Figure 7.5: Impacts of the NBN on national real GDP in the long term

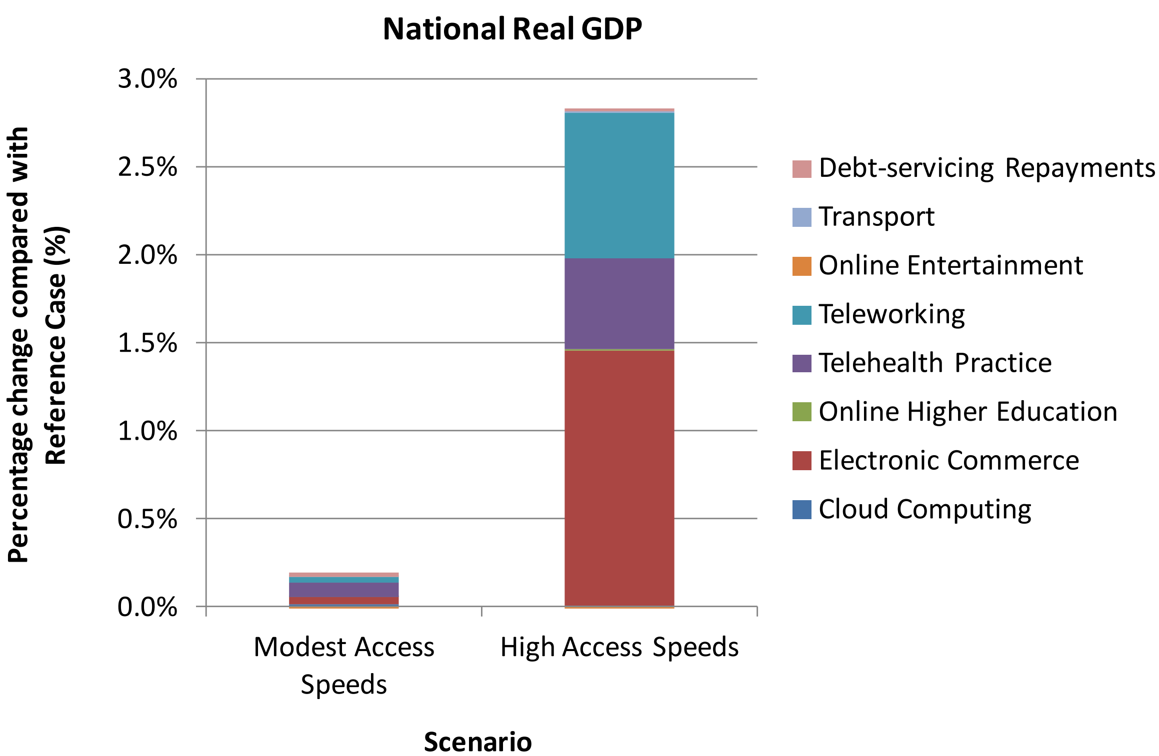


Table 7.3 shows the percentage changes in National Real GDP as shown in Figure 7.5.

Table 7.3: Effects of the NBN on national real GDP in the long term

Service Group	Modest Access Speeds	High Access Speeds
Cloud Computing	0.0142%	0.0067%
Electronic Commerce	0.0429%	1.4457%
Online Higher Education	0.0005%	0.0150%
Telehealth Practice	0.0824%	0.5149%
Teleworking	0.0298%	0.8288%
Online Entertainment	-0.0005%	-0.0004%
Transport	0.0001%	0.0019%
Debt-servicing Repayments	0.0207%	0.0207%
Net effect (Total)	**0.1899%**	**2.7725%**

In the future scenarios with the NBN where broadband-enabled services require modest and high access speeds, Real GDP will be about 0.2% and 2.8% higher, respectively, in a typical long-run year than the value it would have had in the absence of the NBN.

Figure 7.6 shows the percentage changes in selected macroeconomic variables in a typical long-run year with the NBN compared with the reference case when services require modest access speeds.

Figure 7.6: Macroeconomic effects of the NBN in the long term when services require modest access speeds

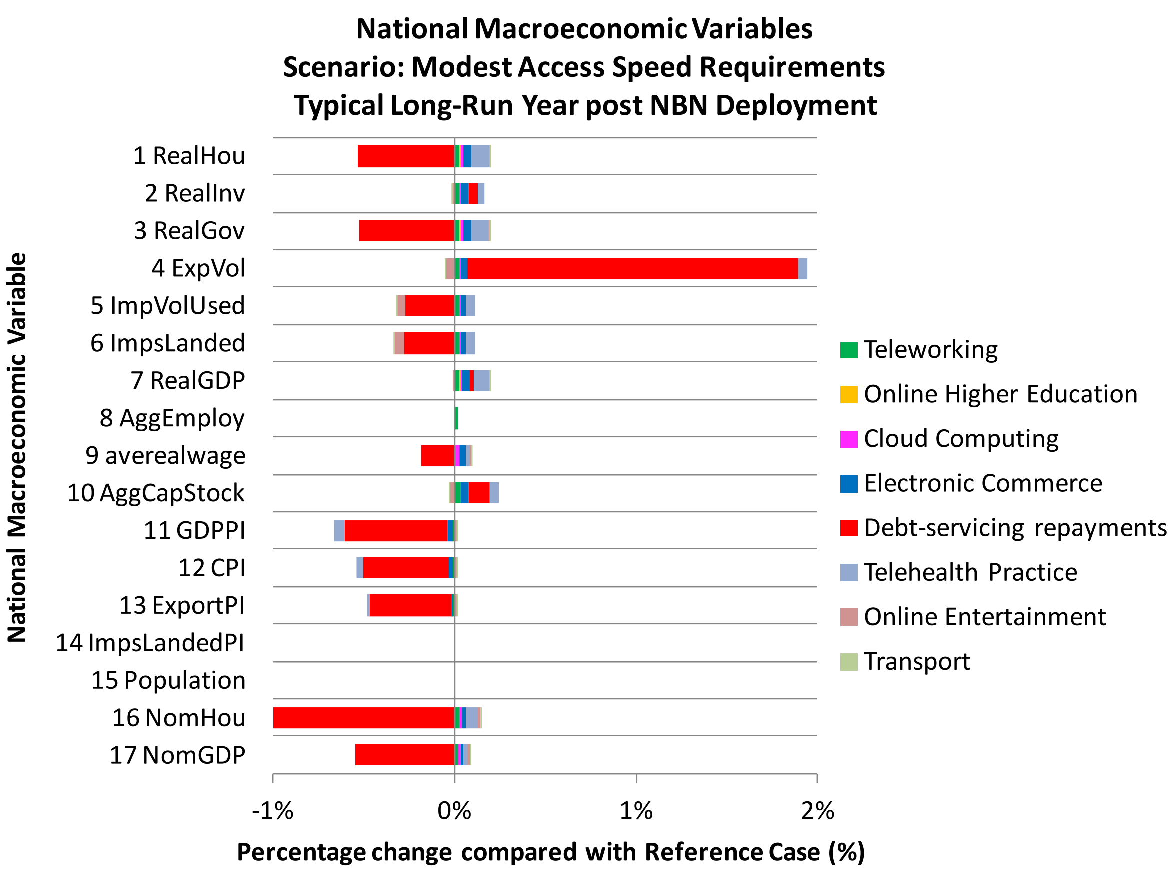


Table 7.4 shows a summary of the macroeconomic effects of the NBN shown in Figure 7.6.

Table 7.4: Macroeconomic effects of the NBN in the long term when services require modest access speeds

National Macroeconomic Variable	Long Name	Cloud Computing	Online Higher Education	Electronic Commerce	Tele-working	Telehealth Practice	Online Enter-tainment	Transport	Debt-servicing repayments	Net effect (Total)
1 RealHou	Real household consumption	0.0174%	0.0020%	0.0428%	0.0298%	0.0987%	0.0019%	0.0002%	-0.5296%	**-0.34%**
2 RealInv	Real investment	0.0054%	-0.0035%	0.0433%	0.0300%	0.0394%	-0.0066%	-0.0002%	0.0470%	**0.15%**
3 RealGov	Real government consumption	0.0176%	0.0020%	0.0427%	0.0298%	0.0978%	0.0021%	0.0002%	-0.5259%	**-0.33%**
4 ExpVol	Export volume	0.0063%	0.0002%	0.0356%	0.0254%	0.0517%	-0.0447%	-0.0016%	1.8236%	**1.90%**
5 ImpVolUsed	Import volume (used)	0.0056%	0.0002%	0.0353%	0.0250%	0.0479%	-0.0496%	-0.0018%	-0.2677%	**-0.21%**
6 ImpsLanded	Import volume (landed)	0.0054%	0.0002%	0.0348%	0.0249%	0.0485%	-0.0493%	-0.0018%	-0.2808%	**-0.22%**
7 RealGDP	Real GDP	0.0142%	0.0005%	0.0429%	0.0298%	0.0824%	-0.0005%	0.0001%	0.0207%	**0.19%**
8 AggEmploy	Aggregate employment	0%	0%	0%	0.0225%	0%	0%	0%	0%	**0.02%**
9 averealwage	Average real wage	0.0208%	0.0006%	0.0346%	0.0048%	0.0258%	0.0059%	0.0001%	-0.1811%	**-0.09%**
10 AggCapStock	Aggregate capital stock	0.0041%	-0.0009%	0.0433%	0.0304%	0.0517%	-0.0225%	0.0000%	0.1140%	**0.22%**
11 GDPPI	GDP price index	-0.0052%	-0.0005%	-0.0229%	-0.0077%	-0.0608%	0.0137%	0.0005%	-0.5687%	**-0.65%**
12 CPI	Consumer price index	-0.0045%	-0.0003%	-0.0172%	-0.0063%	-0.0315%	0.0111%	0.0004%	-0.4789%	**-0.53%**
13 ExportPI	Export price index	-0.0016%	-0.0001%	-0.0089%	-0.0063%	-0.0129%	0.0112%	0.0004%	-0.4508%	**-0.47%**

National Macroeconomic Variable	Long Name	Cloud Computing	Online Higher Education	Electronic Commerce	Tele-working	Telehealth Practice	Online Enter-tainment	Transport	Debt-servicing repayments	Net effect (Total)
14 ImpsLandedPI	Imports landed price index	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
15 Population	Population size	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
16 NomHou	Nominal household consumption	0.0130%	0.0016%	0.0256%	0.0235%	0.0672%	0.0130%	0.0006%	-1.0060%	**-0.86%**
17 NomGDP	Nominal GDP	0.0090%	-0.0001%	0.0200%	0.0221%	0.0216%	0.0133%	0.0006%	-0.5480%	**-0.46%**

The macroeconomic impacts of the NBN in the long term when services require modest access speeds are dominated by the debt-servicing repayments. For most services, the macro results are only marginally different compared with the reference case. Real Household Consumption {1} is about 0.3% smaller than it otherwise would have been in the absence of the NBN, mainly due to the debt-servicing repayments.

Figure 7.7 shows the percentage changes in selected macroeconomic variables in a typical long-run year with the NBN compared with the reference case when services require high access speeds.

Figure 7.7: Macroeconomic effects of the NBN when services require high access speeds

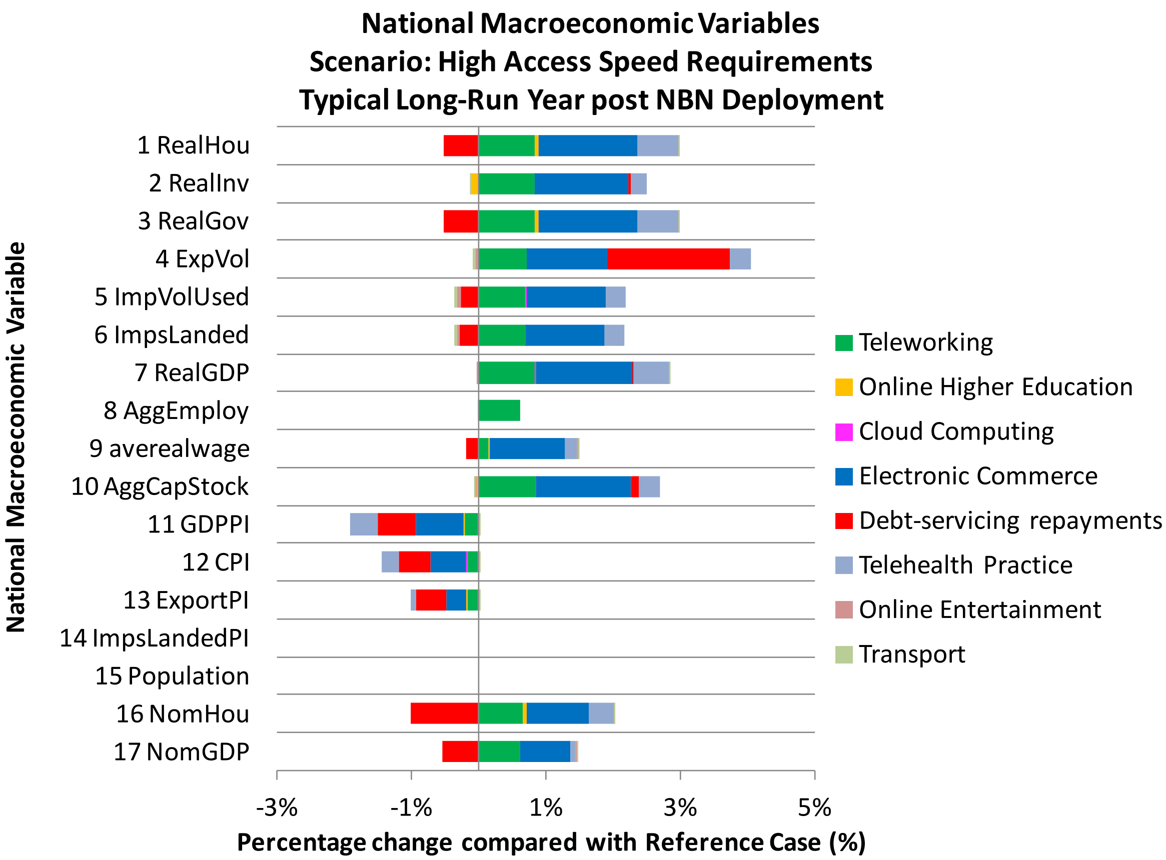


Table 7.5 shows a summary of the macroeconomic effects of the NBN shown in Figure 7.7.

Table 7.5: Macroeconomic effects of the NBN in the long term when services require high access speeds

National Macroeconomic Variable	Long Name	Cloud Computing	Online Higher Education	Electronic Commerce	Tele-working	Telehealth Practice	Online Enter-tainment	Transport	Debt-servicing repayments	Net effect (Total)
1 RealHou	Real household consumption	0.0084%	0.0596%	1.4663%	0.8274%	0.6209%	0.0019%	0.0043%	-0.5296%	**2.37%**
2 RealInv	Real investment	0.0022%	-0.1041%	1.3942%	0.8345%	0.2359%	-0.0065%	-0.0044%	0.0470%	**2.37%**
3 RealGov	Real government consumption	0.0083%	0.0596%	1.4677%	0.8275%	0.6181%	0.0020%	0.0044%	-0.5259%	**2.37%**
4 ExpVol	Export volume	0.0028%	0.0075%	1.2030%	0.7073%	0.3100%	-0.0440%	-0.0393%	1.8236%	**3.97%**
5 ImpVolUsed	Import volume (used)	0.0025%	0.0065%	1.1905%	0.6987%	0.2885%	-0.0488%	-0.0438%	-0.2677%	**1.78%**
6 ImpsLanded	Import volume (landed)	0.0024%	0.0068%	1.1781%	0.6947%	0.2887%	-0.0486%	-0.0435%	-0.2808%	**1.75%**
7 RealGDP	Real GDP	0.0067%	0.0150%	1.4457%	0.8288%	0.5149%	-0.0004%	0.0019%	0.0207%	**2.77%**
8 AggEmploy	Aggregate employment	0%	0%	0%	0.6191%	0%	0%	0%	0%	**0.62%**
9 averealwage	Average real wage	0.0101%	0.0191%	1.1096%	0.1412%	0.1906%	0.0058%	0.0035%	-0.1811%	**1.27%**
10 AggCapStock	Aggregate capital stock	0.0016%	-0.0255%	1.4271%	0.8492%	0.3048%	-0.0221%	-0.0015%	0.1140%	**2.61%**
11 GDPPI	GDP price index	-0.0028%	-0.0146%	-0.7048%	-0.2063%	-0.4248%	0.0135%	0.0115%	-0.5687%	**-1.82%**
12 CPI	Consumer price index	-0.0025%	-0.0085%	-0.5316%	-0.1667%	-0.2532%	0.0109%	0.0097%	-0.4789%	**-1.37%**
13 ExportPI	Export price index	-0.0007%	-0.0019%	-0.2985%	-0.1760%	-0.0774%	0.0110%	0.0098%	-0.4508%	**-0.97%**

National Macroeconomic Variable	Long Name	Cloud Computing	Online Higher Education	Electronic Commerce	Tele-working	Telehealth Practice	Online Enter-tainment	Transport	Debt-servicing repayments	Net effect (Total)
14 ImpsLandedPI	Imports landed price index	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
15 Population	Population size	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
16 NomHou	Nominal household consumption	0.0059%	0.0511%	0.9269%	0.6594%	0.3661%	0.0128%	0.0139%	-1.0060%	**0.96%**
17 NomGDP	Nominal GDP	0.0039%	0.0003%	0.7308%	0.6208%	0.0879%	0.0131%	0.0134%	-0.5480%	**0.91%**

For most broadband-enabled services, the economic outcomes of the NBN shown in Figure 7.7 in the future scenario where broadband-enabled service require high access speeds are significantly different from the economic outcomes in the reference case. Overall, Real GDP {7} and Real Household Consumption {1} are about 2.8% and 2.4% greater, respectively, than they otherwise would have been in the absence of the NBN, mainly due to electronic commerce, telehealth practice and telework made more widely available through the NBN. The long-term effects of the debt-servicing repayments are not influenced by network access speeds and are therefore the same as shown in Figure 7.6.

We now discuss the macroeconomic effects of the NBN in the long term in more detail. Our interpretation of the model long-run simulation results applies equally to both access-speed scenarios because the direction of change is the same in each case. However, the quantity of change (except for Debt-servicing Repayments) is different in the two scenarios.

Debt-servicing Repayments

The imposed trade surplus allows for greater domestic absorption, leaving the size of the economy or Real GDP {7} almost unchanged. All expenditure variables are smaller than they otherwise would have been, except Real Investment {2}, which increases marginally, similar to Real GDP {7}. The trade surplus and resulting rise in Export Volume {4} are accompanied by a decrease in their foreign-currency prices (Export Price Index {13}). On the import side, we assume that changes in domestic demand have no effect on foreign-currency prices (Imports Landed Price Index {14}) and are therefore exogenous. This deterioration in the terms of trade pushes the Average Real Wage {9} down and forces the domestic economy to decrease its consumption (both Real Household Consumption {1} and Real Government Consumption {3}) relative to its Real GDP {7}.

With the rate of return on capital investments and Aggregate Employment {8} assumed to be unchanged (exogenous), and the capital-to-labour ratio positively related to the terms of trade, a decline in the terms of trade would suggest Aggregate Capital Stock {10} would fall. Aggregate Capital Stock {10} is, in fact, greater with the NBN in the long run. This is because of the expansion in production in capital intensive industries such as mining. To increase production by the necessary amount, mining industries will demand more capital. With the rate of return on capital investments assumed to be fixed, investment is bound to the gross capital growth trend in the base year data. With the rise in Aggregate Capital Stock {10}, the overall investment-to-capital ratio leads to greater Real Investment {2}. The increased Aggregate Capital Stock {10} has a small second-round effect on Real GDP {7}, with the economy expanding marginally.

Teleworking

The macroeconomic impacts of the NBN enabling people to telework more are twofold. First, increases in effective employment of labour through an increase in the number of people employed lead to an expansion of the overall size of the economy, or Real GDP {7}, allowing higher domestic absorption. The fall in the marginal product of labour due to the imposed increase in Aggregate Employment {8} pushes the Average Real Wage {9} down. With the rate of return on capital investments assumed to be fixed, the rise in the marginal product of capital leads to an increase in the Aggregate Capital Stock {10} and terms of trade decline. The increase in the Aggregate Capital

Stock {10} has a positive second-round effect on Real GDP {7}. The overall investment-to-capital ratio leads to greater Real Investment {2}.

With foreign-currency prices fixed on the import side (Imports Landed Price Index {14}), the deterioration in the terms of trade comes at the expense of foreign-currency prices for exports (Export Price Index {13}). Foreign demand increases, with exports (Export Volume {4}) of domestically produced goods and services becoming more competitive on the world market. Imports (Import Volume (Used) {5}) also expand, reflecting the higher level of domestic absorption, especially investment (Real Investment {2}).

The imposed labour-saving technological improvement in various industries, due to people telework more with the NBN, has a positive impact on the overall size of the economy, or Real GDP {7}, allowing higher domestic absorption. In terms of capital accumulation, the effect of labour-saving technological progress is similar to the effect of an increase in the supply of labour. In both cases the effective employment of labour increases. This in turn increases the quantity of capital that can earn a given rate of return. The increase in the Aggregate Capital Stock {10} has a positive second-round effect on Real GDP {7}.

Export Volume {4} rises with an increase in the overall size of the economy, or Real GDP {7}. With no change assumed with the NBN to foreign-demand curves for Australian exports, the rise in Export Volume {4} is accompanied by a decrease in their foreign-currency prices (Export Price Index {13}). Imports (Import Volume (Used) {5}) also expand, reflecting the higher level of domestic absorption, especially investment (Real Investment {2}). With the rate of return on capital investments and Aggregate Employment {8} assumed to be fixed, and the capital-to-labour ratio positively related to the terms of trade, the terms of trade decline has a small negative second-round effect on the Aggregate Capital Stock {10}. Despite the fall in the marginal product of labour and the terms of trade decline, the Average Real Wage {9} increases, reflecting higher marginal product of labour associated with labour-saving technological progress.

Electronic Commerce

The interpretation of the macroeconomic impacts of the NBN with respect to Electronic Commerce is similar to our interpretation of the macroeconomic impacts of labour-saving technological progress as a result of people telework more with the NBN and not repeated here.

Telehealth Practice

All of the factors and consequent shocks related to telehealth described in chapter 6.4 lead to the same direction of change. The technological progress in the Community Services industry with the NBN increases the overall size of the economy (Real GDP {7}). Exports of the bigger economy are increased and the rise in Export Volume {4} is accompanied by a decrease in their foreign-currency prices (Export Price Index {13}). Imports (Import Volume (Used) {5}) also expand, reflecting the higher level of domestic absorption. With the rate of return on capital investments and Aggregate Employment {8} assumed to be fixed, the Aggregate Capital Stock {10} and Average Real Wage {9} increase, reflecting technological improvement. The increases are slightly offset by the terms of trade decline, which has a small negative second-round effect on the Aggregate Capital Stock {10} the real producer wage.

Online Higher Education

Real GDP {7} is increased as a direct consequence of capital-saving technological progress in the Education industry with the NBN, which is slightly offset by a decrease in Aggregate Capital Stock {10}. Aggregate Capital Stock {10} is decreased because of the inelastic supply and demand schedule of the Education industries. The supply schedule of a labour intensive industry such as Education is relatively inelastic in the long term where aggregate employment is assumed to be largely unaffected by the NBN. The demand schedule is relatively inelastic since most of the labour intensive industry's demand comes from household and government consumption, with only marginal import competition. A capital-saving technological improvement will shift the Education industries' relatively steep supply schedule and move down (and out) its steep demand schedule resulting in a marginal shift of the market (supply-demand) equilibrium. The expansion in production and subsequent demand for primary factors, including capital, which follows from the technological progress, fails to offset the significant capital savings. The decreased Aggregate Capital Stock {10} has a negative second-round effect on Real GDP {7}, and the overall investment-to-capital ratio leads to a decline in Real Investment {2}. The Average Real Wage {9} is increased, reflecting a fall in the marginal productivity of labour.

Online Entertainment

Real GDP {7} is largely unaffected by households demanding more entertainment (Recreation and Personal) services in exchange for other commodities with the NBN. The resources needed to increase production of the Recreation and Personal Services industries by the necessary amount become available from reductions in other consumer- and traded-goods activities, resulting in a fall in Export Volume {4} accompanied by an increase in their foreign-currency prices. On the import side, we assume that changes in domestic demand have no effect on foreign-currency prices (Export Price Index {13}). The terms of trade improvement pushes the Average Real Wage {9} up and allows the domestic economy to increase its consumption (both Real Household Consumption {1} and Real Government Consumption {3}) relative to its Real GDP {7}. Real GDP {7}, Aggregate Capital Stock {10} decline because traded-goods activities and consumer-goods activities such as Finance and Business Services are, on average, more capital intensive than entertainment activities. With the fall in Aggregate Capital Stock {10}, the overall investment-to-capital ratio leads to smaller Real Investment {2}. Imports (Import Volume (Used) {5}) fall, reflecting decreased Real Investment {2} and NBN-induced contractions in industries with comparatively high import shares.

Transport

Real GDP {7} is largely unaffected by households reducing their usage of transport in exchange for other commodities with the NBN. The shift of household spending away from transport goods and services results in increased demand for commodities from industries with comparatively little import competition, such as Finance and Business Services, and Recreation and Personal Services. The resources needed to increase their production by the necessary amount become available mainly from reductions in activity in transport and other trade-exposed industries, resulting in a fall in Export Volume {4} accompanied by an increase in their foreign-currency prices (Export Price Index {13}). With Imports Landed Price Index {14} exogenous, the terms of trade improvement pushes the Average Real Wage {9} up and allows the domestic economy to increase its consumption (both Real Household Consumption and Real Government Consumption) relative to its Real GDP {7}. Aggregate

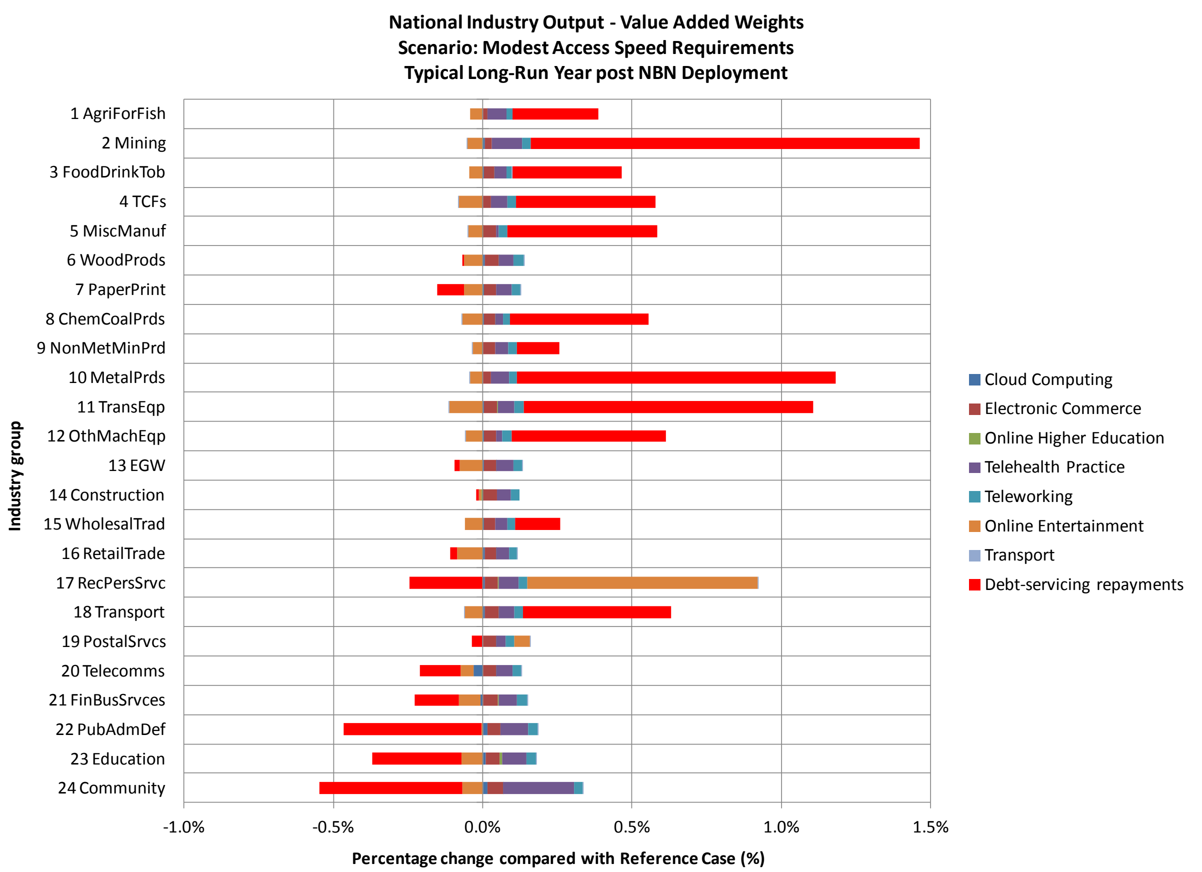
Capital Stock {10} declines because traded-goods activities are, on average, more capital intensive than consumer-goods activities. With the fall in Aggregate Capital Stock {10}, the overall investment-to-capital ratio leads to smaller Real Investment {2}. Real GDP {7} is only marginally increased because of the fall in Aggregate Capital Stock {10} and its negative second-round effect on Real GDP.

Sectoral results

We now provide the structural results for the national industry output effects of the NBN. The direction of change for each variable is the same in both access-speed scenarios. We then describe in broad terms how these results arise from the macro results.

Figure 7.8 shows the percentage change in national output of the 24 industry groups in a typical long-run year with the NBN when services require modest access speeds.

Figure 7.8: National industry output effects of the NBN in the long term when services require modest access speeds



Changes to the industry activity level with the NBN in the long term when services require modest access-speeds are dominated by the debt-servicing repayments. For most services, industry output is only marginally different compared with the reference case.

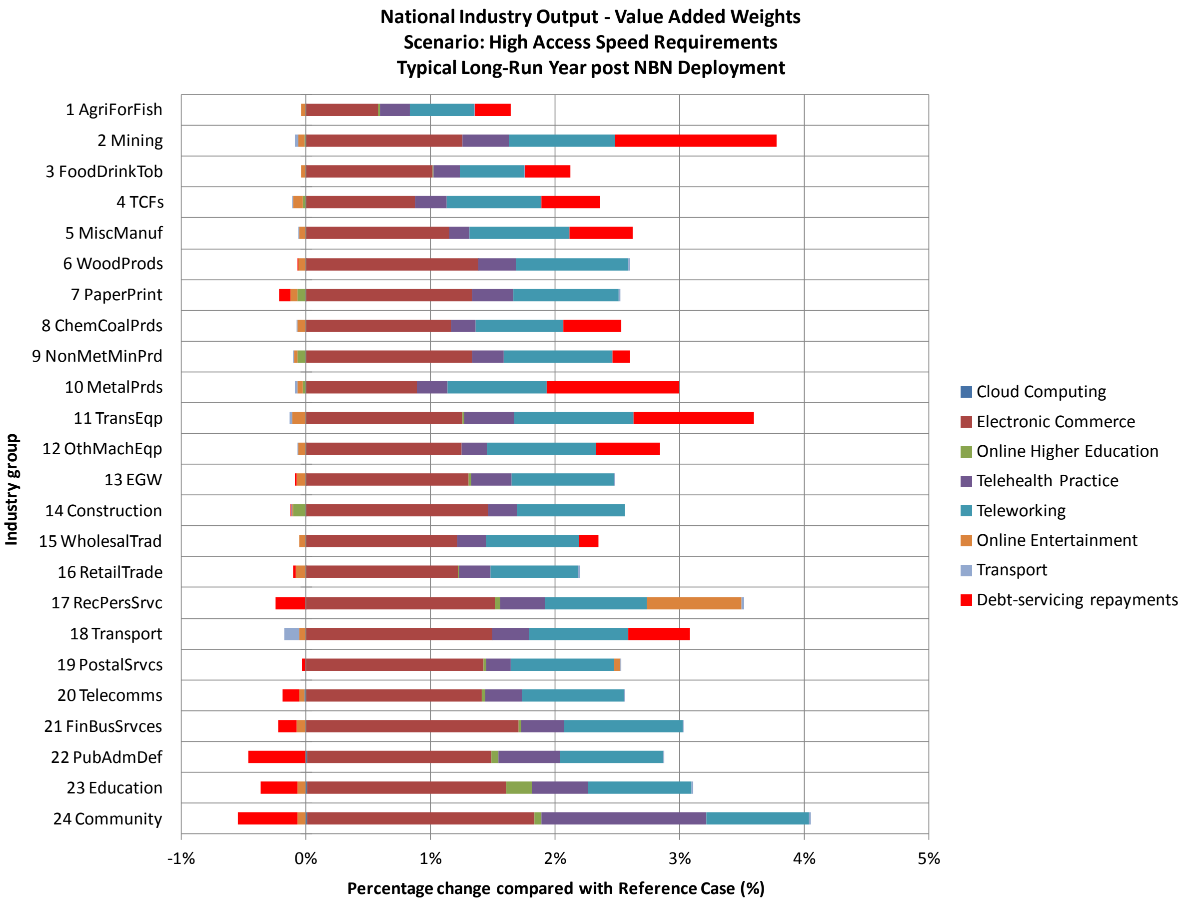
Table 7.6 shows a summary of the percentage change in national output of the 24 industry groups in a typical long-run year with the NBN when services require modest access speeds shown in Figure 7.8.

Table 7.6: Summary of national industry output effects of the NBN in the long term when services require modest access speeds

Industry group	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing repayments	Net effect (Total)
1 AgriForFish	-0.0005%	0.0152%	0.0005%	0.0651%	0.0198%	-0.0422%	0.0002%	0.2860%	**0.3440%**
2 Mining	0.0062%	0.0239%	-0.0007%	0.1018%	0.0290%	-0.0514%	-0.0011%	1.3014%	**1.4106%**
3 FoodDrinkTob	0.0050%	0.0328%	0.0005%	0.0405%	0.0193%	-0.0457%	0.0004%	0.3656%	**0.4186%**
4 TCFs	-0.0019%	0.0280%	-0.0007%	0.0544%	0.0294%	-0.0761%	-0.0002%	0.4672%	**0.5003%**
5 MiscManuf	0.0022%	0.0413%	-0.0002%	0.0098%	0.0292%	-0.0467%	-0.0001%	0.5015%	**0.5375%**
6 WoodProds	0.0083%	0.0459%	0.0001%	0.0488%	0.0332%	-0.0626%	0.0006%	-0.0054%	**0.0689%**
7 PaperPrint	0.0028%	0.0418%	-0.0022%	0.0520%	0.0304%	-0.0610%	0.0006%	-0.0890%	**-0.0247%**
8 ChemCoalPrds	0.0054%	0.0371%	0.0000%	0.0243%	0.0252%	-0.0687%	-0.0003%	0.4633%	**0.4867%**
9 NonMetMinPrd	-0.0007%	0.0424%	-0.0023%	0.0421%	0.0313%	-0.0310%	-0.0001%	0.1422%	**0.2240%**
10 MetalPrds	-0.0010%	0.0266%	-0.0010%	0.0604%	0.0282%	-0.0398%	-0.0009%	1.0677%	**1.1413%**
11 TransEqp	0.0051%	0.0436%	0.0006%	0.0551%	0.0346%	-0.1116%	-0.0010%	0.9666%	**0.9939%**
12 OthMachEqp	0.0038%	0.0412%	-0.0002%	0.0206%	0.0312%	-0.0552%	-0.0001%	0.5166%	**0.5584%**
13 EGW	0.0050%	0.0390%	0.0007%	0.0581%	0.0294%	-0.0785%	0.0004%	-0.0148%	**0.0394%**
14 Construction	0.0013%	0.0454%	-0.0035%	0.0460%	0.0311%	-0.0108%	-0.0002%	-0.0065%	**0.1027%**
15 WholesalTrad	0.0037%	0.0379%	0.0000%	0.0404%	0.0270%	-0.0590%	0.0001%	0.1514%	**0.2015%**
16 RetailTrade	0.0064%	0.0384%	0.0003%	0.0426%	0.0254%	-0.0864%	0.0005%	-0.0231%	**0.0041%**
17 RecPersSrvc	0.0084%	0.0427%	0.0013%	0.0671%	0.0295%	0.7721%	0.0009%	-0.2444%	**0.6747%**
18 Transport	0.0065%	0.0481%	0.0002%	0.0511%	0.0290%	-0.0587%	-0.0048%	0.4966%	**0.5686%**
19 PostalSrvcs	-0.0012%	0.0444%	0.0007%	0.0318%	0.0299%	0.0509%	0.0002%	-0.0341%	**0.1224%**
20 Telecomms	-0.0302%	0.0440%	0.0009%	0.0543%	0.0295%	-0.0432%	0.0003%	-0.1361%	**-0.0808%**
21 FinBusSrvces	-0.0078%	0.0517%	0.0006%	0.0630%	0.0340%	-0.0719%	0.0004%	-0.1496%	**-0.0797%**
22 PubAdmDef	0.0159%	0.0429%	0.0018%	0.0927%	0.0298%	-0.0052%	0.0001%	-0.4610%	**-0.2838%**
23 Education	0.0102%	0.0474%	0.0068%	0.0826%	0.0301%	-0.0717%	0.0005%	-0.2979%	**-0.1925%**
24 Community	0.0149%	0.0516%	0.0018%	0.2367%	0.0296%	-0.0682%	0.0006%	-0.4792%	**-0.2137%**

Figure 7.9 shows the percentage change in national output of the 24 industry groups in a typical long-run year with the NBN when services require high access speeds.

Figure 7.9: National industry output effects of the NBN in the long term when services require high access speeds



With the NBN in the long term when services require high access speeds, changes to the industry activity level are dominated by electronic commerce and teleworking. Changes to industry output overall with the NBN follow a similar pattern in both future access-speed scenarios.

Table 7.7 shows a summary of the percentage change in national output of the 24 industry groups in a typical long-run year with the NBN when services require modest access speeds shown in Figure 7.9.

Table 7.7: Summary of national industry output effects of the NBN in the long term when services require high access speeds

Industry group	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing repayments	Net effect (Total)
1 AgriForFish	0.0001%	0.5812%	0.0112%	0.2429%	0.5137%	-0.0414%	0.0058%	0.2860%	**1.5955%**
2 Mining	0.0008%	1.2538%	-0.0132%	0.3720%	0.8517%	-0.0506%	-0.0283%	1.3014%	**3.7206%**
3 FoodDrinkTob	0.0028%	1.0107%	0.0118%	0.2048%	0.5157%	-0.0451%	0.0114%	0.3656%	**2.0907%**
4 TCFs	-0.0007%	0.8722%	-0.0285%	0.2523%	0.7677%	-0.0748%	-0.0028%	0.4672%	**2.2606%**
5 MiscManuf	0.0015%	1.1446%	-0.0067%	0.1644%	0.8068%	-0.0461%	-0.0028%	0.5015%	**2.5748%**
6 WoodProds	0.0041%	1.3758%	0.0009%	0.3012%	0.9024%	-0.0617%	0.0138%	-0.0054%	**2.5369%**
7 PaperPrint	0.0014%	1.3331%	-0.0671%	0.3286%	0.8424%	-0.0600%	0.0152%	-0.0890%	**2.3084%**
8 ChemCoalPrds	0.0028%	1.1569%	0.0018%	0.1986%	0.7069%	-0.0677%	-0.0088%	0.4633%	**2.4646%**
9 NonMetMinPrd	-0.0005%	1.3357%	-0.0678%	0.2528%	0.8728%	-0.0305%	-0.0026%	0.1422%	**2.5102%**
10 MetalPrds	-0.0005%	0.8866%	-0.0289%	0.2490%	0.7935%	-0.0392%	-0.0225%	1.0677%	**2.9221%**
11 TransEqp	0.0029%	1.2540%	0.0152%	0.3983%	0.9580%	-0.1099%	-0.0241%	0.9666%	**3.4863%**
12 OthMachEqp	0.0019%	1.2455%	-0.0071%	0.2074%	0.8681%	-0.0544%	-0.0033%	0.5166%	**2.7873%**
13 EGW	0.0019%	1.3027%	0.0238%	0.3200%	0.8226%	-0.0772%	0.0102%	-0.0148%	**2.3955%**
14 Construction	0.0002%	1.4572%	-0.1036%	0.2366%	0.8647%	-0.0106%	-0.0043%	-0.0065%	**2.4406%**
15 WholesalTrad	0.0018%	1.2075%	-0.0008%	0.2342%	0.7461%	-0.0581%	0.0025%	0.1514%	**2.2905%**
16 RetailTrade	0.0031%	1.2148%	0.0103%	0.2526%	0.7038%	-0.0851%	0.0119%	-0.0231%	**2.0934%**
17 RecPersSrvc	0.0040%	1.5137%	0.0397%	0.3610%	0.8168%	0.7605%	0.0215%	-0.2444%	**3.2989%**
18 Transport	0.0027%	1.4899%	0.0042%	0.2900%	0.7994%	-0.0577%	-0.1168%	0.4966%	**2.9241%**
19 PostalSrvcs	-0.0005%	1.4254%	0.0223%	0.1962%	0.8301%	0.0502%	0.0056%	-0.0341%	**2.5043%**
20 Telecomms	-0.0139%	1.4117%	0.0260%	0.2967%	0.8179%	-0.0428%	0.0069%	-0.1361%	**2.3711%**
21 FinBusSrvces	-0.0037%	1.7068%	0.0188%	0.3492%	0.9450%	-0.0708%	0.0096%	-0.1496%	**2.8130%**
22 PubAdmDef	0.0074%	1.4802%	0.0541%	0.4973%	0.8278%	-0.0051%	0.0031%	-0.4610%	**2.4087%**
23 Education	0.0048%	1.6053%	0.2046%	0.4474%	0.8314%	-0.0706%	0.0123%	-0.2979%	**2.7568%**
24 Community	0.0073%	1.8243%	0.0549%	1.3272%	0.8254%	-0.0672%	0.0138%	-0.4792%	**3.5675%**

Next, we provide simulation-specific interpretations and describe in broad terms how these results arise from the macro results.

Debt-servicing Repayments

Trade-exposed industries, such as Mining {4} and Metal Products {10}, do comparatively better as a result of the real devaluation of the real exchange rate associated with the NBN-induced trade surplus. Industries with significant import competition, such as Textiles, Clothing and Footwear {4}, Miscellaneous Manufacturing {5}, Transport Equipment {11}, and Other Machinery and Equipment {12}, benefit from decreased imports, reflecting the lower level of domestic absorption, especially consumption (both Real Government Consumption and Real Household Consumption). Industries with very little import competition and whose goods and services are used predominantly by the domestic economy are comparatively worse off; such industries include Recreation and Personal Services {17}, Finance and Business Services {21}, Public Administration and Defence {22}, Education {23} and Community Services {24}. The Food, Beverages and Tobacco {3} industry is subject to little import competition but is comparatively better off due to the change in foreign demand.

Electronic Commerce

Service-oriented industries, such as the Community {24} industry, are comparatively better off because of the relatively high imposed labour-saving technological improvement due to firms' adoption of Electronic Commerce made more widely available through the NBN. Consumer-good and service-oriented industries, such as Recreation, and Personal Services {17}, Public Administration and Defence {22}, and Community Services {24}, also benefit from an expanding local market. Labour intensive traditional export industries, which do not directly benefit from labour-saving technological improvement, such as Agricultural, Forestry and Fishing {1}, are made less competitive by NBN-induced real wage increases. Other Labour intensive industries facing only a modest increase in local demand, such as Food, Beverages and Tobacco {3}, Clothing and Footwear {4}, and Metal Products {10}, are comparatively worse off.

Online Higher Education

Education {23} activities benefit from the imposed capital-saving technological improvement because of less classroom use at public universities than in traditional courses. Consumer-good and service-oriented activities, such as Recreation, and Personal Services {17}, Public Administration and Defence {22}, and Community Services {24}, are comparatively better off due to the domestic economy increasing its consumption. Industries whose goods and services are used for capital creation in the Education industry are comparatively worse off reflecting decreased capital and investment; such industries include Paper and Printing {7}, and Construction {14}. Upstream industries to the Construction {14} industry, such as Non-metallic mineral products {9}, Metal Products {10}, and Clothing and Footwear {4}, are comparatively worse off. Export-oriented activities, such as Metal Products {10}, and Other Machinery and Equipment {12}, are made less competitive by NBN-induced real wage increases.

Telehealth Practice

Community Services {24} benefit from the imposed all-input-saving technological improvement due to people using more telehealth through the NBN. Import-competing industries expand, such as

Transport Equipment {11}, wood and wood products {6}, reflecting the higher level of domestic absorption, especially investment. Consumer-goods and service-oriented activities, such as recreation, and personal services {17}, Public Administration and Defence {22}, and Education {23}, are comparatively better off due to the domestic economy increasing its consumption. Industries whose goods and services are used for capital creation in the Community Services {24} industry are comparatively worse off, reflecting decreased capital and investment in areas such as Miscellaneous Manufacturing {5}. Mining {2} is comparatively better off because of increased local demand and exports. Labour-intensive export-oriented activities, such as other machinery equipment (12) and Miscellaneous Manufacturing {5}, are made less competitive by NBN-induced real wage increases and are comparatively worse off.

Teleworking

Labour intensive activities, such as in Education {23} and Community Services {24}, are comparatively better off reflecting the imposed increase in effective employment of labour due to the NBN enabling people to telework more. Transport equipment {11} and Finance and Business Services {21} industries expand reflecting the higher level of domestic absorption, especially investment. Traditional export industries such as Mining (2) and Metal Products {10} are made more competitive by real devaluation of the real exchange rate. Agriculture, Forestry and Fishing {1} industry is comparatively worse off due to increased rental price of land. This leads to increased input costs in downstream industries such as Food, Beverages and Tobacco {3}.

Online Entertainment

The Recreation and Personal Services {17} industry is comparatively better off, reflecting the imposed increase in consumer spending on entertainment services made more widely available through the NBN. Upstream industries, such as Food, Beverages and Tobacco {3}, and Postal Services {19}, and Construction {14} industries, that provide heavy inputs for the creation of fixed capital, benefit from the NBN-induced expansion in the Recreation and Personal Services {17} industry. Consumer-good activities, such as Food, Beverages and Tobacco {3}, Textiles, Clothing and Footwear {4}, Transport Equipment {11}, and Retail Trade {16}, are comparatively worse off because consumer spending on commodities other than Recreation and Personal Services {17} decreases. The Public Administration and Defence {22} industry is comparatively better off due to the domestic economy increasing its public consumption marginally. Traditional export industries, such as Agriculture, Forestry and Fishing {1}, Mining {2}, and Food, Beverages and Tobacco {3}, are made less competitive by real appreciation of the real exchange rate and NBN-induced real wage increases.

Transport

Food, Beverages and Tobacco {3}, and Recreation and Personal Services {17} are comparatively better off due to the domestic economy increasing its consumption. Transport {18} is comparatively worse off, reflecting the imposed decrease in consumer spending on transport because more people are able to make use of telehealth with the NBN. Export-oriented industries, such as Mining {2} and Metal Products {10}, and import-competing industries, such as Transport Equipment {11}, are made less competitive by real appreciation of the real exchange rate and NBN-induced real wage increases. Upstream industries, such as Metal Products {10} and Transport Equipment {11}, are comparatively worse off.

Regional results

We now provide the regional results for the NBN and describe in broad terms how these results arise from the macro and sectoral results, and our estimates of the NBN impact on service delivery.

Figures 7.10 and 7.11 show the results for Real Gross Regional Product (GRP) and regional contributions to national Real GDP, respectively, with the NBN in the long term when services require high access speeds. Regional contributions are derived from the percentage change in a region's Real GRP, computed by the economic model, multiplied with the region's Real GDP in proportion of total Real GRP.

Figure 7.10: Effects of the NBN on Real GRP in the long term when services require high access speeds

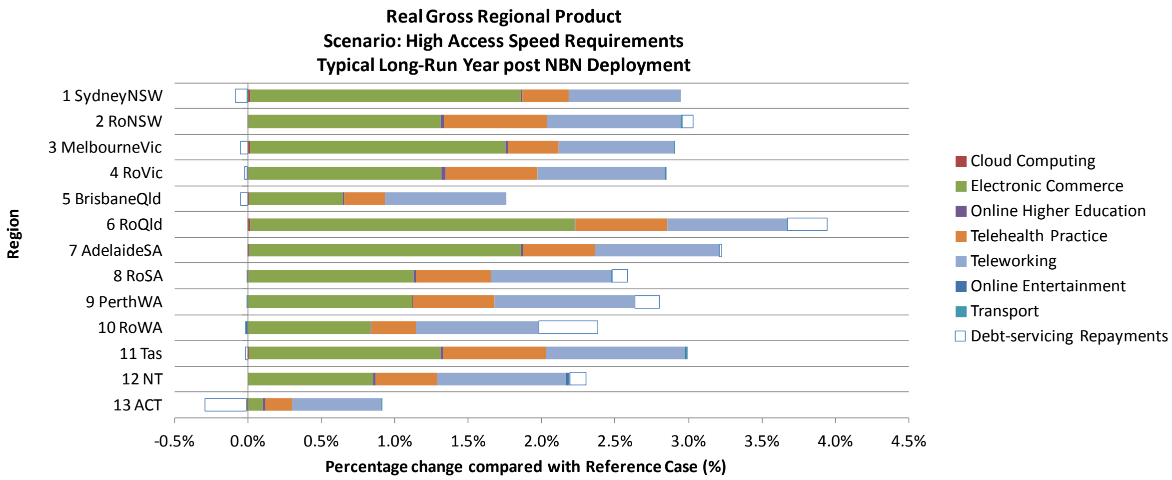


Table 7.8 shows a summary of the effects of the NBN on Real GRP shown in Figure 7.10.

Table 7.8: Summary of the effects of the NBN on Real GRP in the long term when services require high access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.0156%	1.8396%	0.0146%	0.3140%	0.7622%	-0.0022%	-0.0001%	-0.0872%	**2.8688%**
2 RoNSW	-0.0048%	1.3128%	0.0213%	0.6999%	0.9114%	0.0047%	0.0064%	0.0764%	**3.0505%**
3 MelbourneVic	0.0140%	1.7386%	0.0200%	0.3405%	0.7867%	0.0004%	0.0010%	-0.0547%	**2.8605%**
4 RoVic	-0.0046%	1.3158%	0.0295%	0.6285%	0.8670%	0.0018%	0.0086%	-0.0183%	**2.8468%**
5 BrisbaneQld	0.0055%	0.6425%	0.0067%	0.2769%	0.8299%	-0.0005%	-0.0002%	-0.0519%	**1.7116%**
6 RoQld	0.0126%	2.2125%	0.0029%	0.6306%	0.8145%	-0.0012%	0.0023%	0.2669%	**3.9765%**
7 AdelaideSA	0.0095%	1.8463%	0.0189%	0.4870%	0.8449%	-0.0005%	0.0007%	0.0221%	**3.2519%**
8 RoSA	-0.0051%	1.1261%	0.0192%	0.5113%	0.8124%	-0.0068%	0.0086%	0.1055%	**2.5863%**
9 PerthWA	-0.0019%	1.1139%	0.0103%	0.5531%	0.9556%	-0.0029%	-0.0018%	0.1700%	**2.8143%**
10 RoWA	-0.0039%	0.8364%	0.0043%	0.3057%	0.8335%	-0.0121%	-0.0026%	0.4050%	**2.3805%**
11 Tas	0.0073%	1.3057%	0.0170%	0.6974%	0.9501%	0.0041%	0.0115%	-0.0189%	**2.9955%**
12 NT	0.0014%	0.8496%	0.0205%	0.4191%	0.8755%	0.0160%	0.0104%	0.1110%	**2.3153%**
13 ACT	-0.0106%	0.1016%	0.0155%	0.1855%	0.6016%	0.0035%	0.0026%	-0.2838%	**0.6079%**

Figure 7.11: Regional contributions to the effects of the NBN on national Real GDP in the long term when services require high access speeds

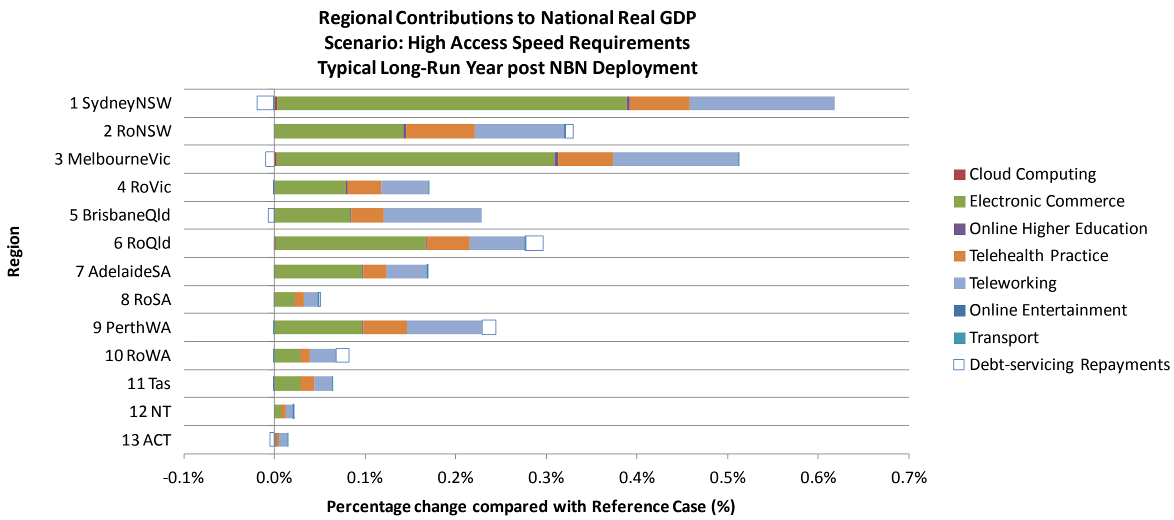


Table 7.9 shows a summary of the regional contributions to the effects of the NBN on national Real GRP shown in Figure 7.11.

Table 7.9: Summary of regional contributions to the effects of the NBN on Real GDP in the long term when services require high access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.00327%	0.38548%	0.00307%	0.06601%	0.16008%	-0.00047%	-0.00002%	-0.01829%	**0.60184%**
2 RoNSW	-0.00053%	0.14256%	0.00231%	0.07579%	0.09889%	0.00051%	0.00070%	0.00830%	**0.33042%**
3 MelbourneVic	0.00247%	0.30692%	0.00354%	0.06020%	0.13897%	0.00008%	0.00018%	-0.00966%	**0.50535%**
4 RoVic	-0.00028%	0.07858%	0.00176%	0.03745%	0.05172%	0.00011%	0.00052%	-0.00109%	**0.16968%**
5 BrisbaneQld	0.00071%	0.08337%	0.00087%	0.03588%	0.10743%	-0.00006%	-0.00002%	-0.00672%	**0.22232%**
6 RoQld	0.00095%	0.16644%	0.00022%	0.04748%	0.06139%	-0.00009%	0.00018%	0.02014%	**0.29905%**
7 AdelaideSA	0.00050%	0.09677%	0.00099%	0.02552%	0.04434%	-0.00003%	0.00004%	0.00116%	**0.17017%**
8 RoSA	-0.00010%	0.02206%	0.00038%	0.00999%	0.01589%	-0.00013%	0.00017%	0.00206%	**0.05065%**
9 PerthWA	-0.00016%	0.09699%	0.00089%	0.04808%	0.08310%	-0.00025%	-0.00016%	0.01480%	**0.24493%**
10 RoWA	-0.00013%	0.02878%	0.00015%	0.01050%	0.02861%	-0.00041%	-0.00009%	0.01392%	**0.08208%**
11 Tas	0.00016%	0.02805%	0.00036%	0.01493%	0.02039%	0.00009%	0.00025%	-0.00041%	**0.06415%**
12 NT	0.00001%	0.00809%	0.00020%	0.00399%	0.00833%	0.00015%	0.00010%	0.00106%	**0.02206%**
13 ACT	-0.00017%	0.00164%	0.00025%	0.00299%	0.00967%	0.00006%	0.00004%	-0.00455%	**0.00983%**

All regions increase overall economic activity with the NBN in the long term when services require high access speeds. Electronic commerce, telehealth practice and teleworking make noticeable differences, especially in the major cities because of their larger economic activity. Rest of Queensland {6} and Rest of New South Wales {2} benefit from a comparatively high NBN impact on service delivery relative to regions outside major cities.

Figures 7.12 and 7.13 show the results for regional Real Household Consumption and regional contributions to national Real Household Consumption, respectively, in the long term when services require high access speeds.

Figure 7.12: Effects of the NBN on regional Real Household Consumption with the NBN in the long term when services require high access speeds

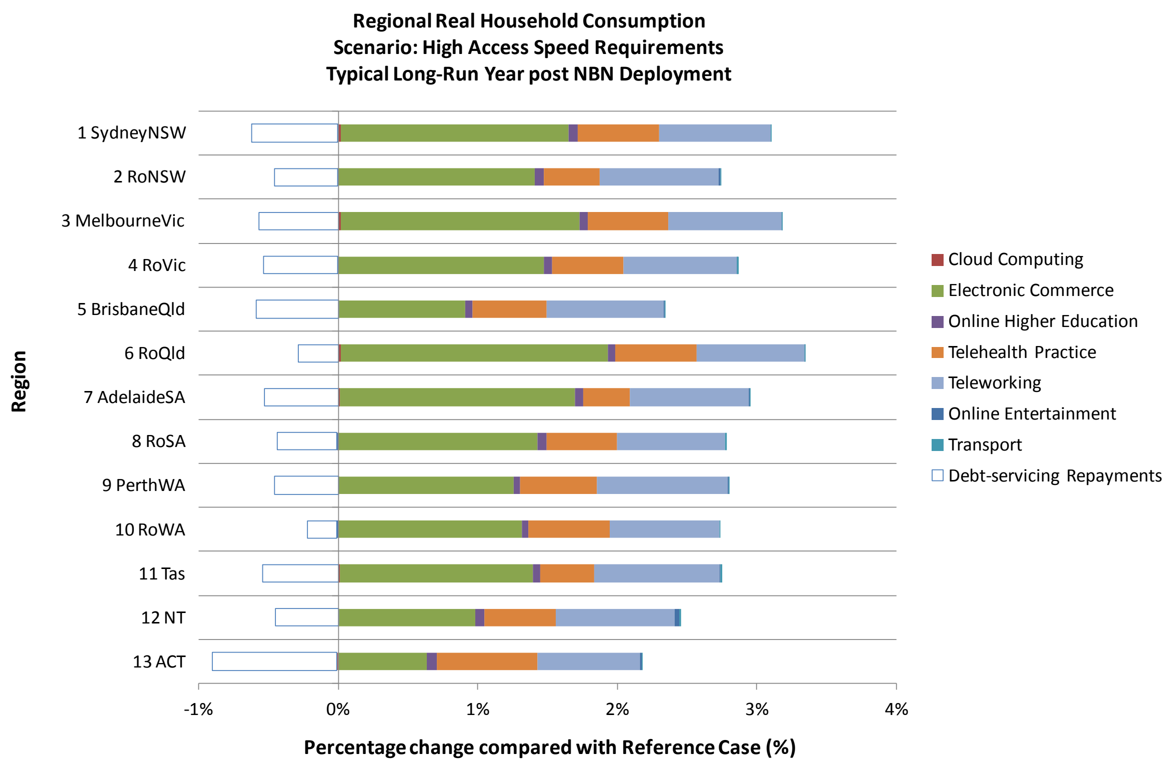


Table 7.10 shows a summary of the effects of the NBN on Regional Real Household Consumption shown in Figure 7.12.

Table 7.10: Summary of the effects of the NBN on regional Real Household Consumption in the long term when services require high access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.0163%	1.6341%	0.0654%	0.5815%	0.8031%	-0.0034%	0.0011%	-0.6180%	**2.4792%**
2 RoNSW	-0.0033%	1.4048%	0.0647%	0.4001%	0.8547%	0.0111%	0.0108%	-0.4551%	**2.3019%**
3 MelbourneVic	0.0163%	1.7106%	0.0613%	0.5770%	0.8117%	0.0007%	0.0028%	-0.5709%	**2.6111%**
4 RoVic	-0.0025%	1.4719%	0.0625%	0.5103%	0.8088%	0.0023%	0.0126%	-0.5332%	**2.3406%**
5 BrisbaneQld	0.0067%	0.9024%	0.0522%	0.5339%	0.8395%	0.0004%	0.0010%	-0.5899%	**1.7375%**
6 RoQld	0.0166%	1.9156%	0.0486%	0.5838%	0.7764%	0.0018%	0.0032%	-0.2868%	**3.0812%**
7 AdelaideSA	0.0120%	1.6815%	0.0594%	0.3334%	0.8563%	0.0024%	0.0034%	-0.5289%	**2.4311%**
8 RoSA	-0.0027%	1.4298%	0.0620%	0.5084%	0.7696%	-0.0071%	0.0131%	-0.4255%	**2.3562%**
9 PerthWA	-0.0009%	1.2535%	0.0520%	0.5456%	0.9367%	0.0062%	0.0011%	-0.4535%	**2.3472%**
10 RoWA	-0.0021%	1.3140%	0.0502%	0.5773%	0.7928%	-0.0119%	0.0001%	-0.2066%	**2.5227%**
11 Tas	0.0101%	1.3840%	0.0523%	0.3849%	0.8982%	0.0080%	0.0148%	-0.5404%	**2.2192%**
12 NT	0.0030%	0.9776%	0.0655%	0.5101%	0.8517%	0.0367%	0.0126%	-0.4496%	**2.0051%**
13 ACT	-0.0119%	0.6354%	0.0718%	0.7217%	0.7339%	0.0081%	0.0075%	-0.8904%	**1.2552%**

Figure 7.13: Regional contributions to the effects of the NBN on national Real Household Consumption with the NBN in the long term when services require high access speeds

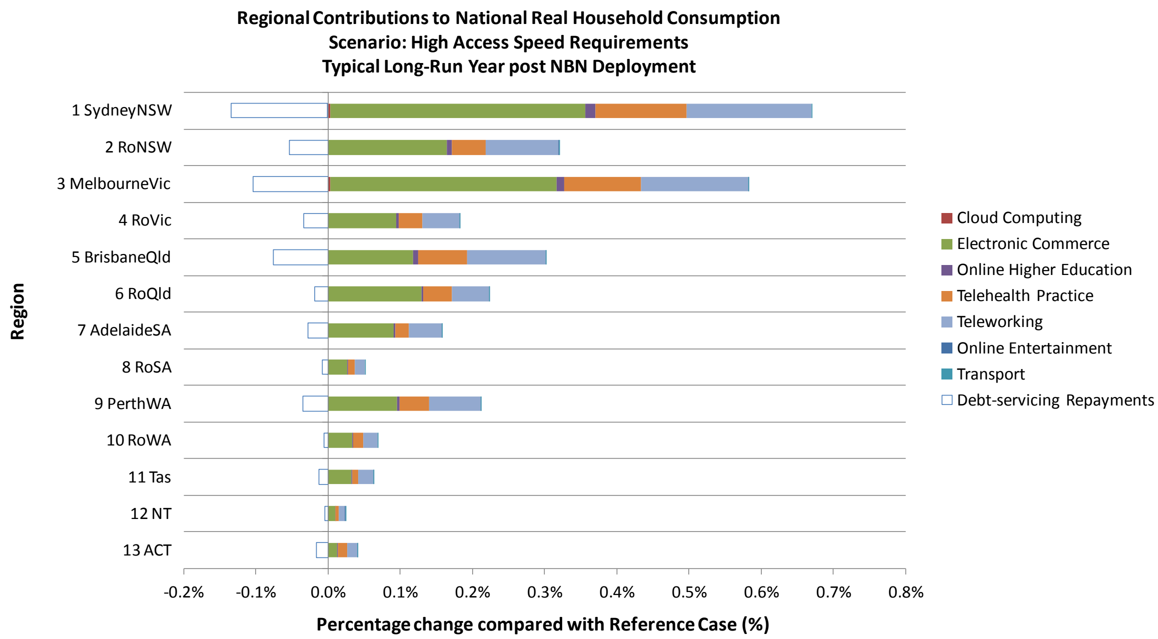


Table 7.11 shows a summary of the regional contributions to the effects of the NBN on national Real Household Consumption shown in Figure 7.13.

Table 7.11: Summary of regional contributions to the effects of the NBN on national Real Household Consumption in the long term when services require high access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.00353%	0.35276%	0.01413%	0.12578%	0.17360%	-0.00073%	0.00024%	-0.13352%	**0.53560%**
2 RoNSW	-0.00039%	0.16447%	0.00758%	0.04678%	0.10002%	0.00130%	0.00127%	-0.05327%	**0.26916%**
3 MelbourneVic	0.00298%	0.31315%	0.01123%	0.10572%	0.14865%	0.00012%	0.00051%	-0.10454%	**0.47825%**
4 RoVic	-0.00016%	0.09378%	0.00398%	0.03247%	0.05150%	0.00015%	0.00081%	-0.03396%	**0.14895%**
5 BrisbaneQld	0.00087%	0.11657%	0.00673%	0.06888%	0.10825%	0.00005%	0.00013%	-0.07604%	**0.22456%**
6 RoQld	0.00111%	0.12791%	0.00325%	0.03900%	0.05191%	0.00012%	0.00021%	-0.01919%	**0.20562%**
7 AdelaideSA	0.00064%	0.08973%	0.00317%	0.01778%	0.04572%	0.00013%	0.00018%	-0.02824%	**0.12963%**
8 RoSA	-0.00005%	0.02657%	0.00115%	0.00944%	0.01429%	-0.00013%	0.00024%	-0.00790%	**0.04376%**
9 PerthWA	-0.00007%	0.09493%	0.00394%	0.04127%	0.07089%	0.00047%	0.00008%	-0.03435%	**0.17771%**
10 RoWA	-0.00005%	0.03322%	0.00127%	0.01458%	0.02002%	-0.00030%	0.00000%	-0.00522%	**0.06381%**

The calculated increase of Real Household Consumption with the NBN in the long term when services require higher access speeds is more evenly spread across the regions than overall economic activity. In addition to electronic commerce, telehealth practice and teleworking, online higher education also makes a difference, albeit small, to Real Household Consumption. Figure 7.14 shows the results for regional employment of labour with the NBN in the long term when services require high access speeds.

Figure 7.14: Effects of the NBN on regional employment of labour in the long term when services require high access speeds

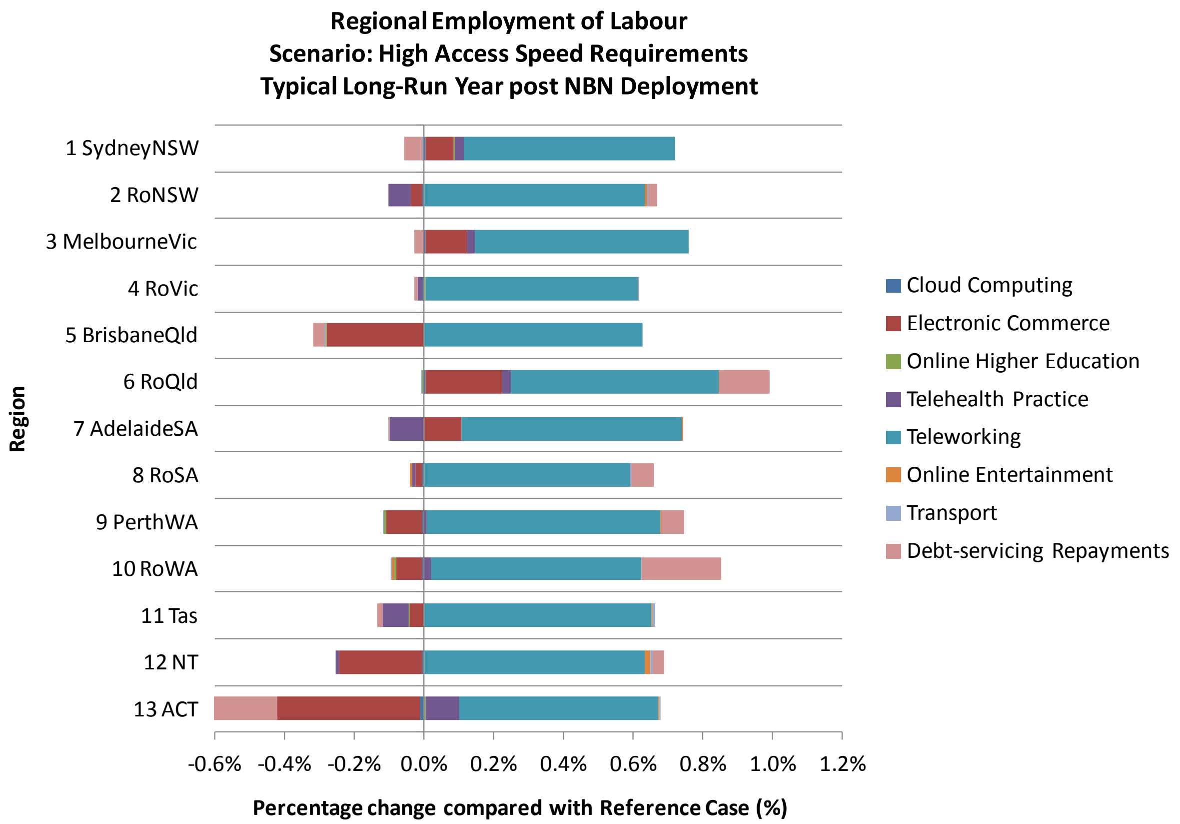


Table 7.12 shows a summary of the effects of the NBN on regional employment of labour shown in Figure 7.14.

Table 7.12: Summary of the effects of the NBN on regional employment of labour in the long term when services require high access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.0038%	0.0833%	0.0030%	0.0250%	0.6069%	-0.0025%	-0.0015%	-0.0524%	**0.6639%**
2 RoNSW	-0.0060%	-0.0297%	0.0026%	-0.0652%	0.6326%	0.0047%	0.0034%	0.0249%	**0.5722%**
3 MelbourneVic	0.0038%	0.1209%	0.0009%	0.0228%	0.6111%	-0.0005%	-0.0006%	-0.0259%	**0.7316%**
4 RoVic	-0.0056%	0.0034%	0.0015%	-0.0104%	0.6097%	0.0003%	0.0043%	-0.0113%	**0.5944%**
5 BrisbaneQld	-0.0010%	-0.2776%	-0.0036%	0.0013%	0.6250%	-0.0007%	-0.0015%	-0.0321%	**0.3052%**
6 RoQld	0.0040%	0.2218%	-0.0054%	0.0262%	0.5935%	0.0000%	-0.0005%	0.1468%	**0.9922%**
7 AdelaideSA	0.0017%	0.1066%	0.0000%	-0.0984%	0.6334%	0.0003%	-0.0003%	-0.0005%	**0.6474%**
8 RoSA	-0.0057%	-0.0174%	0.0013%	-0.0113%	0.5902%	-0.0044%	0.0045%	0.0637%	**0.6230%**
9 PerthWA	-0.0048%	-0.1043%	-0.0037%	0.0072%	0.6735%	0.0022%	-0.0015%	0.0642%	**0.6332%**
10 RoWA	-0.0054%	-0.0744%	-0.0046%	0.0230%	0.6017%	-0.0068%	-0.0020%	0.2291%	**0.7606%**
11 Tas	0.0007%	-0.0399%	-0.0036%	-0.0728%	0.6543%	0.0031%	0.0054%	-0.0175%	**0.5321%**
12 NT	-0.0028%	-0.2405%	0.0030%	-0.0105%	0.6311%	0.0175%	0.0043%	0.0345%	**0.4331%**
13 ACT	-0.0103%	-0.4096%	0.0062%	0.0947%	0.5723%	0.0032%	0.0017%	-0.2087%	**0.0417%**

Telework, electronic commerce and telehealth practice make noticeable differences in the future with the NBN where services require high access speeds. The effect of telework is a significant increase in effective employment of labour, as shown in Figure 7.14.

Telehealth practice has a positive impact on effective employment of labour in regions that have less than their share of Community Services industries and more than their share of other growing industries with relatively large labour demand.

Electronic commerce has a positive impact on employment of labour in regions that have less than their share of Community Services, Education and Public Administration and Defence industries, and more than their share of other growing industries with relatively large labour demand. Sydney {1}, Melbourne {3}, rest of Queensland {6} and Adelaide {7} have a comparative advantage because of relatively large labour savings in various industries which result in an increase in the industries' activity. To increase their production by the necessary amount, the majority of industries in these regions will demand more labour. This more than offset the significant labour savings that occur as a result of Electronic Commerce made more widely available through the NBN.

With Online Higher Education with the NBN in the long term, employment of labour is greater than it would have been in consumer-oriented regions because of increased local demand and an incline in activity in the service sector. To increase their production by the necessary amount, consumer-oriented industries will demand more labour which more than offsets the significant fall in the demand of labour in the Education and Construction industries. In export-oriented regions, increased labour demand in the underrepresented service industries fails to offset the significant fall in the demand of labour in the Education and Construction industries.

We now discuss the regional simulation results in the high access-speed scenario in more detail.

Debt-servicing Repayments

Export-oriented regions, such as Rest of Queensland {6} and Rest of Western Australia {10}, are comparatively better off because of NBN-induced expansions in trade-exposed industries. Regions specialising in consumer-oriented industries and the public sector are comparatively worse off because of NBN-induced contractions in non-trade exposed industries; such regions include Sydney {1}, Melbourne {3}, Brisbane {5} and Australian Capital Territory {13}.

Telehealth Practice

Rest of New South Wales {2}, Rest of Queensland {6} and Tasmania {11} are comparatively better off with respect to Real GRP because of relatively large input savings in the Community Services industries.

In consumer-oriented regions, such as Sydney {1}, Melbourne {3} and Australian Capital Territory {13}, industry demand for labour in particular in the Finance and Business Services industry, which is overrepresented in these regions, more than offsets the significant labour savings in the Community Services industries. The increased industry demand of labour in expanding industries in Rest of Queensland {6}, Perth {9} and Rest of Western Australia {10} outweighs the significant labour savings in the underrepresented Community Services industries. Employment of labour in Rest of New South Wales {2}, Rest of Victoria {4}, Adelaide {7}, Rest of Southern Australia {8}, Tasmania {11} and

Northern Territory {12} is decreased because the industry demand of labour in expanding industries fails to offset the significant labour savings in the Community Services industries. These regions are comparatively worse off with respect to Real Private Household Consumption.

Regions where employment of labour increases are comparatively better off with respect to Real Private Household Consumption; these regions include Sydney {1}, Melbourne {3}, Rest of Queensland {6}, Perth {9}, Rest of Western Australia {10} and Australian Capital Territory {13}.

Electronic Commerce

Sydney {1}, Melbourne {3}, Rest of Queensland {6} and Adelaide {7} are comparatively better off because of relatively large labour savings in various industries, increased local demand and exports. The majority of industries in these regions will demand more labour to increase their production by the necessary amount. The increases in the demand of labour more than offsets the significant labour savings in the Public Administration and Defence, Education and Community Services industries. These regions {1; 3; 6; 7} are comparatively better off with respect to Real Private Household Consumption because of increases in employment of labour. Brisbane {5}, Northern Territory {12} and Australian Capital Territory {13} are comparatively worse off because of relatively small labour savings in various industries.

Online Higher Education

Regions with relatively large capital savings in the Education industry, such as Rest of New South Wales {2}, Melbourne {3}, Rest of Victoria {4}, Adelaide {7}, Rest of Southern Australia {8}, Tasmania {11} and Northern Territory {12} are comparatively better off with respect to Real GRP. The significant incline in Education activity is supported by increased regional exports and weakened import competition. Brisbane {5}, Rest of Queensland {6}, Perth {9} and Rest of Western Australia {10} are comparatively worse off because they have less than their share of faster growing industries, such as Education, and a relatively large share of contracting industries, such as Construction. Australian Capital Territory {13} has more than its share of Education and less than its share of Construction. However, the capital savings in the Education industry in the Australian Capital Territory {13} is insignificant because the NBN impact on service delivery is negligible.

Employment of labour is increased in consumer-oriented regions, and regions that have less than their share of contracting industries, such as Construction, and relatively large capital savings in the Education industry. To increase their production by the necessary amount, consumer-goods industries will demand more labour. The increases in the demand of labour in consumer-goods industries more than offsets the significant fall in the demand of labour in the Education and Construction industries. In export-oriented regions, and regions that have more than their share of Construction industries and relatively small capital savings in the Education industries, increased labour demand in the underrepresented service industries fails to offset the significant fall in the demand of labour in the Education and Construction industries; these regions include Brisbane {5}, Rest of Queensland {6}, Perth {9}, Rest of Western Australia {10} and Tasmania {11}. These regions are comparatively worse off with respect to Real Private Household Consumption because regional employment of labour is decreased.

Teleworking

Rest of New South Wales {2}, Perth {9} and Tasmania {11} are comparatively better off because of relatively large labour savings in various industries. In these regions, the labour-saving technological progress resulting from people telework more with the NBN leads to significant increases in local demand. To increase their production by the necessary amount, the majority of industries will demand more labour which more than offset the significant labour savings. Australian Capital Territory {13} is comparatively worse off because of relatively small labour savings in various industries. For the majority of industries, increases in local demand failed to offset decreased exports and strengthened import competition.

Employment of labour is increased in all regions because people generally telework more with the NBN. Regions that have more than their share of labour-intensive industries benefit more from increases in employment of labour with the NBN. These regions include Sydney {1}, Melbourne {3}, Brisbane {5}, Adelaide {7}, Perth {9} and Australian Capital Territory {13}. Regions that benefit less include Rest of Queensland {6}, Rest of Southern Australia {8} and Rest of Western Australia {10}.

Regions are comparatively better off with respect to Real Private Household Consumption where the increases in employment of labour are relatively large; these regions include Perth {9} and Tasmania {11}. Increases in Real Private Household Consumption are comparatively modest in regions where the increases in employment of labour are comparatively small; these regions include Rest of Queensland {6}, Rest of Southern Australia {8} and Australian Capital Territory {13}.

Online Entertainment

Northern Territory {12} is comparatively better off because it has more than its share of the faster growing Recreation and Personal Services industry. The Australian Capital Territory {13} has the greatest share of the Recreation and Personal Services industry. However, the industry expands only marginally in the Australian Capital Territory {13}. Regions that have less than their share of the Recreation and Personal Services industry are comparatively worse off; these regions include Rest of Southern Australia {8} and Rest of Western Australia {10}. Rest of Queensland {6} has the fastest growing Recreation and Personal Services industry of all regions. The increased demand for labour in the Recreation and Personal Services industry more than offsets the decreased demand for labour in contracting industries. This leads to marginal increases in Real Household Consumption in the Rest of Queensland {6}.

Transport

Rest of New South Wales {2}, Rest of Victoria {4}, Rest of Southern Australia {8}, Tasmania {11} and Northern Territory {12} are comparatively better off. The faster growing Food, Beverages and Tobacco industry is overrepresented in Tasmania {11} and Northern Territory {12}, and Public Administration and Defence in Northern Territory {12}. Rest of New South Wales {2}, Rest of Victoria {4}, Rest of Southern Australia {8} have less than their share of contracting industries, such as Transport, and the Food, Beverages and Tobacco industry is overrepresented. Perth {9} and Rest of Western Australia {10} are comparatively worse off because they have more than their share of contracting industries such as mining. Rest of Queensland {6}, which is also specialising in mining, has more than its share of faster growing utilities and agricultural industries.

Figures 7.15 and 7.16 show the results for real Gross Regional Product and regional contributions to national Real GDP, respectively, with the NBN in the long term when services require modest access speeds.

Figure 7.15: Effects of the NBN on real Gross Regional Product in the long term when services require modest access speeds

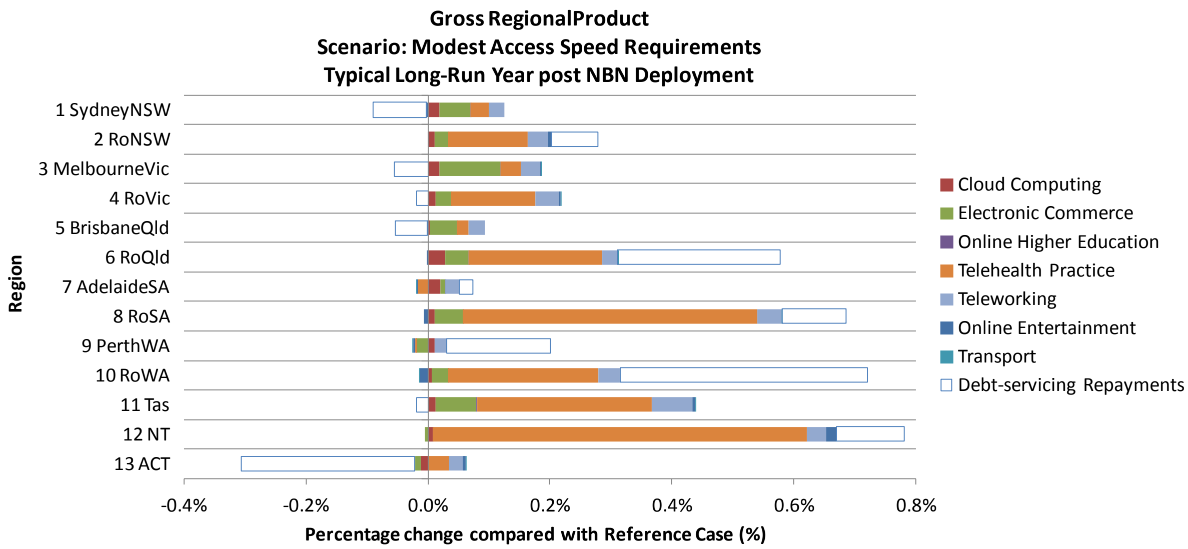


Table 7.13 shows a summary of the effects of the NBN on real Gross Regional Product shown in Figure 7.15.

Table 7.13: Summary of the effects of the NBN on regional Real Gross Regional Product in the long term when services require modest access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.01828%	0.05145%	0.00043%	0.02926%	0.02667%	-0.00238%	-0.00005%	-0.08718%	**0.03586%**
2 RoNSW	0.01063%	0.02217%	0.00072%	0.12939%	0.03373%	0.00485%	0.00031%	0.07645%	**0.27836%**
3 MelbourneVic	0.01867%	0.09998%	0.00077%	0.03253%	0.03281%	0.00032%	0.00005%	-0.05467%	**0.13004%**
4 RoVic	0.01221%	0.02529%	0.00128%	0.13834%	0.03717%	0.00275%	0.00046%	-0.01827%	**0.19916%**
5 BrisbaneQld	0.00256%	0.04485%	0.00020%	0.01914%	0.02761%	-0.00058%	-0.00003%	-0.05193%	**0.04140%**
6 RoQld	0.02930%	0.03697%	0.00006%	0.21939%	0.02569%	-0.00117%	0.00002%	0.26695%	**0.57794%**
7 AdelaideSA	0.02023%	0.00815%	0.00018%	-0.01659%	0.02236%	-0.00077%	-0.00008%	0.02212%	**0.05600%**
8 RoSA	0.01026%	0.04613%	0.00130%	0.48281%	0.03953%	-0.00670%	0.00051%	0.10547%	**0.67951%**
9 PerthWA	0.01110%	-0.01749%	-0.00025%	-0.00358%	0.02020%	-0.00305%	-0.00017%	0.17004%	**0.17675%**
10 RoWA	0.00654%	0.02629%	0.00031%	0.24608%	0.03598%	-0.01218%	-0.00001%	0.40498%	**0.70900%**
11 Tas	0.01232%	0.06683%	0.00130%	0.28640%	0.06652%	0.00476%	0.00136%	-0.01889%	**0.42146%**
12 NT	0.00757%	-0.00536%	0.00066%	0.61356%	0.03099%	0.01623%	0.00040%	0.11099%	**0.77793%**
13 ACT	-0.01181%	-0.00975%	0.00048%	0.03508%	0.02229%	0.00364%	0.00012%	-0.28382%	**-0.24453%**

Figure 7.16: Regional contributions to the effects of the NBN on national Real GDP in the long term when services require modest access speeds

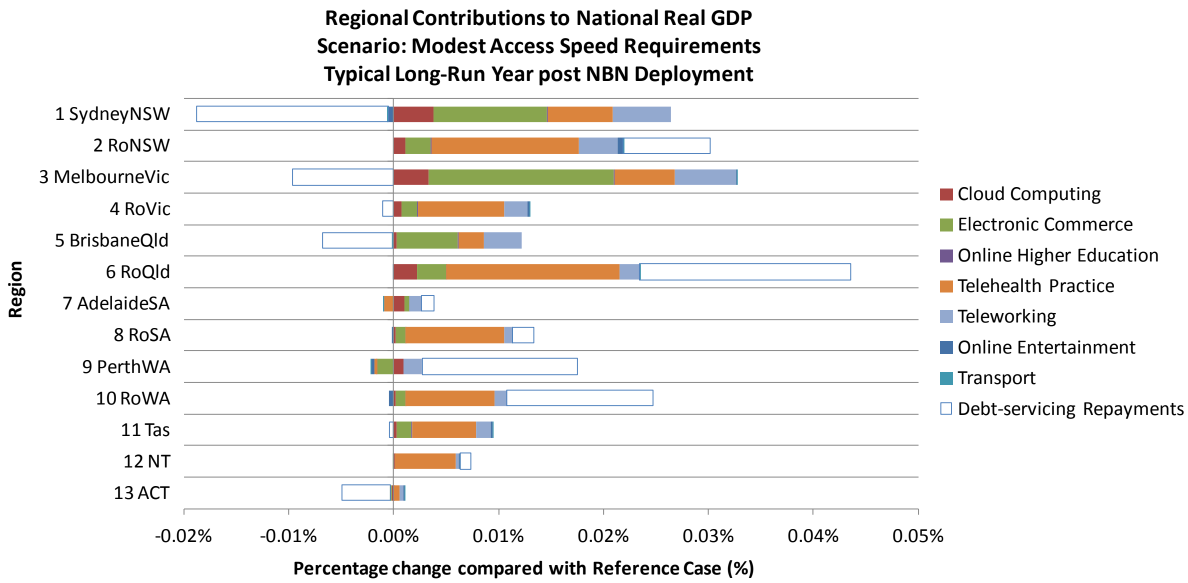


Table 7.14 shows a summary of the regional contributions to the effects of the NBN on national Real GDP shown in Figure 7.16.

Table 7.14: Summary of the regional contributions to the effects of the NBN on national GDP in the long term when services require modest access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.00384%	0.01080%	0.00009%	0.00615%	0.00560%	-0.00050%	-0.00001%	-0.01829%	**0.00753%**
2 RoNSW	0.00115%	0.00241%	0.00008%	0.01404%	0.00366%	0.00053%	0.00003%	0.00830%	**0.03021%**
3 MelbourneVic	0.00330%	0.01766%	0.00014%	0.00575%	0.00579%	0.00006%	0.00001%	-0.00966%	**0.02297%**
4 RoVic	0.00073%	0.00151%	0.00008%	0.00825%	0.00222%	0.00016%	0.00003%	-0.00109%	**0.01188%**
5 BrisbaneQld	0.00033%	0.00581%	0.00003%	0.00248%	0.00357%	-0.00008%	0.00000%	-0.00672%	**0.00536%**
6 RoQld	0.00221%	0.00279%	0.00001%	0.01652%	0.00194%	-0.00009%	0.00000%	0.02014%	**0.04357%**
7 AdelaideSA	0.00106%	0.00043%	0.00001%	-0.00087%	0.00117%	-0.00004%	0.00000%	0.00116%	**0.00294%**
8 RoSA	0.00020%	0.00090%	0.00003%	0.00942%	0.00077%	-0.00013%	0.00001%	0.00206%	**0.01327%**
9 PerthWA	0.00097%	-0.00152%	-0.00002%	-0.00031%	0.00176%	-0.00027%	-0.00002%	0.01480%	**0.01540%**
10 RoWA	0.00022%	0.00090%	0.00001%	0.00844%	0.00124%	-0.00042%	0.00000%	0.01392%	**0.02436%**
11 Tas	0.00026%	0.00144%	0.00003%	0.00614%	0.00143%	0.00010%	0.00003%	-0.00041%	**0.00903%**
12 NT	0.00007%	-0.00005%	0.00001%	0.00581%	0.00030%	0.00015%	0.00000%	0.00106%	**0.00737%**
13 ACT	-0.00019%	-0.00016%	0.00001%	0.00056%	0.00036%	0.00006%	0.00000%	-0.00455%	**-0.00392%**

Overall economic activity is increased in all regions except Australian Capital Territory {13} where overall economic activity is decreased with the NBN in the future scenario where broadband-enabled services require modest access-speeds. Electronic Commerce makes noticeable differences in the major cities, while regions outside major cities benefit comparatively more from telehealth.

Figures 7.17 and 7.18 show the results for regional Real Household Consumption and regional contributions to national Real Household Consumption, respectively, in the long term when services require modest access speeds.

Figure 7.17: Effects of the NBN on regional Real Household Consumption in the long term when services require modest access speeds

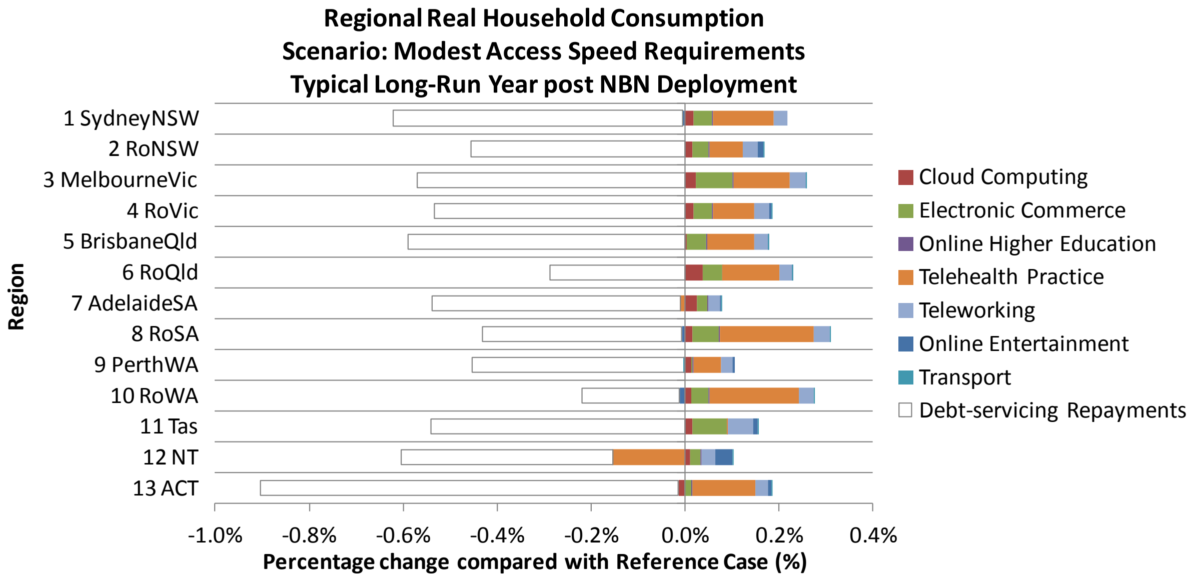


Table 7.15 shows a summary of the effects of the NBN on regional Real Household Consumption shown in Figure 7.17.

Table 7.15: Summary of the effects of the NBN on regional Real Household Consumption in the long term when services require modest access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.019144%	0.037745%	0.002159%	0.130120%	0.028294%	-0.003615%	-0.000008%	-0.618030%	**-0.406455%**
2 RoNSW	0.015783%	0.035046%	0.002152%	0.070188%	0.031276%	0.011376%	0.000496%	-0.455102%	**-0.288992%**
3 MelbourneVic	0.022129%	0.078751%	0.002006%	0.121012%	0.033027%	0.000500%	0.000118%	-0.570902%	**-0.315290%**
4 RoVic	0.017901%	0.040656%	0.002112%	0.085849%	0.033074%	0.003856%	0.000634%	-0.533203%	**-0.349494%**
5 BrisbaneQld	0.003713%	0.041540%	0.001755%	0.101062%	0.028337%	0.000230%	0.000008%	-0.589854%	**-0.414841%**
6 RoQld	0.037126%	0.041256%	0.001631%	0.121368%	0.025505%	0.001823%	0.000040%	-0.286813%	**-0.057721%**
7 AdelaideSA	0.025233%	0.023511%	0.001856%	-0.009989%	0.024890%	0.001959%	0.000023%	-0.528853%	**-0.460970%**
8 RoSA	0.017078%	0.053787%	0.002693%	0.200887%	0.033211%	-0.006611%	0.000701%	-0.425519%	**-0.123978%**
9 PerthWA	0.014286%	0.001468%	0.001595%	0.060658%	0.022420%	0.005882%	-0.000097%	-0.453489%	**-0.348006%**
10 RoWA	0.012320%	0.038787%	0.001875%	0.189519%	0.031231%	-0.011935%	0.000119%	-0.206566%	**0.055511%**
11 Tas	0.016576%	0.071773%	0.001095%	0.001527%	0.053770%	0.009170%	0.001514%	-0.540448%	**-0.383425%**
12 NT	0.010747%	0.021412%	0.002192%	-0.154511%	0.030546%	0.037194%	0.000478%	-0.449630%	**-0.494789%**
13 ACT	-0.013351%	0.012443%	0.002291%	0.134772%	0.027005%	0.008450%	0.000326%	-0.890385%	**-0.721154%**

Figure 7.18: Regional contributions to the effects of the NBN on national Real Household Consumption in the long term when services require modest access speeds

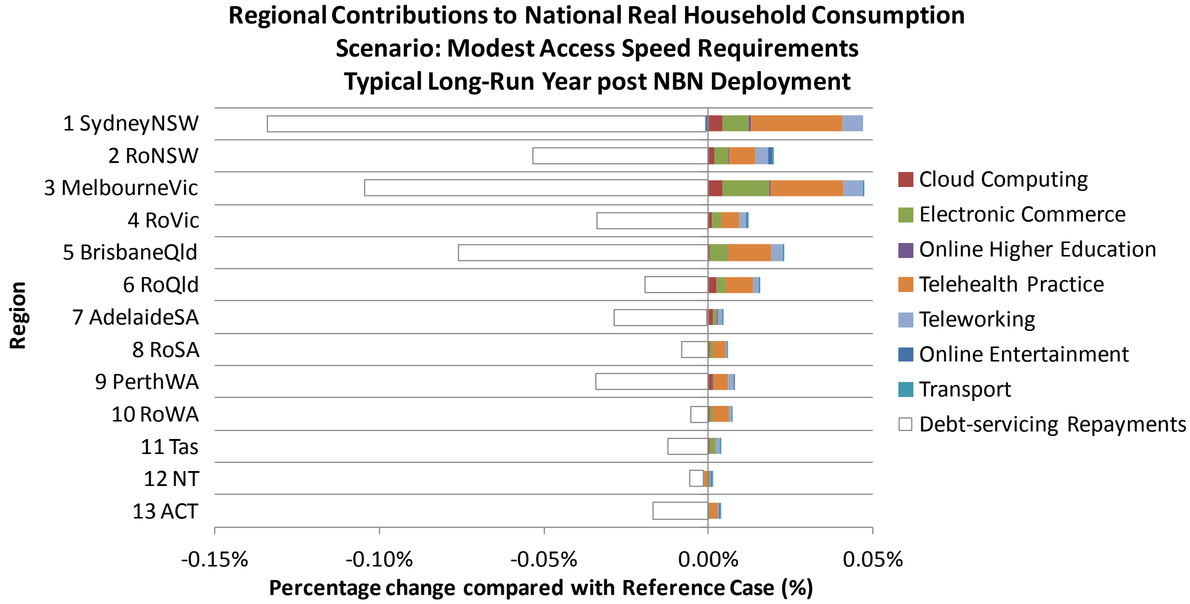


Table 7.16 shows a summary of the regional contributions to the effects of the NBN on national Real Household Consumption shown in Figure 7.18.

Table 7.16: Summary of the regional contributions to the effects of the NBN on national Real Household Consumption in the long term when services require modest access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.004137%	0.008157%	0.000467%	0.028131%	0.006115%	-0.000781%	-0.000002%	-0.133520%	**-0.087839%**
2 RoNSW	0.001847%	0.004102%	0.000252%	0.008214%	0.003661%	0.001332%	0.000058%	-0.053274%	**-0.033823%**
3 MelbourneVic	0.004052%	0.014419%	0.000367%	0.022165%	0.006048%	0.000092%	0.000022%	-0.104536%	**-0.057739%**
4 RoVic	0.001140%	0.002589%	0.000135%	0.005466%	0.002106%	0.000246%	0.000040%	-0.033960%	**-0.022253%**
5 BrisbaneQld	0.000479%	0.005356%	0.000226%	0.013034%	0.003654%	0.000030%	0.000001%	-0.076043%	**-0.053494%**
6 RoQld	0.002482%	0.002759%	0.000109%	0.008111%	0.001705%	0.000122%	0.000003%	-0.019187%	**-0.003859%**
7 AdelaideSA	0.001347%	0.001255%	0.000099%	-0.000533%	0.001329%	0.000105%	0.000001%	-0.028239%	**-0.024616%**
8 RoSA	0.000317%	0.000999%	0.000050%	0.003727%	0.000617%	-0.000123%	0.000013%	-0.007904%	**-0.002300%**
9 PerthWA	0.001081%	0.000111%	0.000121%	0.004593%	0.001697%	0.000445%	-0.000007%	-0.034351%	**-0.026369%**
10 RoWA	0.000311%	0.000980%	0.000047%	0.004784%	0.000789%	-0.000301%	0.000003%	-0.005222%	**0.001402%**
11 Tas	0.000381%	0.001648%	0.000025%	0.000035%	0.001234%	0.000211%	0.000035%	-0.012408%	**-0.008793%**
12 NT	0.000105%	0.000209%	0.000021%	-0.001501%	0.000297%	0.000362%	0.000005%	-0.004379%	**-0.004808%**
13 ACT	-0.000248%	0.000231%	0.000043%	0.002508%	0.000502%	0.000157%	0.000006%	-0.016551%	**-0.013411%**

In the future scenario where broadband-enabled services require modest access speeds, Real Household Consumption with the NBN is decreased in most regions except Rest of Western Australia {10}. In those regions where households are worse off, the increased debt-servicing payments caused by the NBN outweigh the benefits that the NBN can bring.

Figure 7.19 shows the results for regional employment of labour with the NBN in the long term when services require modest access speeds.

Figure 7.19: Effects of the NBN on regional employment of labour in the long term when services require modest access speeds

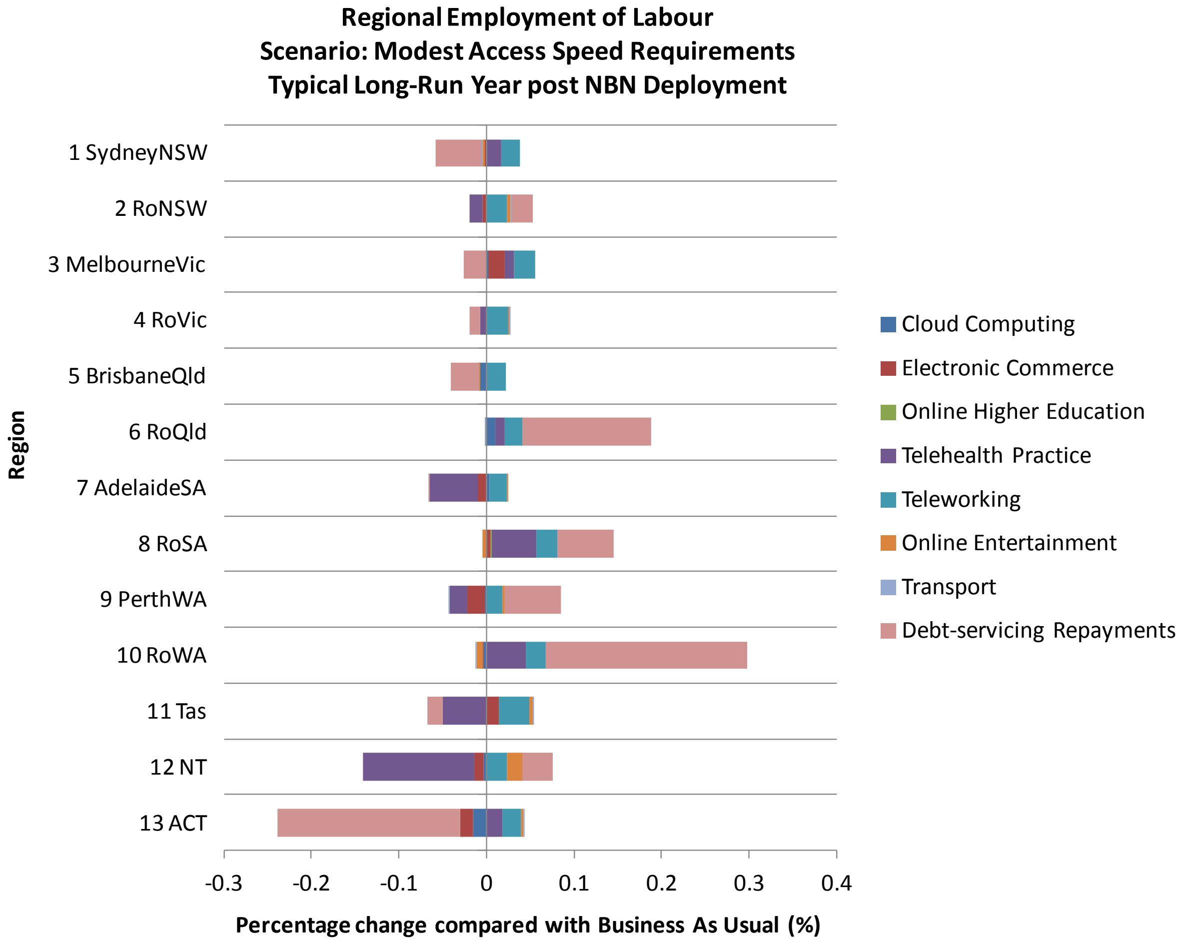


Table 7.17 shows a summary of the effects of the NBN on regional employment of labour shown in Figure 7.19.

Table 7.17: Summary of the effects of the NBN on regional employment of labour in the long term when services require modest access speeds

Region	Cloud Computing	Electronic Commerce	Online Higher Education	Telehealth Practice	Teleworking	Online Entertainment	Transport	Debt-servicing Repayments	Net effect (Total)
1 SydneyNSW	0.00087%	-0.00247%	0.00010%	0.01535%	0.02186%	-0.00267%	-0.00009%	-0.05243%	**-0.01974%**
2 RoNSW	-0.00081%	-0.00382%	0.00010%	-0.01458%	0.02335%	0.00483%	0.00017%	0.02488%	**0.03412%**
3 MelbourneVic	0.00236%	0.01802%	0.00002%	0.01080%	0.02422%	-0.00061%	-0.00002%	-0.02588%	**0.02880%**
4 RoVic	0.00025%	-0.00102%	0.00008%	-0.00676%	0.02425%	0.00107%	0.00023%	-0.01126%	**0.00716%**
5 BrisbaneQld	-0.00685%	-0.00058%	-0.00010%	0.00084%	0.02188%	-0.00074%	-0.00008%	-0.03211%	**-0.01791%**
6 RoQld	0.00986%	-0.00072%	-0.00016%	0.01098%	0.02046%	0.00005%	-0.00006%	0.14676%	**0.18795%**
7 AdelaideSA	0.00391%	-0.00959%	-0.00005%	-0.05465%	0.02016%	0.00012%	-0.00007%	-0.00054%	**-0.04084%**
8 RoSA	-0.00016%	0.00554%	0.00037%	0.05069%	0.02432%	-0.00416%	0.00027%	0.06370%	**0.14157%**
9 PerthWA	-0.00156%	-0.02061%	-0.00018%	-0.01935%	0.01892%	0.00208%	-0.00013%	0.06416%	**0.04312%**
10 RoWA	-0.00254%	-0.00195%	-0.00004%	0.04501%	0.02333%	-0.00683%	-0.00002%	0.22913%	**0.28702%**
11 Tas	-0.00042%	0.01453%	-0.00043%	-0.04889%	0.03459%	0.00373%	0.00067%	-0.01748%	**-0.01374%**
12 NT	-0.00333%	-0.01064%	0.00012%	-0.12690%	0.02298%	0.01774%	0.00016%	0.03451%	**-0.06169%**
13 ACT	-0.01538%	-0.01512%	0.00017%	0.01768%	0.02121%	0.00337%	0.00008%	-0.20874%	**-0.19679%**

The effect of the NBN on employment of labour varies widely across regions with the NBN in the long term when services require modest access speeds. Telehealth practice, telework, and debt-servicing repayments make noticeable differences. The effects of the NBN due to Debt-servicing Repayments are identical to the effects in the long term when services require high access speeds. The effect of people telework more with the NBN is to increase the effective employment of labour in each region. Employment of labour is decreased with the NBN due to Telehealth Practice in regions that have more than their share of Community Services industries and less than their share of other industries with relatively large inputs of labour. Employment of labour is increased with the NBN due to Electronic Commerce in regions that have less than their share of Community Services, Education and Public Administration and Defence industries, and more than their share of other growing industries with relatively large inputs of labour. Sydney {1}, Melbourne {3} and Brisbane {5} have a comparative advantage because of comparatively large labour savings in various industries which result in a significant increase in their activity level. To increase their production by the necessary amount, the majority of industries in these regions {1; 3; 5} will demand more labour which more than offsets the significant labour savings.

We now discuss the regional simulation results under the modest access-speed scenario in more detail.

Debt-servicing Repayments

The effects of the NBN with respect to the Debt-servicing Repayments are the same in both access speeds scenarios. Thus, the description how these results arise are identical and not repeated here.

Telehealth Practice

Rest of Southern Australia {8} and Northern Territory {12} are comparatively better off in terms of Real GRP. The Community Services industry in these regions {8; 12} benefits from comparatively large input savings with the NBN. A growing local market, weakened regional import competition and increased regional exports of Community Services reflect the comparative advantage over regions with relatively little input savings in the Community Services industries; these regions include Sydney {1}, Melbourne {3}, Brisbane {5}, Adelaide {7}, Perth {9} and Australian Capital Territory {13}, which are comparatively worse off in terms of Real GRP.

In terms of Real Household Consumption, Adelaide {7}, Tasmania {11} and Northern Territory {12} are comparatively worse off because increases in industry demand of labour in expanding industries fails to offset labour savings in the Community Services industry. While regional output is increased in Tasmania {11} and Northern Territory {12}, industries with relatively large inputs of labour are underrepresented in these regions {11; 12}, such as Finance and Business Services and Construction.

Electronic Commerce

Melbourne {3} is comparatively better off because of relatively large labour savings in industries that are overrepresented in the region, expanding local markets and increased exports. Tasmania {12} benefits from relatively large labour savings in the Construction industry. Simulated by the productivity improvement and increases in the capital stock, the majority of industries will demand more labour to increase their production by the necessary amount. The increases in the demand of labour particularly in the Mining industry, more than offset the labour savings in various industries.

Perth {9}, Northern Territory {12} and Australian Capital Territory {13} benefit least from electronic commerce with the NBN and are comparatively worse off.

Online Higher Education

Rest of Victoria {4}, Rest of Southern Australia {8} and Tasmania {11} benefit from relatively large capital savings in the Education industries and are comparatively better off with respect to Real GRP. To increase their production by the necessary amount, consumer-goods industries will demand more labour. Employment of labour is increased in Rest of Victoria {4} and Rest of Southern Australia {8}. The comparatively steep supply schedule of the Education industry in Tasmania {11} results in a relatively small expansion in production and subsequent demand for primary factors such as capital and labour. Regional employment of labour is decreased and Tasmania {11} comparatively worse off in term of Real Household Consumption. Export-oriented regions, such as Rest of Queensland {6}, Perth {9} and Rest of Western Australia {10}, are comparatively worse off because of NBN-induced contractions in trade-exposed industries such as Mining.

Teleworking

Regions with relatively large labour savings in various industries are comparatively better off such as Tasmania {11}. Adelaide {7}, Perth {9} and Australian Capital Territory {13} are comparatively worse off because of relatively small labour savings with the NBN.

Online Entertainment

The regional results in the modest access-speeds scenario are similar to the regional results in the high access-speeds scenario due to the fact that the imposed changes to consumer spending in each region are similar.

Transport

Albeit with a much smaller magnitude, the regional results in the modest access-speeds scenario are similar to the regional results in the high access-speeds scenario because of the similar pattern of the imposed changes to consumer spending on transport.

7.6 Concluding Remarks

Previous analysis of the NBN has not accounted for all the linkages between sectors and agents of an economy. In an independent cost-benefit analysis of the NBN, the Department of Communications and the Arts (2014a) investigated and explored the effects of various policy options on network coverage, speed, and incremental net benefits in what was originally announced as “[...] a (relatively) simple partial equilibrium analysis [...]” (Robson, 2014, p. 19).

In this chapter, we have presented the results from our general equilibrium analysis and described the effects of the NBN with the inputs to the economic model derived in the previous chapters. This presents an outlook of the changes to the economy subject to the latest Government expectations (Department of Communications and the Arts, 2014b) of NBN deployment and account for all the linkages between sectors and agents of an economy.

Our main contribution in this chapter is to provide quantitative estimates of the effects of the NBN on the economy on various levels. We follow the general strategy suggested by Adams (2005), focusing first on macroeconomic variables, then on structural variables such as industry output. The regional results are a specific feature of TERM and provide additional insights for regional policy makers. In addition, we describe at a broad level how these results are obtained in the economic model.

The results show that, subject to the access-speed requirements, one or two services with significant intrinsic value made widely available through the NBN will be sufficient to achieve a net improvement to the Australian economy over and above the economic cost of deploying the NBN itself. However, the economic benefits of the NBN in the long term arise from how it is put to use. Key for harnessing these benefits is the actual use of the new services.

While the NBN undoubtedly increases the availability of high-speed broadband outside the metropolitan areas, an analysis of the regional impact of the NBN shows that the greater stimulatory effects still occur in the major metropolitan areas, but with some significant additions in the regional areas of the east-coast states.

In the chapter that follows, we will use our results from this chapter to measure the carbon footprint impact of the NBN. We include estimates of the energy consumption of the NBN and of the networks that will be overbuilt. The incremental energy consumption is then converted into carbon emissions equivalents.

CHAPTER 8
CARBON IMPACT OF THE NBN

8.1 Introduction

In the previous chapter, we have provided quantitative estimates of the effects of the NBN on the economy. We have focused on macroeconomic variables, structural variables such as industry output, and regional macroeconomic variables. Key findings indicate that the NBN effects on the broader economy in the construction phase are negligible. In a typical long-run year post NBN deployment, however, the NBN leads to a significant expansion of the overall size of the economy in particular when services require high access speeds.

National GHG emissions will be affected by the NBN for two reasons. First, the use of the NBN causes the overall size of the economy to change. Second, the NBN itself produces scope 1 and 2 emissions. Scope 1, also referred to as direct, emissions are produced from sources that are owned or controlled by the entity and can include emissions from fossil fuels burned on site, emissions from entity-owned or entity-leased vehicles, manufacturing processes which produce emissions, fugitive emissions and on-site waste management, transportation of people, materials and products waste (Department of the Environment and Energy, 2016). Scope 2, also referred to indirect, emissions are emissions generated in the broader economy as a consequence of an entity's activity from sources that are not owned or controlled by the entity. A typical source of indirect emissions is the consumption of purchased electricity, which may be generated, for example, from coal or natural gas. Other examples of indirect emissions include upstream emissions generated in the extraction and production of fossil fuels, downstream emissions from transport of an organisation's product to customers, and emissions from contracted or outsourced activities (Department of the Environment and Energy, 2016).

In this chapter, we describe our approach to estimate the carbon impact of the NBN. We use our results from chapter 7 for industry output and Real Private Household Consumption to estimate national GHG emissions of all economic sectors with the NBN. We also present a model we have developed for the purpose of estimating the incremental energy consumption of the NBN network. The estimated energy consumption is then converted to GHG emissions using the latest official emissions conversion factors available at the time of our analysis.

This chapter consists of two thematic sections with relevant sub-sections. In the first section, we use our results from the previous chapter and emissions data from the national greenhouse gas inventory to estimate the carbon impact of the NBN on the broader economy. Next, we analyse the energy consumption of the NBN. Finally, we give a summary of the carbon impact of the NBN, in which we convert our estimate of the incremental electricity purchased and consumed by the NBN network to GHG emissions; some concluding remarks and a focus for the following chapter are provided.

In the following section, we describe our estimates of NBN's carbon impact on economic sectors.

8.2 Carbon impact of the NBN on the broader economy

To estimate NBN's carbon impact on economic sectors, first, we have adopted base year emissions data by ANZSIC sector for the fiscal year 2011 from the Australian Government Department of the Environment and Energy (hereafter "Department"). We have mapped the ANZSIC sector emissions data across to the equivalent industry group used in our economic model database, which is described in more detail in Appendix D.1. The final allocation by industry group is shown in Table 8.1.

Table 8.1: Base year (2010/2011) direct GHG emissions by industry group in the economic model

Industry group	GHG (1,000 Tonnes CO2-e)
Agriculture, forestry & fishing	84,800.9
Mining	61,095.1
Food, beverages & tobacco	4,788.4
Textiles, clothing & footwear	490.8
Miscellaneous manufacturing	3,180.8
Wood & wood products	710.2
Paper and printing	1,264.2
Chemicals & coal products	16,919.5
Non-metallic mineral products	11,516.7
Metal products	31,514.0
Transport equipment	363.2
Other machinery & equipment	584.4
Electricity, gas & water	203,629.6
Construction	9,483.0
Wholesale trade	1,745.6
Retail trade	1,796.0
Recreation & personal services	1,934.0
Transport & storage	23,417.7
Postal services	2,678.3
Telecommunication services	3,899.7
Finance & business services	4,475.1
Public admin. & defence	212.9
Education	5,852.8
Health, welfare & community services	7,510.4

We then used our results of industry output or activity level with the NBN in the short term from Table 7.2, and in the long term from Tables 7.6 and 7.7, respectively, to estimate the (percentage) change in industries' GHG emissions.

In addition to industrial emissions, we also need to consider residential emissions to account for activities like the use of fuels such as coal and gas. These make up almost 10% of national GHG emissions of which the majority are related to transport. Similar to industrial emissions, we have assumed that Real Private Household Consumption is driving residential GHG emissions. Accordingly, we have used our results of Real Private Household Consumption with the NBN in the short term from Table 7.1, and in the long term from Tables 7.4 and 7.5, respectively, to estimate the (percentage) change in residential GHG emissions. Table 8.2 shows our estimates of GHG emissions with the NBN in a typical short-run year. Column (2) shows the base year GHG emissions from Table 8.1, column (3) the percentage change in national industry output and Real Private Household Consumption with the NBN in the short term from Tables 7.2 and 7.1, respectively.

Table 8.2: Carbon impact of the NBN on economic sectors in the short term

Industry	**Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)**	**Economic Sector Activity Level Growth (%); (3)**	**GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)**	**Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)**
1 AgriForFish	84,800.9	-0.24%	-205.2	84,595.8
2 Mining	61,095.1	-0.08%	-48.6	61,046.5
3 FoodDrinkTob	4,788.4	-0.28%	-13.4	4,775.0
4 TCFs	490.8	0.08%	0.4	491.2
5 MiscManuf	3,180.8	-0.11%	-3.5	3,177.3
6 WoodProds	710.2	0.02%	0.2	710.4
7 PaperPrint	1,264.2	-0.02%	-0.2	1,264.0
8 ChemCoalPrds	16,919.5	-0.16%	-26.7	16,892.9
9 NonMetMinPrd	11,516.7	0.95%	109.8	11,626.5
10 MetalPrds	31,514.0	-0.23%	-73.5	31,440.5
11 TransEqp	363.2	-0.53%	-1.9	361.2
12 OthMachEqp	584.4	0.35%	2.1	586.5
13 EGW	203,629.6	0.04%	83.7	203,713.3
14 Construction	9,483.0	1.73%	164.3	9,647.3
15 WholesalTrad	1,745.6	0.31%	5.4	1,751.0
16 RetailTrade	1,796.0	0.10%	1.8	1,797.8
17 RecPersSrvc	1,934.0	-0.03%	-0.6	1,933.4
18 Transport	23,417.7	-0.16%	-37.1	23,380.5
19 PostalSrvcs	2,678.3	0.02%	0.6	2,678.9
20 telecoms	3,899.7	0.05%	1.8	3,901.5
21 NBNRetailSrv	0.0	0.20%	0.0	0.0
22 NBNCoSrvcs	0.0	0.20%	0.0	0.0
23 FinBusSrvces	4,475.1	0.12%	5.5	4,480.6
24 PubAdmDef	212.9	0.02%	0.04	212.9
25 Education	5,852.8	-0.07%	-4.0	5,848.8
26 Community	7,510.4	-0.004%	-0.3	7,510.1
Residential	54,956.7	0%	0	54,956.7
Total	**538,820.2**	-0.007%	**-39.6**	538,780.6

GHG emissions of the NBN retail service (21) and NBN wholesale service (22) industries are insignificant because industry output in the base-period is negligible. We will focus on NBN's direct and indirect GHG emissions in the short term in section 8.4. Overall, national GHG emissions are effectively unchanged by the construction of the NBN.

Table 8.3 shows our estimates of the GHG emissions by economic sector with the NBN in the long term when services require modest access speeds. Column (2) shows the base year GHG emissions from Table 8.1, column (3) the percentage change in national industry output and Real Private Household Consumption with the NBN in the long term from Tables 7.6 and 7.4, respectively.

Table 8.3: Carbon impact of the NBN on economic sectors in the long term when services require modest access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.34%	291.7	85,092.6
2 Mining	61,095.1	1.41%	861.8	61,957.0
3 FoodDrinkTob	4,788.4	0.42%	20.0	4,808.5
4 TCFs	490.8	0.50%	2.5	493.2
5 MiscManuf	3,180.8	0.54%	17.1	3,197.9
6 WoodProds	710.2	0.07%	0.5	710.7
7 PaperPrint	1,264.2	-0.02%	-0.3	1,263.9
8 ChemCoalPrds	16,919.5	0.49%	82.3	17,001.9
9 NonMetMinPrd	11,516.7	0.22%	25.8	11,542.5
10 MetalPrds	31,514.0	1.14%	359.7	31,873.7
11 TransEqp	363.2	0.99%	3.6	366.8
12 OthMachEqp	584.4	0.56%	3.3	587.7
13 EGW	203,629.6	0.04%	80.2	203,709.8
14 Construction	9,483.0	0.10%	9.7	9,492.8
15 WholesalTrad	1,745.6	0.20%	3.5	1,749.1
16 RetailTrade	1,796.0	0.00%	0.1	1,796.1
17 RecPersSrvc	1,934.0	0.67%	13.0	1,947.0
18 Transport	23,417.7	0.57%	133.1	23,550.8
19 PostalSrvcs	2,678.3	0.12%	3.3	2,681.5
20 Telecomms	3,899.7	-0.08%	-3.2	3,896.6
21 FinBusSrvces	4,475.1	-0.08%	-3.6	4,471.5
22 PubAdmDef	212.9	-0.28%	-0.6	212.2
23 Education	5,852.8	-0.19%	-11.3	5,841.5
24 Community	7,510.4	-0.21%	-16.1	7,494.4
Residential	54,956.7	-0.34%	-185.7	54,771.0
Total	**538,820.2**	**0.31%**	**1,690.6**	540,510.8

Table 8.4 shows our estimates of the GHG emissions by economic sector with the NBN in the long term when services require high access speeds. Column (2) shows the base year GHG emissions from Table 8.1, column (3) the percentage change in national industry output and Real Private Household Consumption with the NBN in the long term from Tables 7.7 and 7.5, respectively.

Table 8.4: Carbon impact of the NBN on economic sectors in the long term when services require high access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	1.60%	1,353.0	86,154.0
2 Mining	61,095.1	3.72%	2,273.1	63,368.2
3 FoodDrinkTob	4,788.4	2.09%	100.1	4,888.5
4 TCFs	490.8	2.26%	11.1	501.9
5 MiscManuf	3,180.8	2.57%	81.9	3,262.7
6 WoodProds	710.2	2.54%	18.0	728.3
7 PaperPrint	1,264.2	2.31%	29.2	1,293.4
8 ChemCoalPrds	16,919.5	2.46%	417.0	17,336.5
9 NonMetMinPrd	11,516.7	2.51%	289.1	11,805.8
10 MetalPrds	31,514.0	2.92%	920.9	32,434.9
11 TransEqp	363.2	3.49%	12.7	375.8
12 OthMachEqp	584.4	2.79%	16.3	600.7
13 EGW	203,629.6	2.40%	4,878.0	208,507.6
14 Construction	9,483.0	2.44%	231.4	9,714.5
15 WholesalTrad	1,745.6	2.29%	40.0	1,785.6
16 RetailTrade	1,796.0	2.09%	37.6	1,833.6
17 RecPersSrvc	1,934.0	3.30%	63.8	1,997.8
18 Transport	23,417.7	2.92%	684.7	24,102.4
19 PostalSrvcs	2,678.3	2.50%	67.1	2,745.3
20 Telecomms	3,899.7	2.37%	92.5	3,992.2
21 FinBusSrvces	4,475.1	2.81%	125.9	4,601.0
22 PubAdmDef	212.9	2.41%	5.1	218.0
23 Education	5,852.8	2.76%	161.3	6,014.1
24 Community	7,510.4	3.57%	267.9	7,778.4
Residential	54,956.7	2.37%	1,303.0	56,259.7
Total	**538,820.2**	**2.50%**	**13,480.7**	**552,300.9**

When services require modest access speeds, the use of the NBN causes annual GHG emissions in a typical long-run year to be 0.31% (1.7 million tonnes CO2-e) higher than they otherwise would have been in the absence of the NBN. When services require high access speeds, annual GHG emissions increase 2.5% (13.5 million tonnes CO2-e).

Similar to our estimates shown in Tables 8.2 to 8.4, we have calculated the growth of GHG emissions for each service category separately using our industry results from Tables 7.4 and 7.6 and estimated percentage changes in Real Private Household Consumption with the NBN in the long term from Tables 7.5 and 7.7. In Appendix D.2, Tables D.3 to D.17, we have derived the growth in greenhouse gas emissions in the fourth columns from the base year direct emissions in the second columns multiplied with the economic sector activity level growth in the third columns.

The carbon impact of the NBN is subject to the NBN network's energy consumption and accounts for indirect emissions from the generation of purchased electricity. This is analysed in the following section.

8.3 Energy consumption of the NBN

Energy consumption of the NBN in the short term

The NBN's annual energy consumption in the fiscal year 2015 was reportedly 138,166 gigajoules or 38,379 megawatt hours including purchased electricity, used in offices, sites and to power the network (NBN Company, a). Estimated energy use for the fiscal year 2016 reportedly increased to 340,327 gigajoules or 94,535 megawatt hours (NBN Company, 2016). As part of the reporting requirements under the National Greenhouse and Energy Reporting Act 2007, NBN has converted its energy use to GHG emissions and submitted estimates of direct and indirect emissions to the Clean Energy Regulator since 2015. We account for NBN's direct and indirect emissions estimate in section 8.4.

Energy consumption of the NBN network in the long term

For a typical long-run year post NBN deployment, we have estimated the NBN network's power consumption based on estimates of the per-customer power consumption from the literature and our own modelling. First, we have estimated the power consumption of the NBN network. The energy consumed by the different options for a high-speed access network varies considerably. To estimate the per-customer power consumption of various access networks, we have adopted the network-based model of power consumption in optical IP networks presented by Baliga et al. (2009). Baliga et al. relied on the model for estimating the energy consumption of the Internet, including the core, metro and edge, access and video distribution networks. It accounts for the energy consumption in switching, transmission and customer premises equipment. Because the NBN is predominantly an access network, the equation we have used to estimate the power consumption of access networks, connecting each premises to one of the edge nodes from an Internet service provider, is as follows:

$$P_{premises} = \frac{C \times P_{TU}}{N_{TU}} + \frac{P_{RN}}{N_{RN}} \qquad (1)$$

where

$P_{premises}$ is per-premises power consumption of the access network in Watts;

C is factor to account for additional overheads such as external power supplies, electricity distribution losses, and cooling requirements in the building that houses the terminal equipment;

P_{TU} is power consumed by the terminal unit (locate on the local exchange or central office);

N_{TU} is number of users or subscribers that share a terminal unit;

P_{RN} is power consumed by the remote node between the customer premises and central office; and

N_{RN} is number of users or subscribers that share a remote node.

Table 8.5 shows the values and source of access network parameters used for estimating the per-premises power consumption of FTTP, FTTN and ADSL in equation (1).

Table 8.5: Values of access network parameters in equation (1)

Parameter	Units	FTTP	FTTN	ADSL
C	#	1.5	1.5	1.5
Source		Baliga et al. (2011)	Baliga et al. (2011)	Baliga et al. (2011)
P_{TU}	Watts	1,710	470	1,700
Source		Reconfigurable OLT Cisco ME4620	Baliga et al. (2011)	Baliga et al. (2011)
N_{TU}	#	7,680	1,792	1,008
Source		Assumption	Baliga et al. (2011)	Baliga et al. (2011)
P_{RN}	Watts	Not applicable	766	Not applicable
Source		Not applicable	Taylor (2014); 6,709kWh per annum converted to Watts	Not applicable
N_{RN}	#	Not applicable	384	Not applicable
Source		Not applicable	Taylor (2014)	Not applicable

For FTTP, we have assumed that the numbers of users or subscribers that share a terminal unit are based on 240 slots in the terminal unit and 32 users per slot.

The resulting per-premises power consumption estimates for FTTP, FTTN and ADSL are shown in Table 8.6.

We have derived the per-premises power consumption of HFC from an updated model based on Baliga et al. (2011). For FTTdp/B, we have assumed that the average per-premises power consumption of FTTN is a reasonable approximation because they have a similar architecture. Unlike passive distribution networks such as FTTP, FTTdp/B and FTTN access networks have an active node between the central office and home. Our estimates for the per-premises power consumption of fixed wireless and satellite are based on the values of access network parameters shown in Appendix D.3 and D.4, respectively.

We then used our estimates of the per-premises power consumption to calculate the total power consumption of an access network as follows:

$$P_{AN} = P_{premises} \times N_{PR} + S_{AN} P_{CPE} \qquad (2)$$

where

P_{AN} is power consumption of the access network in Watts;

$P_{premises}$ is per-premises power consumption of the access network in Watts;

N_{PR} is number of end-user premises passed by the access network;

S_{AN} is subscribers of the access network in percent; and

P_{CPE} is power consumed by the customer premises equipment (i.e. the modem).

We have calculated the power consumption of NBN access networks using the access network parameters shown in Table 8.6 in equation (2).

Table 8.6: Values of NBN access network parameters in equation (2)

Parameter	Units	FTTP	FTTN	HFC	FTTdp/B	Fixed Wireless	Satellite
$P_{premises}$	Watts	0.3W	2.4W	1.3W	2.4W	7W	0.5W
Source		Equation (1)	Equation (1)	Assump-tion	Assump-tion	Equation (1)	Estimate (C.4)
N_{PR}	# in million	3.1	3.6	3.3	1.4	0.6	0.4
Source		NBN Company (2014a)	NBN Company (2014a)	NBN Company (2014a)	NBN Company (2014a)	NBN Company (2014a)	NBN Company (2014a)
S_{AN}	%	70%	70%	70%	70%	37.3%	37.3%
Source		NBN Company (2010a)	NBN Company (2010a)	NBN Company (2010a)	NBN Company (2010a)	NBN Company (2010a)	Assumption
P_{CPE}	Watts	15W	15W	15W	15W	25W	50.9W
Source		NBN Company (2013b)	Assump-tion	Assump-tion	Assump-tion	NBN Company email confirma-tion	Estimate (C.4)

For HFC, as noted earlier, we have assumed the per-premises power consumption from an updated model based on Baliga et al. (2011). The average per-premises power consumption estimated for download rates of 8 Mbps and 24 Mbps (0.78 Watts), and 24 Mbps and 100 Mbps (1.57 Watts) were used in proportion of the average NBN fixed line end-users speed tiers. As at 30 June 2014, 62% of end users were on speed tiers of 24 Mbps or more (NBN Company, 2014a). The per-premises power consumption for HFC of 1.27 Watts was estimated as the sum of 62% of 1.57 Watts (0.97 Watts) and 38% of 0.78 Watts (0.3 Watts). For FTTdp/B, as noted earlier, we have assumed the same power consumption per premises as for FTTN. For satellite service, we have assumed the same number of subscribers (take-up) as for fixed wireless. We have assumed that the power consumed by the customer premises equipment (CPE) for FTTN, HFC and FTTdp/B is the same as for FTTP.

Energy consumption of the access networks in the reference case

The NBN will overbuild parts of existing access networks that otherwise would have consumed energy in the absence of the NBN (reference case). In particular, we have assumed that FTTN, DSL and HFC access networks in the reference case will be overbuilt with NBN access networks. Based on this assumption, we calculated the power consumption of the access networks that will be overbuilt with NBN access networks using the access network parameters shown in Table 8.7 in equation (2).

Table 8.7: Values of reference case access network parameters in equation (2)

Parameter	Units	FTTN	ADSL	HFC
$P_{premises}$	Watts	3.3W	2.5W	1.3W
Source		Equation (1)	Equation (1)	Assumption
N_{PR}	# in million	0.06	9.86	2.73
Source		Department of Communications and the Arts (2013a)	Department of Communications and the Arts (2013a)	Department of Communications and the Arts (2013a)
S_{AN}	%	46.9%	51.4%	34.7%
Source		Assumption	ABS (2014)	ABS (2014)
P_{CPE}	Watts	10W	5W	7.5W
Source		Baliga et al. (2011)	Baliga et al. (2011)	Arris CM900 Docsis 3 Cable Modem

For HFC, as in Table 8.6, we have derived the per-premises power consumption of HFC from an updated model based on Baliga et al. (2011). For FTTN, the number of subscribers (take-up) was assumed to be the average of other fixed line services, such as HFC, FTTP (54.8%) and ADSL. For FTTP, we have estimated the number of subscribers (take-up) by dividing 203 thousand internet subscribers as at June 2014 (ABS, 2014) with 370.4 thousand premises passed (Department of Communications and the Arts, 2013a).

In the reference case, the power as consumed by the customer premises equipment is lower than the equivalent NBN access networks such as FTTN and HFC. The reason is that there is currently more customer premises equipment needed per household for the NBN; One owned by NBN and the other owned by the retail service provider.

Incremental energy consumption of the NBN network in the long term

We then calculated the incremental or net power consumption of NBN access networks as the difference between the power consumption of NBN access networks and reference case access networks that will be overbuilt with NBN access networks, i.e. FTTN, DSL and HFC. Table 8.8 shows the estimated power consumption of NBN access networks in the second column and reference case access networks that will be overbuilt in the third column.

Table 8.8: Power consumption of access network results from equation (2)

Access network	Power Consumption of NBN access networks (MW)	Power Consumption of overbuilt access networks (MW)
FTTP	33.6	Not applicable
FTTN	46.4	0.5

FTTdp/B	18	Not applicable
HFC	38.8	10.6
Fixed Wireless	9.5	Not applicable
Satellite	7.9	Not applicable
FTTN (remote footprint)	0.4	Not applicable
ADSL	Not applicable	50.3
Total	**154.7**	**61.3**

It follows that the *incremental* power consumption of NBN access networks is about 93.4 (154.7 – 61.3) MW, or 818,000 megawatt hours per annum assuming that the electricity is consumed throughout the year. The power consumption of the aggregation network domain, which we have estimated in Appendix D.5, is about 16 kW or 141 megawatt hours per annum.

In the following section, we convert our estimate of the incremental energy consumption of NBN network to carbon dioxide equivalents and analyse the NBN's carbon impact in the short and long term.

8.4 Carbon impact of the NBN

Carbon impact of the NBN in the short term

NBN Company's direct and indirect emissions for the fiscal year 2016 were reportedly 72,215 tonnes CO_2-e (NBN Company, 2016). This estimate includes emissions from purchased electricity, used in offices, sites and to power the network. It may also include other sources of emissions from contracted or outsourced activities such as construction, for example. Our estimate of the NBN's carbon impact on the broader economy from section 8.2 accounts for all industry activities including construction of the NBN (network). Our results suggest that construction, operation and use of the NBN in the short term cause annual GHG emissions to be nearly unaffected, if not lower, than they otherwise would have been in the absence of the NBN.

Carbon impact of the NBN in the long term

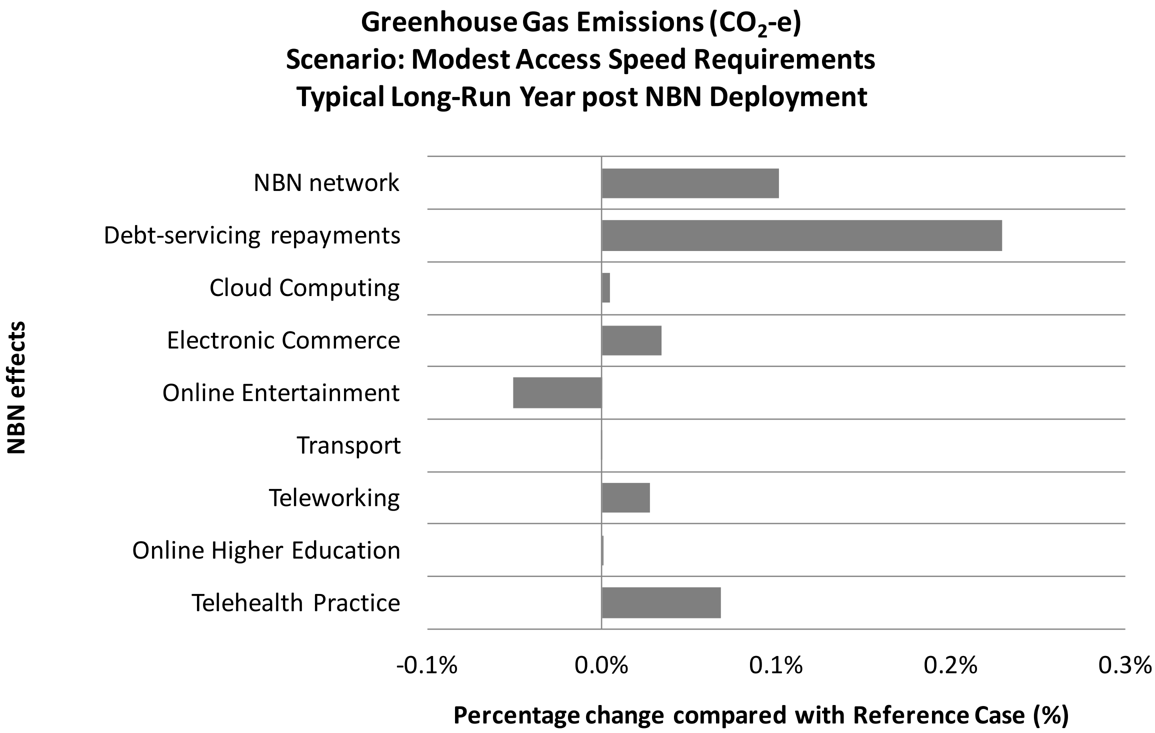
We have converted our estimates of the NBN network's incremental energy consumption in the long term, post NBN deployment, from section 8.3 to GHG emissions using indirect emission factors for consumption of purchased electricity from the grid. The Department provides emission factors for all plants generating electricity for the grid. The ongoing review and annual revision of the emission factors by the Department reflect recent changes within the National Electricity Market. The latest available indirect emissions factors, for the State or Territory in which the electricity is sourced from the grid, were published by the Department of the Environment and Energy (2016). In order to derive an approximate value of the carbon impact of the NBN in the long term, we have not relied on estimates derived from our geospatial analysis of NBN access networks. Instead, we have consistently used the emission factor 0.67 tonnes CO_2-e per GWh (which is the emission factor for the Northern Territory) suggested by the Department if emission factors for the regional electricity grid are not available (Department of the Environment and Energy, 2016). The incremental power consumption of NBN network estimated in section 8.3 then translates to 548,000 (818,000 x 0.67) tonnes CO_2-e.

Subject to future changes within the National Electricity Market, indirect emission factors for consumption of purchased electricity from the grid may continue to decline, reducing NBN's indirect emissions over time, which we have not factored in our results.

NBN Company's actual direct and indirect emissions during the roll-out period in the fiscal year 2015 of reportedly 28,262 tonnes CO_2-e (NBN Company, a) is about 5% of our estimate of the carbon impact of the NBN in the long term. NBN Company's estimate includes other sources of emissions we have not taken into consideration, e.g. purchased electricity used in NBN offices. We have assumed that the other sources of emissions which we have not taken into consideration are negligible because of the comparatively low actual direct and indirect emissions.

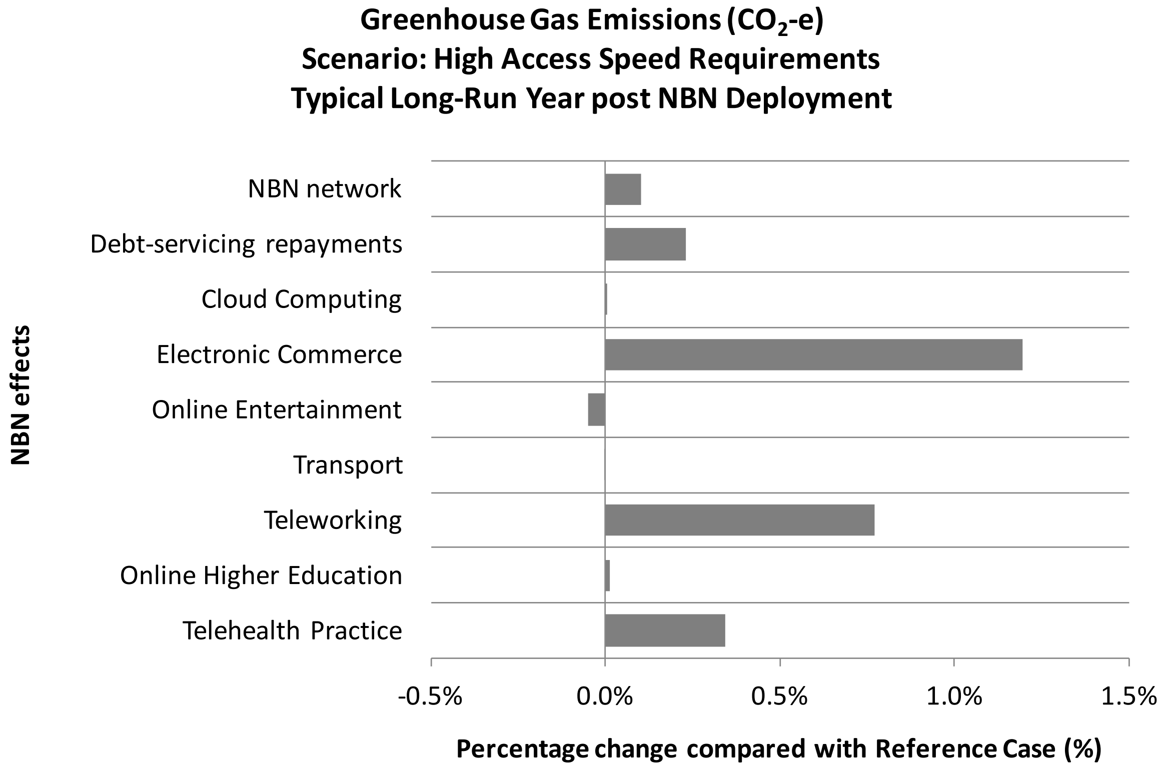
Figures 8.1 and 8.2 summarise the carbon impact of the NBN network and the carbon impact of the NBN on the broader economy in the long term when services require modest and high access speeds, respectively.

Figure 8.1: Effects of the NBN on GHG emissions in the long term when services require modest access speeds



In the modest access speed scenario, Figure 8.1 shows the greatest carbon impact of the NBN stems from the debt-servicing repayments. The trade surplus causes an increase in the activity levels of export oriented industries that maintain comparatively large sources of direct GHG emissions. Other noticeable carbon impacts include the generation of the electricity purchased and used to power the NBN network, telehealth practice, electronic commerce and telework made more widely available through the NBN and the subsequent expansion in the overall size of the economy. The carbon impact of more Online Entertainment services purchased and consumed by households with the NBN is negative. Most related industries' activity levels decrease, including trade oriented industries that maintain comparatively large sources of direct GHG emissions.

Figure 8.2: Effects of the NBN on GHG emissions in the long term when services require high access speeds



For the high access speed scenario, Figure 8.2 shows the three dominant carbon impacts stem from electronic commerce, telework and telehealth practice made more widely available through the NBN and the subsequent expansion of the overall size of the economy. The carbon impact of debt-servicing repayments as a result of funding NBN deployment, the generation of the electricity purchased and used to power the NBN network and other NBN effects carry little weight in the scenario where services require high access speeds.

8.5 Concluding Remarks

There is a shortage of published studies focusing on the carbon impact of ICT at the whole economy level. A review of the literature on environmental effects of information technology by Koomey et al. (2013) concludes that the environmental effects of ICTs on the broader economy have largely been ignored until recently (Koomey et al., 2013). A cross-sectoral study by RWTH Aachen University and DIW Berlin (2008) on behalf of the European Commission investigated and explored, using regression analysis, the links between ICT diffusion and energy consumption in different sectors at the aggregate level for selected European Union member countries. ICT companies themselves regularly publish their findings of the ICT sector's carbon impact in selected countries (The Climate Group and GeSI, 2008; GeSI and Accenture, 2012; GeSI and The Boston Consulting Group, 2015).

In this chapter, we have investigated and explored the carbon impact of the NBN on the broader economy. We have estimated the energy consumption of the NBN network and taken the NBN's direct and indirect emissions into consideration. Our main contribution in this chapter is to quantify the carbon impact on different economic sectors as a result of the construction, diffusion and use of the NBN. Our estimates of the NBN network's energy consumption assist in putting into perspective the NBN's emissions from the generation of the electricity purchased and used to power the network.

The results show that the environmental effects of the NBN on the rest of the economy are much greater than the direct emissions of constructing and operating the NBN. Changes in the electricity market will help to alleviate the burden of the incremental electricity purchased and consumed by the NBN. Similar efforts are required in other markets that are benefitting from a more flexible and efficient economy and a rise in direct GHG emissions as a consequence. This could be achieved, for example, by introducing incentives in the form of price signals or new standards encouraging the shift away from comparatively high carbon intensive economic activities to lower carbon intensive economic activities. Other options may include adopting policies for the use of ubiquitous broadband to reduce carbon production across the economy, as described by The Climate Group and GeSI (2008), GeSI and Accenture (2012), GeSI and The Boston Consulting Group (2015). While the magnitude and importance of the rebound effect are disputed, the emissions abatement potential estimated in studies that do not take into consideration the rebound effect has to be treated with caution.

In the following chapter, we briefly examine the implications of our findings from the previous chapters, such as their likely impact on future work, on other research areas, and on energy and climate policies.

Chapter 9
Discussion and Conclusions

9.1 Introduction

In this chapter, we discuss key findings, draw policy implications and conclusions in response to the aim of this thesis. While we acknowledge the limitations imposed on interpretation of our results, we draw recommendations to contribute to the public policy discussion on the deployment of nationwide broadband networks and their environmental impact (including energy efficiency). We start our discussion by considering the results of the economic impact of the NBN with respect to the access-speed requirements. The results differ from region to region which provides additional insights for regional policy makers. The environmental impact of the NBN is diverse. We focus in our discussion on our key findings of the general equilibrium analysis in terms of the economy-wide effects of improved energy efficiency. Based on the discussion of the key findings and limitations of our work, we will draw the most important policy implications from this thesis. Finally, we provide a succinct description of things that can be concluded from the results of our work.

In section 9.2 and 9.3, we interpret our results of the economic and environmental impact of the NBN, respectively. Uncertainty around model inputs and limitations of our work are discussed in section 9.4. This is followed by a brief examination of policy implications in section 9.5. We then draw conclusions from the discussion in section 9.6. Implications on future research and a brief discussion on how the work in this thesis may be extended are the subject of section 9.7.

9.2 Economic impact of the NBN

Our estimates of the economic effects of the NBN are derived from a general equilibrium analysis. Similar to Access Economics (2009), we have used a CGE model for exploring the way in which improvements in efficiency impact across the Australian economy. However, this thesis is the first such study to look at the NBN as it is currently planned. CGE models account for all the linkages between sectors and agents of an economy. This sets our approach apart from the partial equilibrium analysis of the cost and benefits of the NBN conducted by Department of Communications and the Arts (2014a). In both studies from Department of Communications and the Arts (2014a) and Access Economics (2009), the benefits derived from the use of high-speed broadband have little relation to services and their access-speed requirements. Not considering service requirements and their long-term benefits properly, however, renders broadband impact studies ineffective.

The inputs in this thesis were used to conduct detailed spatial modelling of the NBN and the evolution of broadband in the absence of the NBN. This includes investment in the short term required for NBN deployment and the economic costs in the long term in the form of debt-servicing repayments subject to the peak funding requirements. The economic benefits of the NBN in the long term arise from how it is put to use. To estimate the economic benefits of the NBN, we have focused on the question what are the benefits of services made available through the NBN and which of these services require higher bandwidths than today's offerings? Only services for which there is well-attested, published evidence of economic benefit have been included. Inputs used in this thesis address access-speed requirements of services and capabilities of broadband infrastructure. These were used to determine service availability across regions.

There are no comparable approaches for access-speed considerations in broadband impact studies for the delivery of a wide range of services and their associated benefits. An important aspect of our analysis is the constraint of the upstream access speed for a variety of services. The assumed upstream requirements of the services in the high service requirements scenario are beyond the capabilities of the widely deployed ADSL2+ broadband access network we have assumed in the reference case. The NBN will therefore make a substantial difference in the availability of these services. While streaming audio and video is expected to dominate internet traffic on fixed networks in the near future (Sandvine, 2016; Cisco, 2016), our results suggest that broadband access networks should account for greater symmetry between downstream and upstream speeds for harnessing the economic benefits of service types other than entertainment.

Our results of the economic effects of the NBN are described in detail in chapter 7. In the short run, national economic activity or Real GDP is 0.18 percent larger than it otherwise would have been in the absence of the NBN. The increase is driven by investment in NBN deployment, which increases activities such as construction, for example.

The long-term simulation results are largely driven by service benefits and associated improvements in efficiency such as simultaneous improvements in the productivity of various industry inputs. The increases in efficiency make the use of the respective resource relatively cheaper which in turn encourages increased use. This is reinforced by increased economic growth. The resulting mix of direct rebound effects, indirect effects, and economy-wide effects increases Real GDP. Debt-servicing repayments reflecting the cost of NBN deployment have a negative effect on private consumption and a positive effect on Real GDP. The increase in activity in the traded-goods sectors comes about through the assumption that the NBN is financed mostly through external or foreign debt. This debt is paid for through an increase in the balance of trade surplus. The long-term simulation results are irrespective of broadband take-up in the reference case. Rather, service availability depends first and foremost on access-speed requirements of services and actual access speeds available. Estimates of the NBN impact on service delivery are described in chapter 5.

When services require only modest access-speeds, general broadband development would be sufficient to ensure service availability. The NBN is not needed to ensure availability of the services we have considered in this thesis, except for entertainment. Entertainment services, however, stimulate household expenditure in this area at the expense of others with only limited economic effects. The increased debt-servicing payments caused by the NBN hence outweigh the benefits that the NBN can bring. In other words, if the NBN has only a considerable effect on the availability of entertainment services, then the net effect will not be sufficient to outweigh the cost of deployment. While Real GDP increases by about 0.2 percent, private consumption is about 0.33 percent smaller than it otherwise would have been in the absence of the NBN. Notably, the estimated net cost of the NBN in this scenario is significantly larger than the net cost estimated in a partial equilibrium analysis by the Department of Communications and the Arts (2014a). Department of Communications and the Arts (2014a) estimated a negative net present value of all future cash flows involved with the NBN of about $AU 6 billion or $AU 620 per Australian household.

When services require higher bandwidths than today's offerings, the NBN produces substantial benefit. Our results suggest that one or two services with significant intrinsic value made widely available through the NBN will be sufficient to achieve a net benefit. Real GDP and private consumption are about 2.97 percent and 2.66 percent larger than they otherwise would have been in the absence of the NBN. Electronic commerce made more widely available through the NBN and adopted by small and medium businesses is the major contributor, followed by telework and telehealth practice. Although Access Economics (2009) have reportedly used a "multi-state/region" CGE of the world economy, research to date has not accounted for or published regional results in broadband impact studies. In some discussions of the NBN, its role in providing broadband in regional and rural areas is highlighted. For example, Nepal (2012) and Dods (2012) have explored the potential of the NBN in delivering health services to remote and regional Australia with a particular focus on telehealth delivery models. The NBN undoubtedly increases the availability of high-speed broadband outside the metropolitan areas. Our results show that the greater stimulatory effects of the NBN needed for telework and telehealth practice occur in fact mainly in regional areas. Western Australia is the exception in the scenario where services require higher bandwidths than today's offerings. In this scenario, the greater stimulatory effects of the NBN needed for telework and telehealth applications occur in Western Australia's capital city, Perth. However, the greater stimulatory effects of the NBN needed for business services such as electronic commerce and cloud computing still occur in the major metropolitan areas. This can be explained by the economic activity generated by the small and medium non-agricultural businesses that are more present in the major metropolitan areas. Nevertheless, the NBN provides some significant additions through the use of business services in the regional areas of the east-coast states.

9.3 Environmental impact of the NBN

Existing studies of the environmental impact of high-speed broadband published to date do not account for economy-wide rebound effects of improved efficiency. Even in the wider context of ICT, research to date has primarily focused on two features; these are ICT's contribution to a substantial rise of productivity in various industries, thereby increasing the growth potentials of the economy as a whole (Centre for European Economic Research, a), and its potential to reduce greenhouse gas emissions that can be enabled through ICT applications in various sectors of the economy (The Climate Group and GeSI, 2008; GeSI and Accenture, 2012; GeSI and The Boston Consulting Group, 2015). Although CGE models have been used in the past – notably by Matsumoto et al. (2007) – for assessing the impacts of ICT advances on greenhouse gas emissions of a whole economy, this is the first such study to focus on high-speed broadband.

Economy-wide rebound effects of general-purpose technologies such as broadband Internet services or other ICT applications may not only derive from 'pure' energy efficiency improvements. However, the economy-wide rebound effects in previous CGE investigations do not rely upon simultaneous improvements in the productivity of a variety of industry inputs (Allan et al., 2007). In this thesis, we have only included services that earlier studies had shown to provide significant economic benefits. While these services may partially replace more polluting alternatives, the substantial increase in

Real GDP is likely to stimulate additional greenhouse gas emissions. Other sources of greenhouse gas emissions in the long term are the expansion in export-oriented industries and the NBN network's power consumption. Greenhouse gas emissions are further increased marginally in the short term through investment in NBN deployment, which increases activities such as construction, for example.

This thesis highlights the importance of CGE investigations of economy-wide rebound effects that do not only derive from 'pure' energy efficiency improvements, but rely on upon simultaneous improvements in the productivity of capital and labour inputs. The findings in this thesis coincide with previous CGE investigations of economy-wide rebound effects. In particular, the rebound effects may potentially be large and that the potential of an overall increase in the use of energy cannot be ruled out (Allan et al., 2007). These findings put into perspective current estimates of the ICT-enabled greenhouse gas abatement potential (Ericsson et al., 2013; Ericsson, 2015; The Climate Group and GeSI, 2008; GeSI and Accenture, 2012; GeSI and The Boston Consulting Group, 2015). The methodologies utilised in studies estimating the ICT-enabled greenhouse gas abatement potential fall short of estimating the rebound effect. Moreover, they pay little attention to productivity improvements of other factors of production which increases economic activity and greenhouse gas emissions.

9.4 Uncertainty around model inputs and limitations

In this thesis, we have focused on the specific case of the NBN and the impact of high-speed broadband on the Australian economy. Generalisability, that is, the extension of research findings and conclusions from this thesis to other broadband impact studies, depends on several factors. Transferability of our research findings is only feasible if the same methodology is used and the initial situation is similar to the one in Australia. If circumstances vary widely, the results may well be very different to ours. For example, general broadband development in the reference case may differ from the one in Australia. So may be the proposed initiative aimed at expanding the broadband infrastructure. Nevertheless, our results suggest that economic and employment benefits increase not only with broadband take-up but also with the particular advantages of high-speed broadband.

We have addressed uncertainties about service requirements by providing a range of possible outcomes: one where services require higher bandwidths than today's technology offerings, and one where services require modest bandwidths within the range of current offerings. We note, however, that neither of these scenarios is likely to occur in its entirety. New broadband services are being deployed all the time and their potentially substantial economic impact is not accounted for in this thesis. Other uncertainties such as service take-up in a typical long-run year are addressed in this thesis by adopting assumptions from case studies and making reasonable assumptions where necessary. Service take-up may vary, of course, depending on the willingness to pay for access speed and policy that prevail at the time.

Our estimates of the environmental effects of the NBN on greenhouse gas emissions derived from the CGE model assume that the efficiency improvements have no effect on the ratio of output and greenhouse gas emissions. Since broadband Internet services may assist in decoupling economic growth from resource and energy use, the rate of increase in greenhouse gas emissions may in fact be lower than the rate of increase in industry output.

Due to their complexity, results from CGE models may be used as “road maps” for policy implementation (Inter-American Development Bank). While the selection of one approach over another is driven primarily by data availability (ITU, 2012), results from CGE models may be complemented by additional analytical work using alternative quantitative methods (Inter-American Development Bank). The CGE analysis in this thesis emphasises proper interpretation of results following the general strategy outlined by Adams (2005). This enhances the credibility of the analysis and the ability to provide economic insights that are not obvious from a casual inspection of the results (Adams, 2005). Our carefully constructed CGE analysis also aids overcoming the “black box” criticism (Allan et al., 2007). This criticism rests largely upon lack of accountability and transparency, rather than applicability. We note, however, that the robustness of our results may be examined through careful sensitivity analysis. In general, this helps reveal the source of any modelling surprises (Allan et al., 2007).

9.5 Policy implications

Our results suggest that policies government should pursue to facilitate the benefits of the NBN may be directed towards service take-up by end-users in three areas. First, decision makers should continue efforts in increasing the rate of adoption of electronic commerce by small and medium businesses. Respective policies could be targeted more directly on factors that may influence the adoption of electronic commerce, such as perceived benefits, technology readiness, business owners’ innovativeness, IT ability and IT experience. Second, decision makers should encourage telework among full-time employees nearing retirement, those who have a mobility limitation, and who currently cannot work. Third, decision makers should implement telehealth schemes in inner and outer regional Australia. In particular, decision makers should introduce telehealth interventions into existing aged care programs. In addition, incentives or subsidies may be used to encourage broadband take-up by end-users and increase broadband penetration.

Broadband access networks and future upgrade paths of the NBN should accommodate greater symmetry between downstream and upstream speeds for harnessing the economic benefits of service types other than entertainment.

Complemented with appropriate environmental policies, the growing impact of ICT on globalisation can facilitate sustainable economic growth, towards a resource-efficient, low-carbon and competitive economy. ICT applications, the Internet and broadband Internet services widely deployed and used may assist in decoupling economic growth from resource and energy use. However, initiatives aimed at greenhouse gas emission reductions enabled through the use of a general-purpose technology need to be aware of economy-wide rebound effects. Proper investigations of economy-wide rebound effects are pivotal and may provide an adequate basis for an informed decision. Any recommendation for environmental policies to promote broadband Internet services or ICT applications to reduce greenhouse gas emissions should therefore rely on a suitable tool. “CGE models are a potentially valuable tool for exploring the way in which improvements in efficiency impact across an economy” (Allan et al., 2007, p. vii). The inputs should derive from an independent assessment which improvements in efficiency other than ‘pure’ energy efficiency improvements the application under investigation entails. Studies neglecting rebound effects such as The Climate Group and GeSI (2008), and GeSI and Accenture (2012) will ignore any offsetting effects and are therefore likely to overstate the potential of ICT applications to reduce greenhouse gas emissions.

A more effective way of reducing greenhouse gas emissions may be the Carbon Pollution Reduction Scheme proposed by the Australian Government in 2008 (Parliament of Australia). The potential negative impact of an emissions trading scheme on national economic activity, or Real GDP, (Adams et al., 2014) may be bolstered by broadband Internet services. For example, a fall in total consumption by households (Adams et al., 2014) may be offset in the long term by increasing the rate of adoption of electronic commerce by small and medium businesses, encouraging telework and implementing telehealth schemes, as suggested above.

In the following section, we will draw conclusions from the discussion and interpretation of our findings.

9.6 Conclusions

The economic effects of NBN deployment in the short term are driven by increased investment, which increases activities such as construction, for example. Real GDP increases marginally. In the long term, the economic effects are largely driven by the economy-wide rebound effects. These rebound effects derive from simultaneous improvements in the productivity of various inputs to industry production in particular capital and labour inputs. Three services contribute more than any other service we have included in this thesis to Real GDP and private consumption: electronic commerce, telework and telehealth applications. These effects are particularly pronounced in regions where the NBN ensures service availability and general broadband development would not be sufficient otherwise. The NBN contributes in particular by providing greater upstream speeds for electronic commerce in major metropolitan areas, telework and telehealth applications mainly in regional areas. When services require higher bandwidths than today's technology offerings, the net effect of the NBN will be sufficient to outweigh the cost of deployment. The substantial rise in total consumption by households suggests that households are significantly better off with the NBN.

While Real GDP is generally increased, private consumption is reduced when access-speed requirements are modest and general broadband development would be sufficient to ensure service availability. In this scenario, the net effect of the NBN will not be sufficient to outweigh the cost of deployment. The fall in total consumption by households means that they are worse off than in the absence of the NBN.

The environmental effects on greenhouse gas emissions of NBN network construction in the short term and the generation of the electricity purchased and used to power the NBN network in the long term are negligible. The expansion of the overall economy in the long term predominantly through economy-wide rebound effects can lead to a substantial increase in national greenhouse gas emissions. The rebound effects typically derive from simultaneous improvements in the productivity of various inputs to industry production and require sincere investigation.

9.7 Future research

The present study is unique in the sense that it provides more differentiated regional insights than any other broadband impact study to date. Nevertheless, our model can be used to conduct an even more detailed regional analysis with a more disaggregated regional database available for TERM developed by CoPS. While greater disaggregation also leads to greater uncertainty about the initial values, the TERM database can be disaggregated to represent 182 industry sectors in 205 regions or SSDs (statistical sub-divisions) (ABS, 2001). This allows splitting major cities into regions for a useful disaggregation such as Greater Sydney and Greater Melbourne into inner city and outer city areas, for example. This may yield some more insight into areas that are underserved with general broadband development because of the urban sprawl and the distance dependence of DSL and the fewer number of exchange sites.

Our results could be improved marginally with access to data that was not publicly available at the time of our analysis, such as:

- PSMA Geocoded National Address File (Australian Government, a) for Australia complemented with details about the coverage areas of access networks that correspond to street addresses, to improve our estimates of available access speeds and NBN incremental impact on service delivery;
- Telstra's Cable Plant Records including actual cable lengths, ADSL download and upload speed versus distance profile for the applicable cable gauge, take-up rate and technical specifications, to improve our estimates of ADSL service availability and access speed;
- not anonymised or aggregated census data, to improve our estimates of NBN incremental impact on service delivery;
- actual share of foreign investment in the NBN and expected terms and conditions of the debt-servicing repayments, to improve our results of the economic impact of annual payments overseas to service foreign debt associated with NBN construction and potential reductions in public and private consumption.

The robustness of the results could be examined by conducting a careful sensitivity analysis of various key parameters, such as bandwidth requirements for each service. A consideration which we have not realised in this thesis is peak rates of services running in parallel. These peak rates might be based on scenarios where users' circumstances are changed by broadband Internet services similar to the scenarios developed by the Department (Deloitte Access Economics, 2013). Other key parameters that might be changed for a comprehensive sensitivity analysis are payment period and interest rates for the debt-servicing repayments, and alternative broadband evolution scenarios in the reference case with all ADSL-enabled exchanges and nodes upgraded to FTTN in the future with no NBN.

This thesis might be extended to consider the impact of a different multi-technology mix as currently proposed under the NBN and how the results might differ from our results. This could provide policy makers with additional insights and recommendations about upgrading the NBN in the future for maximising value for money in the long term.

The limited amount of data available in particular for modelling the rollout schedule of the NBN until completion limits the scope of the present study. Once this data becomes available, transition or adjustment costs, such as labour market dislocation, for example, could be analysed using a dynamic or multi-period version of TERM for Australia (Wittwer, 2012). Census data are published on a regular basis reflecting the significant population changes particularly in urban areas which could have a minor impact on the results in this thesis which are based on 2011 figures.

The use of multi-period dynamic CGE models could also be used to address agents' expectations that might depend on the future state of the economy. Lucas (1976) has argued that the parameters of traditional macroeconometric models depended implicitly on agents' expectations of the policy process. Hence their expectations are unlikely to remain stable as policy makers changed their behaviours. While dynamic stochastic general equilibrium models explicitly incorporate uncertainty about the future, Dixon et al. (2003) have described a practical and conceptually simple iterative method for solving large dynamic CGE models under rational expectations.

We have concluded that national greenhouse gas emissions increase with the NBN for the reasons outlined in this thesis. The current model would give some insights into which industries are most affected and therefore should be targeted for mitigation. Future research might therefore focus on mitigating greenhouse gas emissions in industries that are being affected by the NBN. This could include an assessment of the impact on the ratio of industry output to greenhouse gas emissions. The effectiveness of such an initiative could be compared with the regional analysis of the potential economic impacts of a carbon price on the Australian economy that operates as part of a global emissions trading scheme (Adams et al., 2014).

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Appendix A Processing Service Requirements and Technology Capabilities

In this section, we describe the model we have developed to analyse the NBN impact on service delivery. This includes the inputs and their computation for processing the expected service requirements and capabilities of various connection types. This section provides a manual guiding the reader through each step involved in estimating the NBN impact on service delivery in terms of number of persons usually resident, persons aged 65 and above, general practitioner (GP) services, and small and medium-sized enterprises. We describe the various assumptions the user of the model can specify in model. We then describe the steps involved in computing the NBN's aggregated regional impact in percentages by running multiple queries. Finally, we indicate the assumptions we have specified that lead to the resulting percentages shown in section 5.3.

The impact of the NBN is dependent on the technology capabilities of NBN and non-NBN connection types subject to the expected service requirements. Calculating this impact for hundreds of thousands of small regional areas in the form of Project Mesh Blocks requires a tool which can sort through rich datasets relatively quickly under different assumptions. For this purpose, we have developed a model in Microsoft Access. The model was built with the aim to identify and return only those Project Mesh Blocks and related attributes in areas that might rely on the NBN in order to meet the expected service requirements. The resulting estimates, indicating the incremental impact of the NBN relative to the reference case on the Project Mesh Block level, were aggregated to the same number of sub-national regions as in the TERM model database, i.e. 13 regions.

The attributes of the Project Mesh Blocks imported into the MS Access model include information about the estimated availability of connection types with and without the NBN. Since ADSL2+ performance is critically dependent on cable distance, we have derived multiple estimates in the form of spatial analyses in the GIS software based on the minimum bandwidth requirements for each service. Our approach of estimating the availability and quality of ADSL2+ is described in more detail in section 4.4. The table in the MS Access model containing various data sets for each Project Mesh Block includes multiple bandwidths estimated to be available through ADSL2+ connections in the reference case. Other attributes indicate, amongst other things, whether or not the remaining connection types included in the analyses were estimated to be available inside the area of the Project Mesh Blocks. Table A.1 lists all attributes associated with the Project Mesh Blocks. Table A.2 lists key input data tables included in the MS Access model.

The download and upload bandwidth requirements for the modest and high access speeds scenarios are specified in the tables *Service_requirements_low* and *Service_requirements_high*, respectively. In each of the two tables, the user of the model selects for each service one of the following five performance categories for download and upload speeds from the drop-down list boxes:

- Very high;

- High;
- Medium;
- Low; and
- Very low.

The table *Performance_categories* provides the user of the model with a reference about the range of access speeds behind each performance category and is not used elsewhere in the model. A third drop-down list box in the service requirements tables is used to select the minimum bandwidth[24] which is relevant for Project Mesh Blocks where ADSL2+ was estimated to be available. The user of the model also needs to specify one of the following six access speed categories (in Mbps):

- 1;
- 1.5;
- 2.5;
- 10;
- 20; and
- >24.

Tables A.1 and A.2 show our assumptions about required access-speeds selected in the MS Access model.

Table A.1: Selected access-speed requirements in the modest access-speed requirements scenario

Service	Bandwidth_DL	Bandwidth_UL	ADSL2+_requirement_Mbps
Microclinics	Very low	Low	10
Telehealth	Very low	Very low	1
Education (MOOCs)	Very low	Very low	1
Cloud Computing	Low	Low	10
Teleworking	Very low	Very low	1.5
E-Commerce	Low	Very low	2.5
Entertainment	Medium	Low	20

Table A.2: Selected access-speed requirements in the high access-speed requirements scenario

Service	Bandwidth_DL	Bandwidth_UL	ADSL2+_requirement_Mbps
Microclinics	Low	Medium	>24
Education (MOOCs)	Low	Low	10
Cloud Computing	Medium	Medium	>24
Teleworking	Medium	Low	>24
E-Commerce	Medium	Low	20
Telehealth	Low	Low	10
Entertainment	High	Low	>24

[24] The selected bandwidth for each service is the maximum of the required download speed and four times the required upload speed.

The capabilities of connection types that are appropriate for providing the services included in this study are specified in the table *Connection_Type*. In this table, the user of the model can select one of the five performance categories similar to options available in the service requirements tables described above.

Table A.3 shows the assumed capabilities of connection types selected in the MS Access model.

Table A.3: Selected download (DL) and upload (UL) speed categories of connection types

Connection type	Bandwidth_DL	Bandwidth_UL
FTTN	High	Low
HFC Cable	High	High
ADSL2+	Medium	Very low
NBN Fixed Wireless	Medium	Low
FAB (TLS)	Very high	Very high
NBN Fibre (GPON)	Very high	Very high

The input tables are used in the MS Access model to compile a list of Project Mesh Blocks with connection types, estimated to be available inside the area of the Project Mesh Block, that are capable of providing the selected service requirements. When running the appropriate query in the MS Access model, the performance categories of the selected service are directly compared against the performance categories specified by the user of the model for each NBN and non-NBN connection type. Project Mesh Blocks with estimated coverage of non-NBN connection types capable of providing the selected service requirements are filtered by various queries. These Project Mesh Blocks are therefore not returned by the final queries.

In the table *Select_service_remoteness_area_coverage*, the user of the model can select the following statistical remoteness areas applicable for each service:

- Inner Regional Australia;
- Major Cities of Australia;
- Migratory – Offshore – Shipping by State and Territory;
- No usual address by State and Territory;
- Outer Regional Australia;
- Remote Australia; and
- Very Remote Australia.

We have selected all statistical remoteness areas for all services except Microclinics, where we have assumed this service to be applicable in Outer Regional, Remote and Very Remote Australia only.

From a drop-down list in the table *Services_beneficiary*, the following two use types that are applicable for each service can be selected by the user of the model:

- Businesses; and
- Persons.

The use types are relevant for estimated HFC coverage areas connecting residential premises only. We have selected Persons for all services other than electronic commerce and cloud computing where we have selected Businesses as the applicable use type.

In the table *tblMB_HFC_Other*, the user of the model can select additional non-NBN HFC coverage areas in greater Adelaide, Gold Coast and greater Perth by Statistical Area 3. Our assumptions about additional HFC coverage selected for greater Adelaide, Gold Coast and greater Perth is shown in Table 4.4.

Lastly, the user of the model can select one of the following services and scenarios from the two drop-down lists in the table *Select_service* he or she wishes to investigate by running the appropriate queries in the MS Access model:

- Cloud computing;
- E-Commerce;
- Entertainment;
- Microclinics;
- MOOCs;
- Telehealth;
- Teleworking;

and scenario:

- High; and
- Low.

Any changes to the selection by the user of the model will result in changes to the query results and the NBN impact on service delivery varies accordingly. The remaining tables are populated with data which is processed by the various queries in the MS Access model.

Table A.6 lists the queries included in the MS Access model. Seven final queries build on various sub-queries. Four final queries return the estimated percentages of the NBN impact on service delivery in agricultural, industrial, commercial and financial industries by industry and region. Australian Businesses with a turnover of at least $AU 2 million in the financial year 2011 (ABS, 2013d) were assumed to have sufficient access to selected services in the reference case without the NBN and are not included in the final query results. We have estimated businesses' turnover by mesh block as described in section 4.3. The final query results show the NBN impact on delivery of the service selected by the user of the model in terms of estimated businesses' turnover as a percentage of total businesses' turnover in a region.

We have estimated persons usually resident, persons aged 65 and above, and GP services by mesh block as described in section 4.3. The remaining three final queries return the estimated NBN impact on service delivery in terms of persons usually resident, persons aged 65 and above, and GP services as a percentage of total persons usually resident, persons aged 65 and above, and GP services in a region.

The remaining section provides an overview of key tables and Structured Query Language (SQL) queries in the MS Access model.

Table A.4: Attributes of Project Mesh Blocks included in the table MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC in the MS Access model

Field Name	Data Type	Description	Source
ID	AutoNumber	Primary key	Author
ESA_NAME	Text	Name of exchange service area	ExchangeInfo
ESA_CODE	Text	Exchange service area code	ExchangeInfo
STATE	Text	State code	ExchangeInfo
MB_CODE11	Text	Code of the corresponding mesh block (11 digits)	ABS (2013b)
MB_CAT11	Text	Mesh block land use category	ABS (2013b)
SA1_MAIN11	Text	Statistical Area 1 code (11 digits)	ABS (2013b)
SA1_7DIGITCODE_2011	Text	Statistical Area 1 code (7 digits)	ABS (2013b)
SA2_MAIN11	Text	Statistical Area 2 code (9 digits)	ABS (2013b)
SA2_5DIG11	Text	Statistical Area 2 code (5 digits)	ABS (2013b)
SA2_NAME11	Text	Name of Statistical Area 2	ABS (2013b)
SA3_CODE11	Text	Statistical Area 3 code (5 digits)	ABS (2013b)
SA3_NAME11	Text	Name of Statistical Area 3	ABS (2013b)
SA4_CODE11	Text	Statistical Area 4 code (3 digits)	ABS (2013b)
SA4_NAME11	Text	Name of Statistical Area 4	ABS (2013b)
SLA_MAINCODE_2011	Text	Statistical Local Area code (9 digits)	ABS (2013b)
SLA_NAME_2011	Text	Name of Statistical Local Area	ABS (2013b)
GCC_CODE11	Text	Greater Capital City Statistical Area code (5 digits)	ABS (2013b)
GCC_NAME11	Text	Name of Greater Capital City Statistical Area	ABS (2013b)
STE_CODE11	Text	State/Territory code (1 digit)	ABS (2013b)
STE_NAME11	Text	Name of State/Territory	ABS (2013b)
ALBERS_SQM	Number	Albers-Equal Area Conic projection of the corresponding mesh block in square metres	ABS (2013b)
Dwellings	Number	Number of dwellings in the area covered by the corresponding mesh block	ABS (2013b)
Persons_Us	Number	Number of persons usually resident in the area covered by the corresponding mesh block	ABS (2013b)
Area	Number	Area of the corresponding mesh block estimated in the GIS software	Author
Area_inter	Number	Area of Project Mesh Block estimated in the GIS software	Author
Pers_inter	Number	Number of persons estimated in the Project Mesh Block	Author
Pers_65Plus_inter	Number	Number of persons aged 65 and above estimated in the Project Mesh Block	Author

Field Name	Data Type	Description	Source
Pers_WSAM_inter	Number	Number of persons estimated in the NBN wireless service area module in the Project Mesh Block	Author
GP_Services_200910	Number	Number of general practitioners services in the financial year 2009/10	Author
FTTP_NBN	Yes/No	Estimated availability of NBN-FTTP	Author
FIBRE	Yes/No	Estimated availability of NBN-FTTN	Author
WIRELESS	Yes/No	Estimated availability of NBN-Fixed wireless	Author
1Mbps	Yes/No	Estimated availability of a minimum of 1Mbps via ADSL2+	Author
1P5Mbps	Yes/No	Estimated availability of a minimum of 1.5Mbps via ADSL2+	Author
2P5Mbps	Yes/No	Estimated availability of a minimum of 2.5Mbps via ADSL2+	Author
10Mbps	Yes/No	Estimated availability of a minimum of 10Mbps via ADSL2+	Author
20Mbps	Yes/No	Estimated availability of a minimum of 20Mbps via ADSL2+	Author
>24Mbps	Yes/No	Estimated availability of bandwidth greater than 24Mbps	Author
HFC	Yes/No	Estimated availability of HFC	Author
FTTN_iiNet	Yes/No	Estimated availability of iiNet-FTTN	Author
FTTP_iiNet	Yes/No	Estimated availability of iiNet-FTTP	Author
Missing_DA	Yes/No	Project Mesh Block which intersects with an exchange service area containing at least one distribution area listed in the Telstra IP DSLAM ("TopHat") Rollout Schedule where geospatial datasets of respective distribution areas are missing from the available ExchangeInfo data	Author
Missing_DA_only	Yes/No	Project Mesh Block which is located where geospatial datasets of distribution areas listed in the Telstra IP DSLAM ("TopHat") Rollout Schedule is missing	Author
FAB_site	Yes/No	Estimated availability of Telstra-Fibre Access Broadband	Author
ADSL2PLUS	Yes/No	Estimated availability ADSL2+ enabled exchanges	Author
RA_NAME11	Text	Name of remoteness area	ABS (2013g)
UNIQUE_ID	Text	Code consisting of the entries in the fields MB_CODE11, Area_inter and Pers_inter	Author

Table A.5: List of input tables in the MS Access model

Table name	Description	Source
Business_size_2011_12	Business size in Australian dollars by industry division, 2010-11	ABS (2013h); IBISWorld (2012)

Table name	Description	Source
CGEM_industy_mapping	Industry divisions selected to corresponding CGEM industries	User Input
Connection_Type	Selection of performance categories for download and upload speeds by connection type	User Input
Counts_Businesses_Turnover_June_2012	Counts of Australian business by Industry Division by Statistical Area Level 2 by Turnover Size Ranges, June 2012	ABS (2013d)
MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC	Complete list of Project Mesh Blocks	Author
Performance_categories	Reference of access speeds related to each performance category	User Input
Regions_Population_2011	Number of persons usually resident in 2011 by CGEM region	ABS (2011b)
SA1_2011_Persons_Aged	Number of persons aged 65 and above in 2011 by SA1	ABS (2011b)
SA1_2011_RA_2011_AUST	Remoteness Areas in 2011 by SA1	ABS (2011)
Select_service	User selection of the service the queries' output is based on	User Input
Select_service_remoteness_area_coverage	User selection of the applicable remoteness areas for each service	User Input
Services_beneficiary	User selection of commercial and residential service types	User Input
Services_requirements_high	User input of minimum download and upload speed requirements assuming services require relatively high access speeds	User Input
Services_requirements_low	User input of minimum download and upload speed requirements assuming services require relatively modest access speeds	User Input
SLA_Medical_Benefits_Scheme_Services_2009	Number of GP services in 2009/10 by Statistical Local Area	AURIN/Public Health Information Development Unit (PHIDU)
SLA_POP_2011_AUST	Number of persons usually resident in 2011 by Statistical Local Area	ABS (2011b)
tblBusiness_size_2011_12_by_CGEM_REG	Business size of industry division estimated by CGEM region	Author

Table name	Description	Source
tblMB_HFC_Other	User selection of additional HFC coverage	User Input
tblMyNBN_active_fibre_analysis	Selected fields of Project Mesh Blocks with estimated NBN FTTP coverage	Author/MyNBN.info
tblMyNBN_wireless_analysis	Selected fields of Project Mesh Blocks with estimated NBN Fixed Wireless coverage	Author/MyNBN.info
tblPOP_2011_GP_servics_0910_SLA	Number of GP services in 2009/10 per person usually resident in 2011 by Statistical Local Area	Author/AURIN/PHIDU
tblRegions_GCC_to_CGEM_mapping	Mapping of Greater Capital City Statistical Areas (GCCSA) to CGEM regions	Author
tblSA2_SUA_2011_AUST_Wireless	Details of Statistical Area 2 areas with estimated NBN Fixed Wireless coverage	Author/NBN Company
tblUnion_qryGIS_MB_Data	Records saved from the union query Union_qryGIS_MB_Data	Calculation (Union query results)

Table A.6: List of SQL queries in the MS Access model

Query name	Description	Source table (tbl) or query (qry)
Applicable_technologies_Crosstab	Select query which groups applicable connection type data vertically by selected service and horizontally by connection type	Applicable_technologies (qry)
Businesses_estimated_turnover_by_SA2_Crosstab	Select query which groups business size data horizontally by industry division	Businesses_estimated_turnover_by_SA2 (qry)
Regions_CGEM_industries_Crosstab	Select query which groups CGEM industry output data as a percentage of total output of the mapped industry divisions horizontally by CGEM region vertically	Regions_CGEM_industries (qry)
Applicable_technologies	Select query which determines for each connection type whether the download and upload speed requirements of the service selected by the model user are met	Select_service (tbl), Service_requirements_ranking (qry), Technology_capability_ranking (qry)
Businesses_estimated_turnover_by_SA2	Select query which groups counts of Australian businesses and estimated average turnover size data for businesses with a turnover size of less than $AU 2 million by SA2	Counts_Businesses_Turnover_June_2012 (tbl), Business_size_2011_12 (tbl)

Query name	Description	Source table (tbl) or query (qry)
qryMAKE_tblUnion_qryGIS_MB_Data	Make table query which saves records from the union query Union_qryGIS_MB_Data as a table named tblUnion_qryGIS_MB_Data; Excluded are Project Mesh Blocks with estimated coverage of non-NBN connection types subject to their capabilities to meet the service requirements selected by the user of the model	Union_qryGIS_MB_Data (qry), Applicable_technologies_Crosstab (qry)
GCCSA_agricultural_net_impact	Select query which returns the estimated NBN net impact on the agricultural industries by CGEM region as a percentage of estimated total output of agricultural industries in a CGEM region	SA2_agricultural_industry_net_impact (qry), tblRegions_GCC_to_CGEM_mapping (tbl), tblBusiness_size_2011_12_by_CGEM_REG (tbl)
GCCSA_commercial_net_impact	Select query which returns the estimated NBN net impact on the commercial industries by CGEM region as a percentage of estimated total output of commercial industries in a CGEM region	SA2_commercial_industry_net_impact (qry), tblRegions_GCC_to_CGEM_mapping (tbl), tblBusiness_size_2011_12_by_CGEM_REG (tbl)
GCCSA_financial_net_impact	Select query which returns the estimated NBN net impact on the commercial industries by CGEM region mapped to the CGEM finance and business services industry as a percentage of estimated total output of the commercial industries mapped to the CGEM finance and business services industry in a CGEM region	SA2_commercial_industry_net_impact (qry), tblRegions_GCC_to_CGEM_mapping (tbl), tblBusiness_size_2011_12_by_CGEM_REG (tbl)
GCCSA_industrial_net_impact	Select query which returns the estimated NBN net impact on the industrial industries by CGEM region as a percentage of estimated total output of industrial industries in a CGEM region	SA2_industrial_industry_net_impact (qry), tblRegions_GCC_to_CGEM_mapping (tbl), tblBusiness_size_2011_12_by_CGEM_REG (tbl)
GCCSA_CGEM_agricultural_IND_net_impact	Final select query which returns the results of the CGEM agriculture, forestry and fishing industry output data as a percentage of total output of the mapped agricultural divisions multiplied with the estimated percentage NBN net impact in agricultural areas by CGEM region	Regions_CGEM_industries_Crosstab (qry), GCCSA_agricultural_net_impact (qry)

Query name	Description	Source table (tbl) or query (qry)
GCCSA_CGEM_commercial_IND_net_impact	Final select query which returns the results of selected CGEM commercial industries output data as a percentage of total output of the mapped industry divisions multiplied with the estimated percentage NBN net impact in commercial areas by CGEM region	Regions_CGEM_industries_Crosstab (qry), GCCSA_commercial_net_impact (qry)
GCCSA_CGEM_financial_IND_net_impact	Final select query which returns the results of the CGEM finance and business services industry output data as a percentage of total output of the mapped industry divisions multiplied with the estimated percentage NBN net impact in financial areas by CGEM region	Regions_CGEM_industries_Crosstab (qry), GCCSA_commercial_net_impact (qry)
GCCSA_CGEM_industrial_IND_net_impact	Final select query which returns the results of selected CGEM industrial industries output data as a percentage of total output of the mapped industry divisions multiplied with the estimated percentage NBN net impact in industrial areas by CGEM region	Regions_CGEM_industries_Crosstab (qry), GCCSA_industrial_net_impact (qry)
GCCSA_CGEM_residential_aged_net_impact	Final select query which returns the numbers of persons aged 65 and above usually resident in the Project Mesh Blocks where the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of all persons aged 65 and above usually resident by CGEM region and statistical remoteness area	Union_qryRegions_POP_FTTN_FTTP_FWireless_HFC (qry), tblRegions_GCC_to_CGEM_mapping (tbl), qryRegions_POP_65Plus_2011 (qry)
GCCSA_CGEM_residential_GP_net_impact	Final select query which returns the numbers of GP services in the Project Mesh Blocks where the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of all GP services by CGEM region and statistical remoteness area	Union_qryRegions_POP_FTTN_FTTP_FWireless_HFC (qry), tblRegions_GCC_to_CGEM_mapping (tbl), qryRegions_GP_Services_200910 (qry)

Query name	Description	Source table (tbl) or query (qry)
GCCSA_CGEM_residential_persons_net_impact	Final select query which returns the numbers of persons usually resident in the Project Mesh Blocks where the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of all persons usually resident by CGEM region and statistical remoteness area	Union_qryRegions_POP_FTTN_FTTP_FWireless_HFC (qry), tblRegions_GCC_to_CGEM_mapping (tbl), Regions_Population_2011 (tbl)
MB_2011_aust_agricultural_area_by_SA2	Select query which returns the total area in Albers square metres of all Project Mesh Blocks where the land use is classified as “Agricultural” by SA2	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl)
MB_2011_aust_commercial_area_by_SA2	Select query which returns the total area in Albers square metres of all Project Mesh Blocks where the land use is classified as “Commercial” by SA2	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl)
MB_2011_aust_industrial_area_by_SA2	Select query which returns the total area in Albers square metres of all Project Mesh Blocks where the land use is classified as “Industrial” by SA2	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl)
MB_agricultural_%area_by_SA2	Select query which returns the estimated area in Albers square metres of all Project Mesh Blocks where the land use is classified as “Agricultural” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of total agricultural area by SA2	MB_agricultural_by_SA2 (qry)
MB_agricultural_by_SA2	Select query which returns total area in Albers square metres of Project Mesh Blocks where the land use is classified as “Agricultural” and estimated area in Albers square metres of Project Mesh Blocks where the land use is classified as “Agricultural” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types by SA2	MB_net_impact_ agricultural_area_by_SA2 (qry), MB_2011_aust_ agricultural_area_by_SA2 (qry)

Query name	Description	Source table (tbl) or query (qry)
MB_commercial_%area_by_SA2	Select query which returns the estimated area in Albers square metres of all Project Mesh Blocks where the land use is classified as “Commercial” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of total commercial area by SA2	MB_commercial_by_SA2 (qry)
MB_commercial_by_SA2	Select query which returns total area in Albers square metres of Project Mesh Blocks where the land use is classified as “Commercial” and estimated area in Albers square metres of Project Mesh Blocks where the land use is classified as “Commercial” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types by SA2	MB_net_impact_commercial_area_by_SA2 (qry), MB_2011_aust_commercial_area_by_SA2 (qry)
MB_industrial_%area_by_SA2	Select query which returns the estimated area in Albers square metres of all Project Mesh Blocks where the land use is classified as “Industrial” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of total industrial area by SA2	MB_industrial_by_SA2 (qry)
MB_industrial_by_SA2	Select query which returns total area in Albers square metres of Project Mesh Blocks where the land use is classified as “Industrial” and estimated area in Albers square metres of Project Mesh Blocks where the land use is classified as “Industrial” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types by SA2	MB_net_impact_industrial_area_by_SA2 (qry), MB_2011_aust_ industrial_area_by_SA2 (qry)

Query name	Description	Source table (tbl) or query (qry)
MB_net_impact_agricultural_area_by_SA2	Select query which returns the total area in Albers square metres of all Project Mesh Blocks where the land use is classified as "Agricultural" and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types by SA2	Union_qryRegions_POP_FTTN_FTTP_FWireless_HFC (qry)
MB_net_impact_commercial_area_by_SA2	Select query which returns the total area in Albers square metres of all Project Mesh Blocks where the land use is classified as "Commercial" and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types by SA2	Union_qryRegions_POP_FTTN_FTTP_FWireless_HFC (qry)
MB_net_impact_industrial_area_by_SA2	Select query which returns the total area in Albers square metres of all Project Mesh Blocks where the land use is classified as "Industrial" and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types by SA2	Union_qryRegions_POP_FTTN_FTTP_FWireless_HFC (qry)
Performance_ranking	Select query which ranks the bandwidth or performance categories from 1 (highest) to 5 (lowest)	Performance_categories (tbl)
qryADSL2PLUS_applicability_check	Select query which returns TRUE or FALSE depending on whether ADSL2+ meets the bandwidth requirements of the service selected by the user of the model	Applicable_technologies_Crosstab (qry)
qryAged_POP_SA1_GCC	*Check query*	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (qry), SA1_2011_Persons_Aged (tbl)
qryGIS_MB_Data_>24Mbps	Select query which returns the table entries of selected fields for those Project Mesh Blocks that are located in the remoteness areas selected by the user of the model when the minimum service requirements for the service chosen by the user of the model is selected to be greater than 24Mbps	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Select_service_remoteness_area_coverage (tbl), Service_requirements (qry), Applicable_technologies_Crosstab (qry)

Query name	Description	Source table (tbl) or query (qry)
qryGIS_MB_Data_10Mbps	Select query which returns the table entries of selected fields for those Project Mesh Blocks that are located in the remoteness areas selected by the user of the model when the minimum service requirements for the service chosen by the user of the model is selected to be 10Mbps	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Select_service_remoteness_area_coverage (tbl), Service_requirements (qry), Applicable_technologies_Crosstab (qry)
qryGIS_MB_Data_1Mbps	Select query which returns the table entries of selected fields for those Project Mesh Blocks that are located in the remoteness areas selected by the user of the model when the minimum service requirements for the service chosen by the user of the model is selected to be 1Mbps	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Select_service_remoteness_area_coverage (tbl), Service_requirements (qry), Applicable_technologies_Crosstab (qry)
qryGIS_MB_Data_1P5Mbps	Select query which returns the table entries of selected fields for those Project Mesh Blocks that are located in the remoteness areas selected by the user of the model when the minimum service requirements for the service chosen by the user of the model is selected to be 1.5Mbps	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Select_service_remoteness_area_coverage (tbl), Service_requirements (qry), Applicable_technologies_Crosstab (qry)
qryGIS_MB_Data_20Mbps	Select query which returns the table entries of selected fields for those Project Mesh Blocks that are located in the remoteness areas selected by the user of the model when the minimum service requirements for the service chosen by the user of the model is selected to be 20Mbps	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Select_service_remoteness_area_coverage (tbl), Service_requirements (qry), Applicable_technologies_Crosstab (qry)
qryGIS_MB_Data_2P5Mbps	Select query which returns the table entries of selected fields for those Project Mesh Blocks that are located in the remoteness areas selected by the user of the model when the minimum service requirements for the service chosen by the user of the model is selected to be 2.5Mbps	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Select_service_remoteness_area_coverage (tbl), Service_requirements (qry), Applicable_technologies_Crosstab (qry)
qryGIS_MB_Data_applicable_ADSL2PLUS	Select query which returns the table entries of selected fields for those Project Mesh Blocks in the appropriate remoteness areas where access to ADSL2+ with sufficient access speeds is available, subject to the applicability of ADSL2+ for the service selected by the user of the model	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Select_service_remoteness_area_coverage (tbl), qryADSL2PLUS_applicability_check (qry), Service_requirements (qry)

Query name	Description	Source table (tbl) or query (qry)
qryGP_Services_SLA_GCC	Select query which returns the numbers of GP services by Statistical Local Area (SLA)	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), SLA_Medical_Benefits_Scheme_Services_2009 (tbl)
qryMB_DW_Adelaide	Select query which returns the sum of numbers of dwellings for greater Adelaide	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl)
qryMB_DW_Gold_Coast	Select query which returns the sum of numbers of dwellings for the Gold Coast	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl)
qryMB_DW_Perth	Select query which returns the sum of numbers of dwellings for greater Perth	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl)
qryPOP_2011_GP_servics_0910_SLA	Select query which returns the numbers of persons usually resident, GP services and GP services as a proportion of all persons usually resident by SLA	SLA_POP_2011_AUST (tbl), SLA_Medical_Benefits_Scheme_Services_2009 (tbl)
qryRegions_DW_POP_HFC_Other	Select query which returns the table entries of selected fields for those Project Mesh Blocks with additional NBN HFC coverage areas subject to the connection type's capability to meet the service requirements selected by the user of the model; Numbers of persons usually resident, persons 65 and above and GP services are multiplied with 1-2.7/3.4 to account for the premises that are in the geographic area bounded by non-NBN networks, but not passed; Excluded are Project Mesh Blocks with estimated coverage of non-NBN connection types subject to their capabilities to meet the service requirements selected by the user of the model	Union_qryGIS_MB_Data (qry), Applicable_technologies_Crosstab (qry), Union_MB_HFC_Other (qry), Service_requirements (qry)
qryRegions_DW_POP_HFC_Other_Summary	*Check query*	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Union_MB_HFC_Other (qry)
qryRegions_GP_Services_200910	Select query which returns the sum of GP services by GCCSA	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Regions_Population_2011 (tbl)
qryRegions_POP_65Plus_2011	Select query which returns the sum of persons aged 65 and above by GCCSA	MB_DW_POP_ESA_region_intersect_nbn_fibre_wireless_HFC (tbl), Regions_Population_2011 (tbl)

Query name	Description	Source table (tbl) or query (qry)
qryRegions_POP_FTTN_interim	Select query which returns the table entries of selected fields for those Project Mesh Blocks with estimated NBN FTTN coverage subject to the connection type's capability to meet the service requirements selected by the user of the model; Excluded are Project Mesh Blocks with estimated coverage of NBN FTTP and HFC connection types	tblUnion_qryGIS_MB_Data (tbl), Applicable_technologies_Crosstab (qry)
qryRegions_POP_FTTN	Select query which returns records from the select query qryRegions_POP_FTTN_interim; Excluded are Project Mesh Blocks with additional NBN HFC coverage areas	qryRegions_POP_FTTN_interim (qry), qryRegions_DW_POP_HFC_Other (qry)
qryRegions_POP_FTTP_interim	Select query which returns the table entries of selected fields for those Project Mesh Blocks with estimated NBN FTTP coverage subject to the connection type's capability to meet the service requirements selected by the user of the model; Excluded are Project Mesh Blocks with estimated coverage of NBN HFC connection types	tblUnion_qryGIS_MB_Data (tbl), Applicable_technologies_Crosstab (qry)
qryRegions_POP_FTTP	Select query which returns records from the select query qryRegions_POP_FTTP_interim; Excluded are Project Mesh Blocks with additional NBN HFC coverage areas	qryRegions_POP_FTTP (qry), qryRegions_DW_POP_HFC_Other (qry)
qryRegions_POP_FWireless_step1	Select query which returns the table entries of selected fields for all Project Mesh Blocks except the ones estimated to have NBN connection types other than Fixed Wireless; An additional field is included indicating the Project Mesh Blocks within SA2 identified having some NBN Fixed Wireless coverage; Numbers of persons usually resident, persons aged 65 and above and GP services are multiplied with the absolute term 0.457980041050322, the average proportion of NBN Fixed Wireless coverage area in Project Mesh Blocks	tblSA2_SUA_2011_AUST_Wireless (tbl), tblUnion_qryGIS_MB_Data (tbl)

Query name	Description	Source table (tbl) or query (qry)
qryRegions_POP_FWireless_step2	Select query which returns the table entries of selected fields for those Project Mesh Blocks included in the select query qryRegions_POP_FWireless_step1 with estimated NBN Fixed Wireless coverage subject to the connection type's capability to meet the service requirements selected by the user of the model	qryRegions_POP_FWireless_step1 (qry), Applicable_technologies_Crosstab (qry)
qryRegions_POP_FWireless	Select query which returns records from the select query qryRegions_POP_FWireless_step2; Excluded are Project Mesh Blocks with additional NBN HFC coverage areas	qryRegions_POP_FWireless_step2 (qry), qryRegions_DW_POP_HFC_Other (qry)
qryRegions_POP_HFC	Select query which returns the table entries of selected fields for those Project Mesh Blocks with estimated NBN HFC coverage subject to the connection type's capability to meet the service requirements selected by the user of the model; Numbers of persons usually resident, persons 65 and above and GP services are multiplied with 1-2.7/3.4 to account for the premises that are in the geographic area of the non-NBN HFC footprint but not passed	tblUnion_qryGIS_MB_Data (tbl), Applicable_technologies_Crosstab (qry), Service_requirements (qry)
qrySubINDWeights	Select query which groups CGEM industry output data as a percentage of total industry output by CGEM industry	CGEM_industy_mapping (tbl), qrySumOfMAKE_(Output) (qry)
qrySumOfMAKE_(Output)	Select query which groups the sum of industry output data by industry code	CGEM_industry_mapping (tbl)
qryWireless_coverage_ratio_MB_inter	*Check query*	Union_qryGIS_MB_Data (qry)
Regions_CGEM_industries	Select query which adds CGEM industry output data as a percentage of total industry output by CGEM industry to all CGEM regions	Regions_Population_2011 (tbl), qrySubINDWeights (qry)

Query name	Description	Source table (tbl) or query (qry)
SA2_agricultural_industry_net_impact	Select query which returns the estimated size of the agricultural industry with an annual turnover of less than $AU 2 million as a proportion of total turnover multiplied with the estimated area of Project Mesh Blocks where the land use is classified as “Agricultural” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of total agricultural area by SA2	MB_agricultural_%area_by_SA2 (qry), Bussinesses_estimated_turnover_by_SA2_Crosstab (qry)
SA2_commercial_industries_net_impact	Select query which returns the estimated size of the commercial industries with an annual turnover of less than $AU 2 million as a proportion of total turnover multiplied with the estimated area of Project Mesh Blocks where the land use is classified as “Commercial” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of total commercial area by SA2	MB_commercial_%area_by_SA2 (qry), Bussinesses_estimated_turnover_by_SA2_Crosstab (qry)
SA2_industrial_industries_net_impact	Select query which returns the estimated size of the industrial industries with an annual turnover of less than $AU 2 million as a proportion of total turnover multiplied with the estimated area of Project Mesh Blocks where the land use is classified as “Industrial” and the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types as a proportion of total industrial area by SA2	MB_industrial_%area_by_SA2 (qry), Bussinesses_estimated_turnover_by_SA2_Crosstab (qry)
Service_requirements	Select query which returns the minimum service requirements, and service type (residential/commercial) applicable to the service selected by the user of the model	Select_service (tbl), Services_beneficiary (tbl), Union_qryService_requirements (qry)
Service_requirements_ranking	Select query which returns the ranking categories for download and upload speed requirements of the service selected by the user of the model	Service_requirements (qry), Performance_ranking (qry)

Query name	Description	Source table (tbl) or query (qry)
Technology_capability_ranking	Select query which returns the ranking categories for download and upload speed capabilities of each connection type	Connection_Type (tbl), Performance_ranking (qry)
Union_MB_HFC_Other	Union query which combines the additional NBN-HFC coverage areas by Statistical Area 3 selected by the user of the model	tblMB_HFC_Other (tbl)
Union_qryGIS_MB_Data	Union query which combines the results of various select queries and returns the table entries of selected fields for those Project Mesh Blocks that rely on the NBN in order to meet the minimum service requirements selected by the user of the model	qryGIS_MB_Data_1mbps (qry), qryGIS_MB_Data_1P5mbps (qry), qryGIS_MB_Data_2P5mbps (qry), qryGIS_MB_Data_10mbps (qry), qryGIS_MB_Data_20mbps (qry), qryGIS_MB_Data_>24mbps (qry), qryGIS_MB_Data_applicable_ADSL2PLUS (qry)
Union_qryRegions_POP_FTTN_FTTP_FWireless_HFC	Union query which combines various select queries and returns the table entries of selected fields for those Project Mesh Blocks where the minimum service requirements of the service selected by the user of the model are estimated to be exclusively met by the provision of NBN connection types	qryRegions_POP_FTTP (qry), qryRegions_POP_FTTN (qry), qryRegions_POP_FWireless (qry), qryRegions_POP_HFC (qry), qryRegions_DW_POP_HFC_Other (qry)
Union_qryService_requirements	Union query which combines various entries from various tables and returns the minimum service requirements for all services and scenarios	Services_requirements_high (tbl), Services_requirements_low (tbl)

Appendix B Economic Model Modifications

Appendix B.1 Adding the NBN to the model database

Table B.1 shows the sectoral aggregations in the economic model database adopted for this study.

Table B.1: Aggregated industries adopted in the TERM database

No.	Name	Description
1	AgriForFish	Agriculture, forestry & fishing
2	Mining	Mining
3	FoodDrinkTob	Food, beverages & tobacco
4	TCFs	Textiles, clothing & footwear
5	MiscManuf	Miscellaneous manufacturing
6	WoodProds	Wood & wood products
7	PaperPrint	Paper and printing
8	ChemCoalPrds	Chemicals & coal products
9	NonMetMinPrd	Non-metallic mineral products
10	MetalPrds	Metal products
11	TransEqp	Transport equipment
12	OthMachEqp	Other machinery & equipment
13	EGW	Electricity, gas & water
14	Construction	Construction
15	WholesalTrad	Wholesale trade
16	RetailTrade	Retail trade
17	RecPersSrvc	Recreation & personal services
18	Transport	Transport & storage
19	PostalSrvcs	Postal services
20	Telecomms	Telecommunication services
21	FinBusSrvces	Finance & business services
22	PubAdmDef	Public admin. & defence
23	Education	Education
24	Community	Health, welfare & community services

Each industry aggregate shown in Table B.1 demands several commodities and supplies one single commodity aggregate. The sectoral aggregation includes the Telecommunication services (Telecomms) industry. To be able to explicitly model the investment effect of the NBN on the economy in the short run requires NBN-specific industries to be included in the economic model database. We split Telecomms into three industries including two NBN-specific industries using DAggHAR (Horridge, 2012), a tool which was developed for this purpose. We split the Telecomms industry and all related data in the economic model database. This was done in approximate proportion to regional demands and supplies, taxes, margin services, *et cetera*. The industries in the economic model share a common production structure while proportions and behavioural parameters vary. We adjusted the proportions of the new NBN industry aggregates in accordance with the Telecomms industry aggregate using the General Equilibrium Modelling PACKage's TABLO language (Harrison et al., 2014). For this purpose, we have written a TABLO code which we have used with the modelling software to update the database. The complete TABLO code is shown in Appendix B.2.

We have assumed that all commodities of the newly added NBN wholesale service industry is exclusively used in the NBN retail service industry. The total supply of the NBN retail services industry was assumed to be the same as the total supply of the NBN wholesale services industry plus a retail mark-up or margin. Results of the Commonwealth Bank (2011a) in-depth NBN margin analysis suggests NBN retail service provider EBITDA margins of "20% for Telstra and TPG, 15% for iiNet and Optus, and =<10% for other smaller operators or those using wholesale aggregators " (Commonwealth Bank, 2011a, p. 1). We have assumed the average of the estimated NBN margins of 15% in the model's base year data for 2005/2006. This margin increased to about 16% in the model's base year data for 2010/2011 as a result of the historical simulation which is subject of the next section. This margin is within the ballpark of the blended NBN EBITDA margins in the long term assumed by the Commonwealth Bank (2011b).

For the newly added NBN retail service industry, we adopted the proportions of intermediate demand of commodities of the Telecomms service industry. These are the main assumptions that determine the input-output linkage between the NBN-related industries and upstream and downstream markets.

Investment in the NBN during the construction phase was assumed to follow NBN deployment pattern. We have allocated the estimated total supply of NBN-related industry services to regions in proportion to the total premises either planned to be passed by FTTP or work commenced by 30 Jun 2015 (NBN Company, 2012a). To increase investment in the NBN wholesale service industry to the estimated value appropriate for a typical short-run year during the construction phase, we have derived the percentage change values of the relevant exogenous variables in the model short-run simulation. This has required the base year data of the exogenous variables to be greater than zero. For determining the initial values of these exogenous variables, we have used one percent of $AU 2 million revenue forecasted for the financial year 2012 (NBN Company, 2012b). While we could have used any other reasonable starting values, the total investment in a typical short-run year and the initial values determine the percentage change values of the exogenous variables we have adjusted in the model short-run simulation.

Appendix B.2 TABLO code to update the input-output linkage of the NBN industries in the TERM database

We have used the TABLO code shown in this section to update the model database including the newly added NBN industries. Comments in the code are shown in italics. The text in between exclamation marks or hash keys will be ignored by the modelling software. When we refer to 'original' data, it means the data of the model database including the new NBN industries. The code can be copied and pasted into a new tab-file and executed using the modelling software. Default conventions are preserved in the following TABLO code including typical line lengths in a tab-file.

File InFile *# input file #;*

File (New) OutFile *# output file #;*

Set DST *# Regions of use #* read elements from file InFile header "REGD";

Set COM *# Commodities # read elements from file InFile header "COM";*

Set SRC *# description #* (dom, imp);

Set USR *# description #* (AgriForFish, Mining, FoodDrinkTob, TCFs, MiscManuf,

WoodProds, PaperPrint, ChemCoalPrds, NonMetMinPrd, MetalPrds, TransEqp,

OthMachEqp, EGW, Construction, WholesalTrad, RetailTrade, RecPersSrvc,

Transport, PostalSrvcs, Telecomms, NBNRetailSrv, NBNCoSrvcs, FinBusSrvces,

PubAdmDef, Education, Community, HOU, INV, GOV, EXP);

Set EXPORT *# Foreign users #* (EXP);

Subset EXPORT is subset of USR;

Set TELE *# Telecomms #* (Telecomms);

Subset EXPORT is subset of USR;

Set USREXCEXPTEL *# ALl users excluding foreign users #* = USR-EXPORT-TELE;

Set OCC *# Skills #* read elements from file InFile header "OCC";

Set IND *# Industries #* read elements from file InFile header "IND";

Set ORG *# Regions of origin #* read elements from file InFile header "REGS";

Set MAR *# Margin coms #* read elements from file InFile header "MAR ";

Set PRD *# Regions of production #* read elements from file InFile header "REGP";

Set HOU *# Household types #* read elements from file InFile header "HOU ";

Coefficient

(all,c,COM)(all,s,SRC)(all,u,USR)(all,d,DST) USE(c,s,u,d)

 # Basic + margin flows #;

(all,c,COM)(all,s,SRC)(all,u,USR)(all,d,DST) USEN(c,s,u,d)

New basic + margin flows #;

(all,d,DST) PREMPASSFY16(d)

 # Number of premises passed in financial year 2016 #;

(all,c,COM)(all,s,SRC)(all,u,USR)(all,d,DST) TAX(c,s,u,d)

 # Taxes #;

(all,c,COM)(all,s,SRC)(all,u,USR)(all,d,DST) TAXN(c,s,u,d)

 # New taxes #;

(all,i,IND)(all,d,DST) PRODTAX(i,d) *# Taxes on production #;*

(all,i,IND)(all,d,DST) PRODTAXN(i,d) *# New taxes on production #;*

(all,c,COM)(all,d,DST)(all,h,HOU) HOUPUR(c,d,h)

 # Household demands #;

(all,c,COM)(all,d,DST)(all,h,HOU) HOUPURN(c,d,h)

 # New household demands #;

(all,c,COM)(all,s,SRC)(all,o,ORG)(all,d,DST) TRADE(c,s,o,d) *# sourcing matrix #;*

(all,c,COM)(all,s,SRC)(all,o,ORG)(all,d,DST) TRADEN(c,s,o,d)

 # New sourcing matrix #;

(all,m,MAR)(all,o,ORG)(all,d,DST)(all,p,PRD) SUPPMAR(m,o,d,p)

 # margins supplied by PRD on goods passing from ORG to DST #;

(all,c,COM)(all,s,SRC)(all,m,MAR)(all,o,ORG)(all,d,DST)

TRADMAR(c,s,m,o,d) *# margins on trade matrix #;*

(all,c,COM)(all,i,IND)(all,d,DST) MAKE(c,i,d)

 # MAKE matrix #;

(all,c,COM)(all,i,IND)(all,d,DST) MAKEN(c,i,d) *# New MAKE matrix #;*

(all,c,COM)(all,i,IND)(all,d,DST) INVEST(c,i,d)

 # investment at purchasers prices #;

(all,c,COM)(all,i,IND)(all,d,DST) INVESTN(c,i,d)

 # New investment at purchasers prices #;

(all,i,IND)(all,d,DST) STOCKS(i,d) *# Domestic inventories #;*

(all,i,IND)(all,d,DST) STOCKSN(i,d) *# New domestic inventories #;*

(all,i,IND)(all,d,DST) LND(i,d) *# Rentals to land #;*

(all,i,IND)(all,o,OCC)(all,d,DST) LAB(i,o,d) *# Wage matrix #;*

(all,i,IND)(all,o,OCC)(all,d,DST) LABN(i,o,d) *# New wage matrix #;*

(all,i,IND)(all,d,DST) CAP(i,d) *# Rentals to capital #;*

(all,i,IND)(all,d,DST) CAPN(i,d) *# New rentals to capital #;*

(all,i,IND) SIGMALAB(i) *# Labour Sigma #;*

(all,i,IND) SIGMAPRIM(i) *# Primary Factor Sigma #;*

(all,c,COM) ARMSIGMA(c) *# Intermediate Armington #;*

(all,c,COM) SIGMADOMDOM(c) *# Between-region Armington #;*

(all,m,MAR) SIGMAMAR(m)

 # Elasticity of substitution between regions of margin production #;

(all,i,IND) SIGMAOUT(i) *# Output Sigma #;*

(all,d,DST)(all,h,HOU) FRISCHH(d,h)

 # Frisch LES parameter= total/luxury) #;

(all,c,COM) EXP_ELAST(c) *# Individual Export Elasticities #;*

(all,d,DST) POP(d) *# Pop(REG) #;*

(all,c,COM)(all,d,DST)(all,h,HOU) EPSH(c,d,h)

 # Expenditure elasticities #;

(all,s,SRC)(all,d,DST) TELESALES_u(s,d)

 # Total sales of telecommunications services by source and region of use #;

(all,s,SRC)(all,d,DST) TELESALEXP_u(s,d)

 # Total sales of telecommunications services excluding exports by source and region of use #;

(all,u,USR)(all,d,DST) SHRTELSALEXP(u,d)

 # Shares of sales of telecommunications services by each user excluding exports by region of use #;

(all,s,SRC)(all,u,USR)(all,d,DST) SHRTELTAXU(s,u,d)

 # Shares of taxes paid by users of telecommunications services by source and region of use #;

(all,c,COM)(all,s,SRC)(all,d,DST) SHRTELTAXUSE(c,s,d)

 # Shares of taxes paid by the telecommunications service industry by commodity, source and region of use #;

(all,i,IND)(all,d,DST) SHRTELTAX(i,d)

 # Shares of taxes on the provision of telecommunications services by industry and region of use #;

(all,s,SRC)(all,d,DST) TELEINTDEM_c(s,d)

 # Total intermediate demand of the telecommunications service industry by source and region of use #;

(all,c,COM)(all,s,SRC)(all,d,DST) SHRTELINTDEM(c,s,d)

 # Shares of intermediate demand by telecommunications and region of use #;

(all,i,IND)(all,d,DST) SHRTELSTOCKS(i,d)

 # Shares of stocks for telecommunications service industry by region of use #;

(all,i,IND)(all,o,OCC)(all,d,DST) SHRTELLAB(i,o,d)

 # Shares of wages paid by users of telecommunications services by industry, region of origin and region of use #;

(all,i,IND)(all,d,DST) SHRTELPRIM(i,d)

 # Shares of primary factor inputs for telecommunications services by industry and region of use #;

(all,i,IND)(all,d,DST) SHRTELCAP(i,d)

 # Shares of capital rental for telecommunications services by industry and region of use #;

(all,c,COM)(all,d,DST) SHRTELINV(c,d)

 # Shares of investment by commodity, industry and region of use #;

(all,d,DST) SHRTELEMAKE(d)

 # Shares of investment by region of use #;

(all,s,SRC)(all,d,DST) RETAILINTDEM(s,d);

(all,s,SRC)(all,d,DST) WHSALEINTDEM(s,d);

TINY *# A very small number #;*

RETAILMARGIN;

PREMPASS16_d;

TELENBNRMAKE;

TELENBNWMAKE;

Read

MAKE from file InFile header "MAKE";

USE from file InFile header "BSMR";

TAX from file InFile header "UTAX";

PRODTAX from file InFile header "1PTX";

HOUPUR from file InFile header "3PUR";

TRADE from file InFile header "TRAD";

SUPPMAR from file InFile header "MARS";

TRADMAR from file InFile header "TMAR";

INVEST from file InFile header "2PUR";

STOCKS from file InFile header "STOK";

LND from file InFile header "1LND";

LAB from file InFile header "1LAB";

CAP from file InFile header "1CAP";

SIGMALAB from file InFile header "SLAB";

SIGMAPRIM from file InFile header "P028";

ARMSIGMA from file InFile header "P015";

SIGMADOMDOM from file InFile header "SGDD";

SIGMAMAR from file InFile header "SMAR";

SIGMAOUT from file InFile header "SCET";

FRISCHH from file InFile header "P021";

EXP_ELAST from file InFile header "P018";

POP from file InFile header "PO01";

EPSH from file InFile header "XPEL";

PREMPASSFY16 from file InFile header "PP16";

Formula

!Basic and margin flows!

(all,c,COM)(all,s,SRC)(all,u,USR)(all,d,DST) USEN(c,s,u,d) = USE(c,s,u,d); *# Adopting original basic and margin flows #*

(all,s,SRC)(all,d,DST) TELESALEXP_u(s,d)

= sum{u,USREXCEXPTEL, USEN("Telecomms",s,u,d)};

(all,u,USREXCEXPTEL)(all,d,DST) SHRTELSALEXP(u,d)

= USEN("Telecomms","dom",u,d)/TELESALEXP_u("dom",d);

TINY = 0.000000000001; *!TINY is output of NBN wholesale services industry used*

as intermediate demand by NBN retail services industry!

RETAILMARGIN = 0.15; !Assumed 15% retail margin for the NBN retail services!

PREMPASS16_d = sum{d,DST, PREMPASSFY16(d)};

(all,u,USR)(all,d,DST) USEN("NBNRetailSrv","dom",u,d)

= SHRTELSALEXP(u,d)*PREMPASSFY16(d)/PREMPASS16_d*TINY*[1+RETAILMARGIN];

!Sales shares of Telecomms industry to users for the newly added NBN

retail industries including retail margin!

(all,d,DST) USEN("NBNRetailSrv","dom","EXP",d) = 0; *!Zero foreign demand of NBN*

retails services commodities!

(all,u,USR)(all,d,DST) USEN("NBNRetailSrv","imp",u,d)

= 0; *!NBN wholesale services industry does not provide commodities to users other*

than NBN retail services industry!

(all,s,SRC)(all,u,USR)(all,d,DST) USEN("NBNCoSrvcs",s,u,d)

= 0;

!Adopting intermediate demands shares of Telecomms industry!

```
 (all,s,SRC)(all,d,DST) TELEINTDEM_c(s,d)
 = sum{c,COM, USEN(c,s,"Telecomms",d)};
(all,c,COM)(all,s,SRC)(all,d,DST) SHRTELINTDEM(c,s,d)
 = USEN(c,s,"Telecomms",d)/TELEINTDEM_c(s,d);
```

!Adopting ratios of "Telecomms" intermediate demands to "Telecomms" commodity sales!

```
(all,s,SRC)(all,d,DST) RETAILINTDEM(s,d)
 = TELEINTDEM_c(s,d)/TELESALEXP_u(s,d)*TINY*[[1+RETAILMARGIN]-1];
```

!NBN retail services industry uses TINY from NBN wholesale services industry

and some commodities from other industries (rest is primary factors demand)

summing up to total sales (=TINY[1+RETAILMARGIN])!*

```
(all,s,SRC)(all,d,DST) TELESALES_u(s,d)
 = sum{u,USR, USEN("Telecomms",s,u,d)};
(all,s,SRC)(all,d,DST) WHSALEINTDEM(s,d)
 = TELEINTDEM_c(s,d)/TELESALES_u(s,d)*TINY;
(all,c,COM)(all,s,SRC)(all,d,DST) USEN(c,s,"NBNRetailSrv",d)
 = SHRTELINTDEM(c,s,d)*RETAILINTDEM(s,d);
(all,c,COM)(all,s,SRC)(all,d,DST) USEN(c,s,"NBNCoSrvcs",d)
 = SHRTELINTDEM(c,s,d)*WHSALEINTDEM(s,d);
(all,d,DST) USEN("NBNCoSrvcs","dom","NBNRetailSrv",d)
 = PREMPASSFY16(d)/PREMPASS16_d*TINY;
```

!Taxes!

(all,c,COM)(all,s,SRC)(all,u,USR)(all,d,DST) TAXN(c,s,u,d) = TAX(c,s,u,d); *# Adopting original taxes #*

```
(all,s,SRC)(all,u,USR)(all,d,DST) SHRTELTAXU(s,u,d)
 = TAX("Telecomms",s,u,d)/USE("Telecomms",s,u,d);
```

```
(all,s,SRC)(all,u,USR)(all,d,DST) TAXN("NBNRetailSrv",s,u,d)
 = SHRTELTAXU(s,u,d)*USEN("NBNRetailSrv",s,u,d);
(all,s,SRC)(all,u,USR)(all,d,DST) TAXN("NBNCoSrvcs",s,u,d)
 = SHRTELTAXU(s,u,d)*USEN("NBNCoSrvcs",s,u,d);
(all,c,COM)(all,s,SRC)(all,d,DST) SHRTELTAXUSE(c,s,d)
 = TAX(c,s,"Telecomms",d)/USE(c,s,"Telecomms",d);
(all,c,COM)(all,s,SRC)(all,d,DST) TAXN(c,s,"NBNRetailSrv",d)
 = SHRTELTAXUSE(c,s,d)*USEN(c,s,"NBNRetailSrv",d);
(all,c,COM)(all,s,SRC)(all,d,DST) TAXN(c,s,"NBNCoSrvcs",d)
 = SHRTELTAXUSE(c,s,d)*USEN(c,s,"NBNCoSrvcs",d);
```

!Household demands!

```
(all,c,COM)(all,d,DST)(all,h,HOU) HOUPURN(c,d,h) = HOUPUR(c,d,h); # Adopting original household demands #
(all,d,DST)(all,h,HOU) HOUPURN("NBNRetailSrv",d,h)
 = USEN("NBNRetailSrv","dom","HOU",d)+TAXN("NBNRetailSrv","dom","HOU",d);
(all,d,DST)(all,h,HOU) HOUPURN("NBNCoSrvcs",d,h)
 = USEN("NBNCoSrvcs","dom","HOU",d)+TAXN("NBNCoSrvcs","dom","HOU",d);
```

!MAKE matrix!

```
(all,c,COM)(all,i,IND)(all,d,DST) MAKEN(c,i,d) = MAKE(c,i,d); # Adopting original MAKE matrix #
(all,d,DST) MAKEN("Telecomms","NBNRetailSrv",d) = 0;
(all,d,DST) MAKEN("NBNRetailSrv","Telecomms",d) = 0;
(all,d,DST) MAKEN("Telecomms","NBNCoSrvcs",d) = 0;
(all,d,DST) MAKEN("NBNCoSrvcs","Telecomms",d) = 0;
(all,d,DST) MAKEN("NBNRetailSrv","NBNCoSrvcs",d) = 0;
(all,d,DST) MAKEN("NBNCoSrvcs","NBNRetailSrv",d) = 0;
```

(all,d,DST) SHRTELEMAKE(d) =

MAKEN("Telecomms","Telecomms",d)/TELESALEXP_u("dom",d);

(all,d,DST) MAKEN("NBNRetailSrv","NBNRetailSrv",d) =

SHRTELEMAKE(d)*sum{u,USR, USEN("NBNRetailSrv","dom",u,d)};

(all,d,DST) MAKEN("NBNCoSrvcs","NBNCoSrvcs",d) =

SHRTELEMAKE(d)*sum{u,USR, USEN("NBNCoSrvcs","dom",u,d)};

!Sourcing matrix!

(all,c,COM)(all,s,SRC)(all,o,ORG)(all,d,DST) TRADEN(c,s,o,d) =

TRADE(c,s,o,d); *# Adopting original sourcing matrix #*

(all,o,ORG)(all,d,DST) TRADEN("NBNRetailSrv","imp",o,d)

= 0; *# Setting regional trade of imported NBNRetailSrv commodities to zero #*

(all,o,ORG)(all,d,DST) TRADEN("NBNCoSrvcs","imp",o,d)

= 0; *# Setting regional trade of imported NBNCoSrvcs commodities to zero #*

TELENBNRMAKE = sum{d,DST, MAKEN("NBNRetailSrv","NBNRetailSrv",d)}

/sum{d,DST, MAKEN("Telecomms","Telecomms",d)};

 # Calculating national output of NBNRetailSrv commodities as a ratio of Telecomms output #

TELENBNWMAKE = sum{d,DST, MAKEN("NBNCoSrvcs","NBNCoSrvcs",d)}

/sum{d,DST, MAKEN("Telecomms","Telecomms",d)};

 # Calculating national output of NBNCoSrvcs commodities as a ratio of Telecomms output #

(all,o,ORG)(all,d,DST) TRADEN("NBNRetailSrv","dom",o,d)

= TRADEN("Telecomms","dom",o,d)*TELENBNRMAKE;

 # Setting regional trade of NBNRetailSrv commodities as the product of regional trade of Telecomms commodities and the ratio of national output of NBNCoSrvcs commodities to Telecomms output #

(all,o,ORG)(all,d,DST) TRADEN("NBNCoSrvcs","dom",o,d)

= TRADEN("Telecomms","dom",o,d)*TELENBNWMAKE;

Setting regional trade of NBNRetailSrv commodities as the product of regional trade of Telecomms commodities and the ratio of national output of NBNCoSrvcs commodities to Telecomms output #*

!Expenditure elasticities!

!Has been adopted automatically by using command 'duplicate', i.e. 'D', in the split program DaggHAR!

!Domestic inventories!

(all,i,IND)(all,d,DST) STOCKSN(i,d) = STOCKS(i,d); *# Adopting original domestic inventories #*

(all,i,IND)(all,d,DST) SHRTELSTOCKS(i,d)

= STOCKS("Telecomms",d)/MAKEN("Telecomms","Telecomms",d);

(all,d,DST) STOCKSN("NBNRetailSrv",d)

= SHRTELSTOCKS("Telecomms",d)*MAKEN("NBNRetailSrv","NBNRetailSrv",d);

(all,d,DST) STOCKSN("NBNCoSrvcs",d)

= SHRTELSTOCKS("Telecomms",d)*MAKEN("NBNCoSrvcs","NBNCoSrvcs",d);

!Wage matrix!

(all,i,IND)(all,o,OCC)(all,d,DST) LABN(i,o,d) = LAB(i,o,d); *# Adopting original wage matrix #*

(all,o,OCC)(all,d,DST) SHRTELLAB("Telecomms",o,d)

= LAB("Telecomms",o,d)/MAKEN("Telecomms","Telecomms",d);

(all,o,OCC)(all,d,DST) LABN("NBNRetailSrv",o,d)

= SHRTELLAB("Telecomms",o,d)*MAKEN("NBNRetailSrv","NBNRetailSrv",d);

(all,o,OCC)(all,d,DST) LABN("NBNCoSrvcs",o,d)

= SHRTELLAB("Telecomms",o,d)*MAKEN("NBNCoSrvcs","NBNCoSrvcs",d);

!Taxes on production!

(all,i,IND)(all,d,DST) PRODTAXN(i,d) = PRODTAX(i,d); *# Adopting original taxes on production #*

(all,d,DST) SHRTELTAX("Telecomms",d)

= PRODTAX("Telecomms",d)/MAKEN("Telecomms","Telecomms",d);

(all,d,DST) PRODTAXN("NBNRetailSrv",d)

= SHRTELTAX("Telecomms",d)*MAKEN("NBNRetailSrv","NBNRetailSrv",d);

(all,d,DST) PRODTAXN("NBNCoSrvcs",d)

= SHRTELTAX("Telecomms",d)*MAKEN("NBNCoSrvcs","NBNCoSrvcs",d);

!Rentals to capital!

(all,i,IND)(all,d,DST) CAPN(i,d) = CAP(i,d); *# Adopting original rentals to capital #*

(all,d,DST) SHRTELCAP("Telecomms",d)

= CAP("Telecomms",d)/MAKEN("Telecomms","Telecomms",d);

(all,d,DST) CAPN("NBNRetailSrv",d)

= SHRTELCAP("Telecomms",d)*MAKEN("NBNRetailSrv","NBNRetailSrv",d);

(all,d,DST) CAPN("NBNCoSrvcs",d)

= SHRTELCAP("Telecomms",d)*MAKEN("NBNCoSrvcs","NBNCoSrvcs",d);

!Investment at purchasers prices!

(all,c,COM)(all,i,IND)(all,d,DST) INVESTN(c,i,d) = INVEST(c,i,d); *# Adopting original investment at purchasers prices #*

(all,c,COM)(all,d,DST) SHRTELINV(c,d)

= INVESTN(c,"Telecomms",d)/MAKEN("Telecomms","Telecomms",d);

(all,c,COM)(all,d,DST) INVESTN(c,"NBNRetailSrv",d)

= SHRTELINV(c,d)*MAKEN("NBNRetailSrv","NBNRetailSrv",d);

(all,c,COM)(all,d,DST) INVESTN(c,"NBNCoSrvcs",d)

= SHRTELINV(c,d)*MAKEN("NBNCoSrvcs","NBNCoSrvcs",d);

Write

USEN to file Outfile header "BSMR";

TAXN to file Outfile header "UTAX";

PRODTAXN to file Outfile header "1PTX";

HOUPURN to file Outfile header "3PUR";

TRADEN to file Outfile header "TRAD";

SUPPMAR to file Outfile header "MARS";

TRADMAR to file Outfile header "TMAR";

MAKEN to file Outfile header "MAKE";

INVESTN to file Outfile header "2PUR";

STOCKSN to file Outfile header "STOK";

LND to file Outfile header "1LND";

LABN to file Outfile header "1LAB";

CAPN to file Outfile header "1CAP";

SIGMALAB to file Outfile header "SLAB";

SIGMAPRIM to file Outfile header "P028";

ARMSIGMA to file Outfile header "P015";

SIGMADOMDOM to file Outfile header "SGDD";

SIGMAMAR to file Outfile header "SMAR";

SIGMAOUT to file Outfile header "SCET";

FRISCHH to file Outfile header "P021";

EXP_ELAST to file Outfile header "P018";

POP to file Outfile header "PO01";

EPSH to file Outfile header "XPEL";

Appendix B.3 Updating the model's base year data by historical simulation

The 2005/2006 database including the new NBN service industries was updated by running a historical simulation (Wittwer and Anderson, 2000; Dixon et al., 2000). We have used regional population, national real GDP, aggregate consumption, investment, government expenditure and international exports as of June 2011 from the ABS to update the economic model base year data for 2005/2006 to 2010/2011. In the model closure for the historical simulation, we have treated the above national macroeconomic indicators as exogenous and set their new values by specifying for each the percentage change from 2005/2006 to 2010/2011. We then let the economic model determine the values of the endogenous variables and used the resulting values as base year data for 2010/2011.

To exogenously determine national real GDP, government expenditure and international exports in the closure for the historical simulation, we needed to add three exogenous variables to the equation system. In the equation system, variables starting with a lower-case letter are in units of percentage change. Variables written in upper-case letters are absolute values. The three newly added variables are in units of percentage change as follows:

1) all-input-augmenting technical change (atot_id);

2) government demand shift variable (fgovtot_d); and

3) export quantity shift variable (fqexp_csd).

The general approach when adopting new values for national real GDP, government expenditure and international exports is to use the above variables. We needed to add the additional variables because in the TERM equation system the relevant variables relate to industries or commodities, and regions. Hence, they cannot be swapped with the above macroeconomic variables. In the model closure for the historical simulation, we have swapped the three newly added variables with the three national macroeconomic indicators that were previously determined by the model endogenously.

In the following sections, we describe in which model equations we have added the above variables.

Inserting all-input-augmenting technical change "atot_id"

An increase in real GDP over time may be influenced by an increase in all-input-augmenting technical change. All-input-augmenting technical change, also referred to as total factor productivity, is a measure of productivity, which accounts for all inputs to production. The economic model equation system includes all-input-augmenting technical change variables by industry (i) and region (d), represented by atot(i,d). In order to determine national real GDP exogenously, we need to select a previously exogenous all-input-augmenting technical change variable. This variable is then swapped with the previously endogenous national real GDP variable. For this purpose, we have added another all-input-augmenting technical change variable to the equation system; that is atot_id. This was required since the adopted equation system only included atot(i,d) and cannot be swapped with the macroeconomic variable because of the different dimensions.

By determining atot_id endogenously and national real GDP exogenously in the model closure for the historical simulation, we have assumed that the expansion we have imposed upon the Australian economy from 2005/2006 to 2010/2011 occurred partly due to all-input-augmenting technical change over all industries and regions. We have included atot_id in those equations wherever atot(i,d) is used. The new variable atot_id is in units of percentage change and represents a change to the sum of all-input-augmenting technical changes over all industries and regions. The first such equation that needs to be modified defines the industry or intermediate demands in linear percentage change form as follows:

$$\mathrm{xint\_s}(c,i,d) = \mathbf{atot\_id} + \mathrm{atot}(i,d) + \mathrm{aint\_s}(c,i,d) + \mathrm{xtot}(i,d) - 0.15 * \{\mathrm{ppur\_s}(c,i,d) + \mathrm{aint\_s}(c,i,d) - \mathrm{pint}(i,d)\} \tag{B.1}$$

where

$\mathrm{xint\_s}(c,i,d)$ is percentage change of industry demands for domestic/imported composite;

$\mathrm{atot\_id}$ is the added variable;

$\mathrm{atot}(i,d)$ is percentage change of all-input-augmenting technical change by industry and region of use;

$\mathrm{aint\_s}(c,i,d)$ is percentage change of intermediate technical change by commodity, industry and region of use;

$\mathrm{xtot}(i,d)$ is percentage change of industry outputs by industry and region of use;

0.15 is intermediate substitution elasticity;

$\mathrm{ppur\_s}(c,i,d)$ is percentage change of sum of average user prices over all sources by commodity, industry and region of use;

$\mathrm{aint\_s}(c,i,d)$ is percentage change of sum of intermediate technical change by commodity, industry and region of use; and

$\mathrm{pint}(i,d)$ is percentage change of intermediate effective price indices by industry and region of use.

Output is produced using a combination of primary inputs and intermediate goods with a constant proportions technology (Wittwer, 2003). The industry demands for the aggregate primary factor are proportional to total output and technological terms as shown in equation (B.2) in the form of differentiated, linear percentage change terms including the newly added percentage change all-input-augmenting technical change variable over all industries and regions ($\mathrm{atot\_id}$).

$$\mathrm{xprim}(i,d) = \mathrm{xtot}(i,d) + \mathbf{atot\_id} + \mathrm{atot}(i,d) + \mathrm{aprim}(i,d) \tag{B.2}$$

where

$\mathrm{xprim}(i,d)$ is percentage change of composite primary factor composite by industry and region of use;

$\mathrm{xtot}(i,d)$ is percentage change of industry outputs by industry and region of use;

$\mathrm{atot\_id}$ is the added variable;

$\mathrm{atot}(i,d)$ is percentage change of all-input-augmenting technical change by industry and region of use; and

$\mathrm{aprim}(i,d)$ is percentage change of primary-factor-augmenting technical change.

The primary factor aggregate is a constant elasticity of substitution (CES) composite of land, capital and labour aggregate. The labour aggregate is a CES composite of various skill groups.

In the equation system, both the short-run variable cost and total cost of production are subject to all-input-augmenting technical change. The third equation we needed to modify defines the variable cost of production in linear percentage change form as follows:

$$\mathrm{ID01(VARCST(i,d))} * [\mathrm{pvar(i,d)} - \mathrm{atot(i,d)} - \mathbf{atot\_id}] = \mathrm{LAB\_O(i,d)} * [\mathrm{plab\_o(i,d)} + \mathrm{alab\_o(i,d)}] + \mathrm{PUR\_CS(i,d)} * \mathrm{pint(i,d)} \quad \text{(B.3)}$$

where

$\mathrm{ID01(VARCST(i,d))}$ is the short-run variable cost by industry and region of use;

$\mathrm{pvar(i,d)}$ is percentage change of variable cost of production by industry and region of use;

$\mathrm{atot(i,d)}$ is percentage change of all-input-augmenting technical change by industry and region of use;

$\mathrm{atot\_id}$ is the added variable;

$\mathrm{LAB\_O(i,d)}$ is sum of total labour bill over all occupations by industry and region of use;

$\mathrm{plab\_o(i,d)}$ is percentage change of sum of price of labour composite over all occupations by industry and region of use;

$\mathrm{alab\_o(i,d)}$ is the percentage change of sum of labour-augmenting technical change over all occupations by industry and region of use;

$\mathrm{PUR\_CS(i,d)}$ is sum of expenditure on goods over all commodities and sources by industry and region of use; and

$\mathrm{pint(i,d)}$ is the percentage change of intermediate effective price indices by industry and region of use.

The fourth equation we needed to modify defines the total cost of production excluding tax in linear percentage change form, as follows:

$$\mathrm{ID01(VCST(i,d))} * [\mathrm{pcst(i,d)} - \mathrm{atot(i,d)} - \mathbf{atot\_id}] = \mathrm{PRIM(i,d)} * [\mathrm{aprim(i,d)} + \mathrm{pprim(i,d)}] + \mathrm{PUR\_CS(i,d)} * \mathrm{pint(i,d)} \quad \text{(B.4)}$$

where

$\mathrm{ID01(VCST(i,d))}$ is the short-run variable cost by industry and region of use;

$\mathrm{pcst(i,d)}$ is percentage change of cost of production excluding tax by industry and region of use;

$\mathrm{atot(i,d)}$ is percentage change of all-input-augmenting technical change by industry and region of use;

$\mathrm{atot\_id}$ is the added variable;

$\mathrm{PRIM(i,d)}$ is total factor input by industry and region of use;

$\mathrm{aprim(i,d)}$ is percentage change of primary-factor-augmenting technical change by industry and region of use;

$\mathrm{pprim(i,d)}$ is percentage change of effective price of primary factor composite by industry and region of use;

$\mathrm{PUR\_CS(i,d)}$ is sum of expenditure on goods over all commodities and sources by industry and region of use; and

$\mathrm{pint(i,d)}$ is percentage change of intermediate effective price indices by industry and region of use.

Both short-run variable cost and total cost of production are negatively correlated with technical change and therefore decrease when productivity improves (a value less than zero for the percentage change of technical change indicates an improvement in productivity).

The equation defining the contributions of endowments, technical change and tax to national real GDP in linear percentage change form is as follows:

$$
\begin{aligned}
&\mathrm{contincind(i,d,c)} \;=\; [\mathrm{RATIOXGDP/NATGDPINC}] * \{\mathrm{if[c = "Land", LND(i,d) * xlnd(i,d)} \\
&+ \mathrm{if[c = Labour, sum\{o, OCC, LAB(i,o,d) * xlab(i,o,d)\}]} \\
&+ \mathrm{if[c = Capital, CAP(i,d) * xcap(i,d)]} \\
&- \mathrm{if[c = alnd, LND(i,d) * alnd(i,d)]} \\
&- \mathrm{if[c = Capital, CAP(i,d) * acap(i,d)]} \\
&- \mathrm{if[c = alab\_o, LAB\_O(i,d) * alab\_o(i,d)]} \qquad \text{(B.5)} \\
&- \mathrm{if[c = aprim, PRIM(i,d) * aprim(i,d)]} \\
&- \mathrm{if[c = atot, VCST(i,d) * atot(i,d)]} \\
&- \mathrm{if[c = \mathbf{atot\_id}, VCST(i,d) * \mathbf{atot\_id}]} \\
&- \mathrm{if[c = aint\_s, sum\{k, COM, PUR\_S(k,i,d) * aint\_s(k,i,d)\}]} \\
&+ \mathrm{if[c = "prodtax", PRODTAX(i,d) * xtot(i,d)]\}}
\end{aligned}
$$

where

$\mathrm{contincind(i,d,c)}$ is percentage change of industry contribution terms to national real income GDP by industry, region and contributors to real income GDP change;

$\mathrm{RATIOXGDP}$ is ratio of current to initial national real GDP;

$\mathrm{NATGDPINC}$ is national income-side GDP;

$\mathrm{LND(i, d)}$ is rentals to land by industry and region;

$\mathrm{xlnd(i, d)}$ is percentage change of land use by industry and region of use;

OCC is labour skill categories;

$\mathrm{sum\{o, OCC, \dots\}}$ means sum over o, where o takes each of the values in OCC;

$\mathrm{LAB(i, o, d)}$ is wage matrix by industry, occupation and region of use;

$\mathrm{xlab(i, o, d)}$ is labour demands by industry, occupation and region of use;

$\mathrm{CAP(i, d)}$ is rentals to capital by industry and region of use;

$\mathrm{xcap(i, d)}$ is percentage change of capital usage by industry and region of use;

$\mathrm{alnd(i, d)}$ is percentage change of land-augmenting technical change by industry and region of use;

$\mathrm{acap(i, d)}$ is percentage change of capital-augmenting technical change by industry and region of use;

$\mathrm{LAB\_O(i, d)}$ is sum of total labour bill over all occupations by industry and region of use;

$\mathrm{alab\_o(i, d)}$ is percentage change of sum of labour-augmenting technical change over all occupations by industry and region of use;

$\mathrm{PRIM(i, d)}$ is total factor input by industry and region of use;

$\mathrm{aprim(i, d)}$ is percentage change of primary-factor-input augmenting technical change by industry and region of use;

$\mathrm{VCST(i, d)}$ is total cost by industry and region of use;

$\mathrm{atot(i, d)}$ is all-input-augmenting technical change by industry and region of use;

$\mathrm{atot\_id}$ is the added variable;

COM is commodity categories;

$\mathrm{sum\{k, COM, \dots\}}$ means sum over k, where k takes each of the values in COM;

$\mathrm{PUR\_S(k, i, d)}$ is sum of purchasers' values over all sources by commodity, industry and region of use;

$\mathrm{aint\_s(k, i, d)}$ is percentage change of sum of intermediate technical change over all sources by commodity, industry and regions of use;

$\mathrm{PRODTAX(i, d)}$ is taxes on production by industry and region of use; and

$\mathrm{xtot(i, d)}$ is percentage change of industry outputs by industry and region of use.

Inserting government demand shift variable "fgovtot_d"

To swap the previously endogenous government and foreign demand (export) variables in the closure of the historical simulation, we have included two new shift variables. The newly added government demand and export quantity shift variables allow for changes in government and export demand. The value of each variable increases (decreases) if there is an increase (decrease) in the government demand and export quantity, i.e. an upward (downward) movement in the demand curve, respectively. In the historical simulation, the newly endogenous shift variables were then determined endogenously by the respective model equations. The equation where we have included the government demand shift variable defines the government demand in linear percentage change form as follows:

$$\mathrm{xgov(c,s,d)} \;=\; \mathbf{fgovtot\_d} \;+\; \mathrm{fgovtot(d)} \;+\; \mathrm{fgov(c,s,d)} \;+\; \mathrm{fgov\_s(c,d)} \qquad \text{(B.6)}$$

where

$\mathrm{xgov(c,s,d)}$ is percentage change of government demands for all-region composite by commodity, source and region of use;

$\mathrm{fgovtot\_d}$ is the added variable;

$\mathrm{fgovtot(d)}$ is percentage change of government demand shift variable by region of use;

$\mathrm{fgov(c,s,d)}$ is percentage change of government demand shift variable by commodity, source and region of use; and

$\mathrm{fgov\_s(c,d)}$ is percentage change of government demand shift variable over all sources by commodity and region of use.

The version of TERM adopted for the purpose of this study contains no theory for government demands, which is why equation (B6.6) only contains exogenous shift variables. Similar to the composition of investment, the composition of government demands is exogenous.

Inserting export quantity shift variable "fqexp_csd"

The export demand function in linear percentage change form is as follows:

$$\mathrm{xexp(c,s,d)} = \mathrm{fqexp(c,s,d)} \;+\; \mathbf{fqexp\_csd} - \mathrm{ABS[EXP\_ELAST(c)]} * [\mathrm{ppur(c,s,"Exp",d)} - \mathrm{fpexp(c,s,d)} - \mathrm{phi}] \qquad \text{(B.7)}$$

where

$\mathrm{xexp(c,s,d)}$ is percentage change of exports of all-region composite leaving port at the region where goods are loaded onto ship;

$\mathrm{fqexp(c,s,d)}$ is percentage change of export quantity shift variable by commodity, source and region where goods are loaded onto ship;

$\mathrm{fqexp\_csd}$ is the added variable;

$\mathrm{ABS[EXP\_ELAST(c)}$ is export demand elasticites by commodity;

$\mathrm{ppur(c, s, "Exp", d)}$ is percentage change of user (purchasers') prices for export, that is, the foreign-currency prices including margins and taxes by commodity, sources and region where goods are loaded onto ship;

$\mathrm{fpexp(c, s, d)}$ is percentage change of export price shift variable by commodity, source and region where goods are loaded onto ship; and

phi is percentage change of exchange rate, i.e. local divided by foreign currency.

According to equation (B.7), foreign demand responds to the foreign-currency price of domestic commodities.

In the historical simulation, we determine the values for the newly exogenous macroeconomic variables in accordance with the base year data for 2010/2011. The general approach when adopting new values for the macroeconomic variables is to swap them with the types of variables shown in Table B.2.

Table B.2: Swaps of naturally exogenous and endogenous variables in the closure for the historical simulation

Newly exogenous variables	Newly endogenous variables
NatMacro("RealGDP")	atot_id
NatMacro("RealGov")	fgovtot_d
NatMacro("ExpVol")	fqexp_csd
NatMacro("RealHou")	shrBoT
NatMacro("RealInv")	invslack
NatMacro("AggEmploy")	labslack

The choice of swapped variables was originally developed and suggested by CoPS staff. Shift variables are generally used to change the demand for various commodities. They are a convenient choice for a swap without assuming price changes over a given time period. With the export quantity determined exogenously, the swap between real private consumption and the balance of trade means that the changes in private consumption might partly be due to the substitution between imported and domestically produced commodities. The newly endogenous variables invslack and labslack can be interpreted as the economy-wide rate of return and the shadow price or proxy value of labour, respectively. The main purpose of these two variables is to make exogenous national investment and aggregated employment, respectively.

We have set their new values of the national macroeconomic variables shown in Table B.2 by specifying for each variable the percentage change from 2005/2006 to 2010/2011 as shown in Table B.3.

Table B.3: Shock values of national macroeconomic variables applied in the historical simulation

TERM model variable	Description	2005/2006	2010/2011	Growth/Shock (%)
NatMacro("RealGDP")	Sum of GDP components	$AU (million) 967,454	$AU (million) 1,321,614	36.6%

TERM model variable	Description	2005/2006	2010/2011	Growth/Shock (%)
NatMacro("RealGov")	Government consumption expenditure	$AU (million) 173,139	$AU (million) 239,545	38.4%
NatMacro("ExpVol")	Exports	$AU (million) 196,274	$AU (million) 254,710	29.8%
NatMacro("RealHou")	Households consumption expenditure	$AU (million) 547,458	$AU (million) 736,733	34.6%
NatMacro("RealInv")	Gross fixed capital formation	$AU (million) 260,765	$AU (million) 370,484	42.1%
NatMacro("AggEmploy")	Hours worked (index)	93.3	103.2	10.6%

The sources for the national macroeconomic variables were the input-output table for 2005/2006 from ABS (2009b), expenditure on GDP table for 2010/2011 and the index of hours worked from the key national accounts aggregates table from the ABS (2011e). Other variables we have set their new values in the historical simulation include the resident population as shown in Table B.4.

Table B.4: Shock values of regional population variables in the historical simulation

Region	Resident Population in the TERM database	Estimated Resident Population as of June 2011	Growth/Shock (%)	TERM model variable
1 SydneyNSW	4,284,379	4,608,949	7.6%	nhou("SydneyNSW")
2 RoNSW	2,532,803	2,609,580	3.0%	nhou("RoNSW")
3 MelbourneVic	3,755,835	4,169,366	11.0%	nhou("MelbourneVic")
4 RoVic	1,359,776	1,368,451	0.6%	nhou("RoVic")
5 BrisbaneQld	2,633,584	2,147,436	-18.5%	nhou("BrisbaneQld")
6 RoQld	1,457,962	2,329,342	59.8%	nhou("RoQld")
7 AdelaideSA	1,146,119	1,264,091	10.3%	nhou("AdelaideSA")
8 RoSA	422,085	375,523	-11.0%	nhou("RoSA")
9 PerthWA	1,519,510	1,833,567	20.7%	nhou("PerthWA")
10 RoWA	539,535	519,842	-3.6%	nhou("RoWA")
11 Tas	489,922	511,483	4.4%	nhou("Tas")
12 NT	210,674	231,292	9.8%	nhou("NT")
13 ACT	333,940	367,985	10.2%	nhou("ACT")

The source for our estimates of the regional population growth was estimated resident population in 2011 from ABS (2013f).

Appendix B.4 Exogenous variables in the short-term closure in TERM

Table B.5 shows the initial list of exogenous variables. In the short-run closure, we have made changes to the initial list according to the economic environment applicable in the construction phase of the NBN. COM stands for commodity, IND for industry, DST for regions of use, ORG for regions of origin, REG for regions of use intersect regions of origin, HOU for household[25], SRC for source (domestic or imported), and OCC for labour skill categories.

Table B.5: Initial exogenous variables in TERM

Variable	Description	Dimension
acap	Capital-augmenting technical change	IND*DST
ahou_s	Taste change, household imported/domestic composite	COM*DST*HOU(1)
alab_o	Labor-augmenting technical change	IND*DST
alnd	Land-augmenting technical change	IND*DST
aprim	Primary-factor-augmenting technical change	IND*DST
atot	All-input-augmenting technical change by industry and region	IND*DST
atot_id	All-input-augmenting technical change	1
atradmar_cs	Technical change: margin m on goods going from regions of origin to regions of use	MAR*ORG*DST
bint_s	Intermediate technical change	COM*IND*DST
bint_scd	Driver: intermediate tech change	IND
delPTXRATE	Change in rate of production tax	IND*DST
fgov	Government demand shifter	COM*SRC*DST
fgovtot2	Government demand shifter	DST
fgovtot_d	Government demand shifter	1
fgov_s	Government demand shifter	COM*DST
fhou	Regional propensity to consume from labour income	DST*HOU(1)
finv1	Investment shift variable	IND*DST
flab	Wage shifter	IND*OCC*DST
flab_io	Wage shifter	DST
flab_iod	National wage shifter	1
fpexp	Export price shift variable	COM*SRC
fqexp	Export quantity shift variable	COM*SRC
fqexp_csd	Export quantity shift variable	1
houslack	Consumption shift variable for national shift in average propensity to consume from labour income	1
invslack	Economy-wide rate of return	1
labslack	Shadow price or proxy value of labour	1
nhou	Number of households	DST
pfimp	Import prices, foreign currency	COM*ORG
phi	Exchange rate, local currency/$world	1
tuser_ud	Tax shifter by commodity	COM*SRC
xcap	Capital usage	IND*DST
xlnd	Land usage	IND*DST

To accommodate the economic environment applicable in the construction phase of the NBN, in addition to the variables shown in Table B.5, we have also made exogenous the following:

- national real investment;
- national real household consumption; and

[25] There was only one aggregated household included in the economic model database we have adopted.

- national real wage.

In the short-term closure, we have swapped previously exogenous variables with newly exogenous variables as shown in Table B.6.

Table B.6: Newly exogenous variables that are swapped with previously exogenous variables in the short-term closure

Newly exogenous variables	Previously exogenous variables
NatMacro("RealInv")	invslack
NatMacro("RealHou")	houslack
NatMacro("AveRealWage")	flab_iod

To accommodate the model simulation of the increase in investment in the NBN wholesale service industry in a typical short-run year, we have modified the distribution of investment between industries. For NBN wholesale service industry (NBNCoSrvcs), we have made the investment shift variable (finv1) endogenous and the investment variable (xinvitot) exogenous. Investment is therefore linked to profits for all industries except NBNCoSrvcs. Table B.7 summarises the newly exogenous variable in the short-term closure.

Table B.7: Description of newly exogenous variables in the short-term closure

Variable	Description	Dimension
NatMacro("RealInv")	Real Investment	1
NatMacro("RealHou")	Real Household Consumption	1
NatMacro("AveRealWage")	Average Real Wage	1
finv1	Investment shift variable	IND(excl. NBNCoSrvcs)*DST
xinvitot	Investment by industry	1

For the short-term model simulation, we have made changes to the values of investment by region (xinvitot) for the NBN wholesale service industry by region using the percentage change values calculated in section 6.4.

Appendix B.5 Exogenous variables in the long-term closure in TERM

In the long-term closure, we have adopted the initial list of exogenous variables shown in Table B.5. To accommodate the economic environment applicable in the mature phase of the NBN, in addition to the variables shown in Table B.5, we have made exogenous the following:

- balance of trade (as a share of GDP);
- sectoral gross rates of return; and
- aggregate employment of labour.

In the long-term closure, we have swapped previously exogenous variables with newly exogenous variables as shown in Table B.8.

Table B.8: Newly exogenous variables that are swapped with previously exogenous variables in the long-term closure

Newly exogenous variables	Previously exogenous variables
shrBoT	houslack
gret	xcap
NatMacro("AggEmploy")	labslack
flabsup	flab_io

To accommodate making aggregate labour exogenous and avoid the problem of a singular matrix, we have swapped the previously exogenous wage shift variable (flab_io) with the labour migration shift variable (flabsup) of the same dimensions, i.e. regions.

Table B.9 summarises the newly exogenous variable in the long-term closure.

Table B.9: Description of newly exogenous variables in the long-term closure

Variable	Description	Dimension (Size)
shrBoT	balance of trade/GDP	1
gret	Gross rate of return	IND*DST
NatMacro("AggEmploy")	Aggregate labour, wage-weighted	1
flabsup	Labour migration shift variable	DST

For the long-term model simulation, we have then changed the values of exogenous variables using the percentage change values calculated in section 6.4.

Appendix B.6 Model variables in TERM

This section includes all variables in TERM. There are variables that have directly matching equations, more than one matching equations, and no matching equations. Table B.10 shows the variables in TERM that have directly matching equations. CONTINC stands for contributors to real income GDP change, MAINMACROS for selected macroeconomic variables, GDPEXPCAT for GDP expenditure categories, GDPINCCAT for GDP income categories, STATEX for aggregated regions or states, COMMACROS for MAINMACROS with commodity components, MAR for margin commodities, e.g. transport, wholesale and retail trade services, FINDEM for final demanders, and TRADDIR for subset of imported commodities used for exports.

Table B.10: Variables that have directly matching equations in TERM

Variable	Description	Dimension (Size)
aint_s	Intermediate technical change	COM*IND*DST
alux	Taste change, supernumerary demands	COM*DST*HOU(1)
asub	Taste change, subsistence demands	COM*DST*HOU(1)
averealwage	Average real wage	DST
avewage	Average nominal wage	DST
contCPI	Contributions by commodity to % regional CPI	COM*DST*HOU(1)
contincagg	Combined contribution terms to national real income GDP	DST*CONTINC
contincagg_d	Contribution terms to national real income GDP	CONTINC

Variable	Description	Dimension (Size)
continccom	Commodity tax contribution terms to national real income GDP	COM*SRC*DST
contincind	Industry contribution terms to national real income GDP	IND*DST*CONTINC
contincind_d	Industry contribution terms to national real income GDP	IND*CONTINC
contMainMacro	Regional contributions to national macro results	MAINMACROS*REG
contnatxtot	Regional contributions to national industry output	IND*DST
contxgdpexp	Contributions to % regional real GDP expenditure	GDPEXPCAT*REG
contxprim_i	Sector contributions to regional GDP at factor cost	IND*DST
delPRIM	change in cost of primary factors	IND*DST
delPTX	Ordinary change in production tax revenue	IND*DST
delTAXexp	change in export commodity tax revenue	COM*SRC*DST
delTAXgov	change in government commodity tax revenue	COM*SRC*DST
delTAXhou	change in household commodity tax revenue	COM*SRC*DST
delTAXint	change in intermediate commodity tax revenue	COM*SRC*IND*DST
delTAXinv	change in investment commodity tax revenue	COM*SRC*DST
fgovtot2	Government demand shifter	REG
fhou	Regional propensity to consume from labour income	DST*HOU(1)
flabsup	Labour migration shifter	DST
ggro	Gross growth rate of capital = Investment/capital	IND*DST
gret	Gross rate of return = Rental/[Price of new capital]	IND*DST
NatComMacro	Sum of contComMacro(c,m)	COMMACROS
NatComMacrox	Sum of contComMacro(c,m)	COMMACROS
natfhou	National ratio, nominal household consumption to GDP	1
NatMacro	National macros for reporting	MAINMACROS
natphouhtot	National CPI by household	HOU(1)
natxhouhtot	National real consumption by household	HOU(1)
natximp	National imports	COM
natxtot	National industry output -- value added weights	IND
nhouh	Number of households	DST*HOU(1)
pbas2r	Basic prices of goods produced(domestic) or landed(imported) in states of origin	COM*SRC*STATEX
pcap	Rental price of capital	IND*DST
pcapSHO	Rental price of capital	IND*DST
pcst	Ex-tax cost of production	IND*DST
pdelivrd	All-user delivered price of good c, sources from regions of origin to regions of use	COM*SRC*ORG*DST
pdomstq	Statewide produced average price	MAR*STATEX
pfin	Final user price indices	FINDEM*DST
pgdpexp	Price index expenditure GDP	DST
phou	Household price of composites	COM*DST
phouhtot	CPI	DST*HOU(1)

Variable	**Description**	**Dimension (Size)**
pimp	Import prices, local currency	COM*ORG
pimplanded	Price index, imports landed in regions of use	ORG
pimpused	Price index, imports used in regions of use	DST
pint	Intermediate effective price indices	IND*DST
pinvest	Purchaser's price of good c for investment in regions of use	COM*DST
pinvitot	Investment price index by industry	IND*DST
plab	Wage rates	IND*OCC*DST
plab_o	Price of labour composite	IND*DST
plnd	Rental price of land	IND*DST
pmake	Price received by industries	COM*IND*REG
pprim	Effective price of primary factor composite	IND*DST
ppur	User (purchasers) prices, incl. margins and taxes	COM*SRC*USR*DST
ppur_s	User prices, average over sources	COM*USR*DST
pREGm	Regional import price index	REG
pRegMst	State import price index	STATEX
pREGx	Regional export price index	REG
pRegXst	State export price index	STATEX
psuppmar_p	Price of composite margin m on goods from regions of origin	MAR*ORG*DST
ptoft	Terms of trade for DST	REG
ptoftSt	Terms of trade for DST	STATEX
ptot	Industry output prices	IND*DST
puse	Delivered price of regional composite good c, sources to regions of use	COM*SRC*DST
pvar	Short-run variable cost of production	IND*DST
shrBoT	National real balance of trade as % of real GDP	1
StateMacro	State macros for reporting	MAINMACROS*STATEX
statextot	State industry output -- value added weights	IND*STATEX
totdem	Total direct demands for goods produced(domestic) or landed(imported) in regions of origin	COM*SRC*ORG
wcap_i	Total rentals to capital	DST
wfin	Final user expenditures	FINDEM*DST
wgdpdiff	nominal (income - expend) GDP	DST
wgdpexp	Nominal expenditure GDP	DST
wgdpinc	Nominal income GDP	DST
whouhtot	Total nominal household consumption	DST*HOU(1)
wlab_i	Total wage bill	OCC*DST
wlab_io	Total wage bill	DST
wlab_o	Wage bills	IND*DST
wlnd_i	Total rentals to land	DST
wlux	Total nominal supernumerary household expenditure	DST*HOU(1)
wprim	Primary factor payments	IND*DST
wprim_i	Total factor payments	DST

Variable	Description	Dimension (Size)
xcapSHO	Capital usage	IND*DST
xcap_i	Aggregate capital, rental-weighted	DST
xdomexp	Amount good c made in regions of origin sent to other domestic regions (non-margin)	COM*REG
xdomexp_c	Amount goods made in regions of origin sent to other domestic regions (non-margin)	REG
xdomimp	Amount domestic good c used in regions of use made in other domestic regions (non-margin)	COM*REG
xdomimp_c	Amount domestic goods used in regions of use made in other domestic regions (non-margin)	REG
xdomloc	Amount good c made in r and used in regions of origin	COM*REG
xexp	Export of all-region composite leaving port at regions of use	COM*SRC*DST
xexpSHO	Export demands for domestic all-region composite leaving port at regions of use	COM*DST
xexp_s	Export demands, domestic+imported	COM*DST
xgdpexp	Real expenditure GDP	DST
xgov	Government demands for all-region composite	COM*SRC*DST
xgov_s	Government demands, domestic+imported	COM*DST
xhou	Household demands for all-region composite	COM*SRC*DST
xhouh_s	Household demands	COM*DST*HOU(1)
xhoutot	Total real household consumption	DST
xhou_s	Household demands for domestic/imported composite	COM*DST
ximplanded	Volume of imports landed in regions of use	ORG
ximps	Volume of imports used in regions of use	COM*DST
ximpused	Volume of imports used in regions of use	DST
xint	Intermediate demands for all-region composite	COM*SRC*IND*DST
xint_i	Total intermediate demand for regional composite commodities, sources in regions of use	COM*SRC*DST
xint_s	Industry demands for domestic/imported composite	COM*IND*DST
xinv	Investment demands for all-region composite	COM*SRC*DST
xinvi	Amount of good c for investment, industry i in regions of use	COM*IND*DST
xinvitot	Investment by industry	IND*DST
xinvitotSHO	Investment by industry	IND*DST
xinv_s	Investment demands for domestic/imported composite	COM*DST
xlab	Labour demands	IND*OCC*DST
xlab_i	Aggregate labour, wage-weighted	OCC*DST
xlab_io	Aggregate labour, wage-weighted	DST
xlab_o	Effective labour input	IND*DST
xlab_oSHO	Effective labour input	IND*DST
xlnd_i	Aggregate land, rental-weighted	DST

Variable	Description	Dimension (Size)
xlocuse_sd	National non-export demand for good c	COM
xlux	Household - supernumerary demands	COM*DST*HOU(1)
xmake	Output of good c by industry i in regions of use	COM*IND*REG
xprim	Primary factor composite	IND*DST
xprim_i	Regional GDP at factor cost (% change)	DST
xrowdem	Eventually exported goods	COM*ORG*DST
xrowdem_d	Eventually exported goods made in regions of origin	COM*ORG
xstocks	Inventories	IND*DST
xsub	Household - subsistence demands	COM*DST*HOU(1)
xsuppmar	Demand for margin commodities m (made in regions of margin production) on goods	MAR*ORG*DST*PRD
xsuppmar_d	Total margins on goods from regions of origin, produced in regions of margin production	MAR*ORG*PRD
xsuppmar_p	Quantity of composite margin m on goods from regions of origin	MAR*ORG*DST
xsuppmar_rd	Total demand for margins produced in regions of margin production	MAR*PRD
xtrad	Quantity of good commodities, sources from regions of origin to regions of use	COM*SRC*ORG*DST
xtradmar	Margin commodities m on good c, sources going from regions of origin to regions of use	COM*SRC*MAR*ORG*DST
xtrad_r	Total demand for regional composite commodities, sources in regions of use	COM*SRC*DST
xtrad_rd	National direct use of goods	COM*SRC

Table B.11 shows the variables in TERM that have more than one matching equations.

Table B.11: Variables that have more than one matching equation in TERM

Variable	Description	Dimension (size)
contTrmsTrad	Contributions to national export and import price indices	COM*REG*TRADDIR
contComMacro	Commodity contributions to national macro results	COM*COMMACROS
delXGDPEXP	Ordinary change in quantity expenditure GDP component	DST*GDPEXPCAT
delPGDPEXP	Ordinary change in price expenditure GDP component	DST*GDPEXPCAT
MainMacro	Convenient macros for reporting	MAINMACROS*REG
delGDPINC	Ordinary change in nominal income GDP component	DST*GDPINCCAT
pbasic	Basic prices	COM*SRC*ORG
xtot	Industry outputs	IND*DST
xfin	Final user quantity indices	FINDEM*DST
xcom	Total output of commodities	COM*DST
pdom	Output prices (basic prices of domestic goods)	COM*ORG

Table B.12 shows the variables in TERM that have no matching equations.

Table B.12: Variables that have no matching equations in TERM

Variable	Description	Dimension (Size)
acap	Capital-augmenting technical change	IND*DST
ahou_s	Taste change, household imported/domestic composite	COM*DST*HOU(1)
alab_o	Labour-augmenting technical change	IND*DST
alnd	Land-augmenting technical change	IND*DST
aprim	Primary-factor-augmenting technical change	IND*DST
atot	All-input-augmenting technical change	IND*DST
atot_id	All-input-augmenting technical change	1
atradmar_cs	Technical change: margin m on goods going from regions of origin to regions of use	MAR*ORG*DST
bint_s	Intermediate technical change	COM*IND*DST
bint_scd	Driver: intermediate technical change	IND
delPTXRATE	Change in rate of production tax	IND*DST
fgov	Government demand shifter	COM*SRC*DST
fgovtot	Government demand shifter	DST
fgovtot_d	Government demand shifter	1
fgov_s	Government demand shifter	COM*DST
flab	Wage shifter	IND*OCC*DST
flab_io	Wage shifter	DST
flab_iod	National wage shifter	1
fpexp	Export price shift variable	COM*SRC
fqexp	Export quantity shift variable	COM*SRC
fqexp_csd	Export quantity shift variable over commodities, sources and regions of use	1
houslack	Consumption shift variable for national shift in average propensity to consume from labour income	1
invslack	Economy-wide rate of return	1
labslack	Shadow price or proxy value of labour	1
nhou	Number of households	DST
pfimp	Import prices, foreign currency	COM*ORG
phi	Exchange rate, local currency/$world	1
tuser_ud	Tax shifter by commodity	COM*SRC
xcap	Capital usage	IND*DST
xhouhtot	Total real household consumption	DST*HOU(1)
xlnd	Land usage	IND*DST

Appendix C Percentage change values for the model simulations in TERM

This section lists the percentage change values used as inputs to TERM in the model short-run and long-run simulations. The equations for estimating the percentage change values used in the model short-run simulation are described in chapter 6.4, and for the model long-run simulation in chapter 6.5.

Appendix C.1 Percentage change values of exogenous variables in the model short-run simulation

NBN Company wholesale service industry investment

Table C.1 shows the percentage change values of NBN wholesale service industry investment by region estimated in equation (11).

Table C.1: Percentage change values of NBN wholesale services industry investment by region

Region	xinvitot (NBNCoSrvcs) (%)
1 SydneyNSW	2000459701912862720%
2 RoNSW	3208488179548028930%
3 MelbourneVic	1914769125763186690%
4 RoVic	2702949225771040770%
5 BrisbaneQld	2528969652617347070%
6 RoQld	3914626432742981630%
7 AdelaideSA	2191771426611003390%
8 RoSA	4099349334011674620%
9 PerthWA	2744111092824276990%
10 RoWA	4992052720207659010%
11 Tas	2334681549942816770%
12 NT	3089749170085429250%
13 ACT	1860586154819059710%

Aggregate investment

The percentage change value we have estimated for national real investment in equation (12) is shown in Table C.2.

Table C.2: Percentage change value of national real investment

Variable name	Change (%)
NatMacro (RealINV)	1.717272%

The percentage change values we have estimated for the model long-run simulations are shown in the following section.

Appendix C.2 Percentage change values of exogenous variables in the model long-run simulations

Debt-servicing repayments

Table C.3 shows the change of national real balance of trade as percentage of real GDP as a result of the debt-servicing repayments estimated in equation (13).

Table C.3: Change of national real balance of trade as percentage of real GDP

Variable name	Change (%)
shrBoT	0.384821983049671%

Table C.4 shows the percentage change values of regional propensity to consume from labour income estimated in equation (14).

Table C.4: Percentage change value of regional propensity to consume from labour income

Region	fhou (%)
1 SydneyNSW	-0.332580%
2 RoNSW	-0.323435%
3 MelbourneVic	-0.338282%
4 RoVic	-0.329630%
5 BrisbaneQld	-0.344849%
6 RoQld	-0.397814%
7 AdelaideSA	-0.346657%
8 RoSA	-0.371160%
9 PerthWA	-0.400066%
10 RoWA	-0.481421%
11 Tas	-0.324498%
12 NT	-0.337163%
13 ACT	-0.294106%

Cloud computing

Tables C.5 to C.30 show the percentage change values we have estimated in equations (14) and (16) for the intermediate technical change variable over all sources (imported and domestic) by commodity, industry and region of use due to cloud computing made more widely available through the NBN.

Table C.5: Intermediate technical change through cloud computing in Sydney, New South Wales, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	- 0.0000020	- 0.0037521	- 0.0000339	- 0.0000067	- 0.0000060	- 0.0000005	- 0.0000103	- 0.0000001	- 0.0000006	- 0.0000002	- 0.0000011	- 0.0000002	- 0.0000216	- 0.0000887	- 0.0003009	- 0.0002834	- 0.0000093	- 0.0000008	- 0.0000071	- 0.0001734	- 0.0006240	- 0.0000222	- 0.0000970
2 Mining	-	- 0.0004411	- 0.0001035	- 0.0000022	- 0.0000039	- 0.0000050	- 0.0000010	- 0.0003295	- 0.0000621	- 0.0004552	- 0.0000021	- 0.0000087	- 0.0001039	- 0.0001418	- 0.0000295	- 0.0002381	- 0.0000609	- 0.0000093	- 0.0000236	- 0.0001942	- 0.0001643	- 0.0004130	- 0.0001471	- 0.0006640
3 FoodDrinkTob	-	- 0.0000019	- 0.0019046	- 0.0000019	- 0.0000108	- 0.0000003	- 0.0000008	- 0.0000131	- 0.0000002	- 0.0000004	- 0.0000006	- 0.0000010	- 0.0000005	- 0.0000127	- 0.0001257	- 0.0028589	- 0.0012736	- 0.0000094	- 0.0000161	- 0.0001327	- 0.0002723	- 0.0012005	- 0.0004585	- 0.0004700
4 TCFs	-	- 0.0000037	- 0.0000306	- 0.0000749	- 0.0000077	- 0.0000368	- 0.0000048	- 0.0000022	- 0.0000012	- 0.0000102	- 0.0000046	- 0.0000061	- 0.0000012	- 0.0006274	- 0.0001516	- 0.0002580	- 0.0000849	- 0.0000474	- 0.0000125	- 0.0001025	- 0.0003198	- 0.0016868	- 0.0005481	- 0.0019926
5 MiscManuf	-	- 0.0000102	- 0.0002984	- 0.0000061	- 0.0000231	- 0.0000087	- 0.0000278	- 0.0000169	- 0.0000019	- 0.0000073	- 0.0000125	- 0.0000243	- 0.0000063	- 0.0003505	- 0.0002306	- 0.0002597	- 0.0001052	- 0.0001139	- 0.0001215	- 0.0010003	- 0.0002601	- 0.0035041	- 0.0004941	- 0.0009935
6 WoodProds	-	- 0.0000036	- 0.0002873	- 0.0000035	- 0.0000037	- 0.0000256	- 0.0000711	- 0.0000091	- 0.0000031	- 0.0000040	- 0.0000048	- 0.0000052	- 0.0000007	- 0.0000925	- 0.0001575	- 0.0002290	- 0.0000843	- 0.0000230	- 0.0000271	- 0.0002227	- 0.0002215	- 0.0029267	- 0.0008135	- 0.0014793
7 PaperPrint	-	- 0.0000037	- 0.0000366	- 0.0000021	- 0.0000031	- 0.0000050	- 0.0000522	- 0.0000031	- 0.0000012	- 0.0000036	- 0.0000023	- 0.0000084	- 0.0000017	- 0.0000726	- 0.0003156	- 0.0013083	- 0.0001973	- 0.0000374	- 0.0001526	- 0.0012562	- 0.0012251	- 0.0056227	- 0.0030027	- 0.0008505
8 ChemCoalPrds	-	- 0.0001908	- 0.0000893	- 0.0000151	- 0.0000631	- 0.0000189	- 0.0000276	- 0.0001370	- 0.0000189	- 0.0000228	- 0.0000123	- 0.0000260	- 0.0000369	- 0.0006119	- 0.0004244	- 0.0006827	- 0.0003109	- 0.0011250	- 0.0000209	- 0.0007801	- 0.0012081	- 0.0030561	- 0.0003440	- 0.0092505
9 NonMetMinPrd	-	- 0.0000044	- 0.0000702	- 0.0000018	- 0.0000020	- 0.0000013	- 0.0000004	- 0.0000024	- 0.0000590	- 0.0000092	- 0.0000055	- 0.0000082	- 0.0000060	- 0.0010614	- 0.0000938	- 0.0001019	- 0.0000199	- 0.0000019	- 0.0000003	- 0.0000021	- 0.0002801	- 0.0003077	- 0.0000324	- 0.0001496
10 MetalPrds	-	- 0.0000744	- 0.0001646	- 0.0000129	- 0.0000220	- 0.0000189	- 0.0000037	- 0.0000088	- 0.0000099	- 0.0002909	- 0.0000598	- 0.0002202	- 0.0000131	- 0.0013386	- 0.0002227	- 0.0003012	- 0.0000932	- 0.0001206	- 0.0000744	- 0.0006268	- 0.0007171	- 0.0032076	- 0.0005118	- 0.0005910
11 TransEqp	-	- 0.0000138	- 0.0000052	- 0.0000005	- 0.0000018	- 0.0000015	- 0.0000006	- 0.0000004	- 0.0000011	- 0.0000012	- 0.0001130	- 0.0000092	- 0.0000004	- 0.0000986	- 0.0001409	- 0.0023344	- 0.0000235	- 0.0006899	- 0.0000503	- 0.0004137	- 0.0001538	- 0.0097652	- 0.0001739	- 0.0000470
12 OthMachEqp	-	- 0.0003152	- 0.0021738	- 0.0000537	- 0.0000491	- 0.0000445	- 0.0000789	- 0.0001731	- 0.0000535	- 0.0002560	- 0.0000720	- 0.0001120	- 0.0001940	- 0.0030794	- 0.0014934	- 0.0037035	- 0.0012230	- 0.0013460	- 0.0003291	- 0.0032866	- 0.0050675	- 0.0231139	- 0.0044850	- 0.0090678
13 EGW	-	- 0.0000457	- 0.0000951	- 0.0000041	- 0.0000044	- 0.0000050	- 0.0000045	- 0.0000068	- 0.0000074	- 0.0000282	- 0.0000055	- 0.0000149	- 0.0004127	- 0.0001396	- 0.0001022	- 0.0004750	- 0.0001660	- 0.0001758	- 0.0000573	- 0.0004714	- 0.0011935	- 0.0018782	- 0.0016714	- 0.0015447
14 Construction	-	- 0.0001139	- 0.0000251	- 0.0000021	- 0.0000012	- 0.0000006	- 0.0000014	- 0.0000128	- 0.0000006	- 0.0000037	- 0.0000010	- 0.0000046	- 0.0000550	- 0.0053545	- 0.0003814	- 0.0003271	- 0.0001114	- 0.0001947	- 0.0002349	- 0.0019335	- 0.0016303	- 0.0129238	- 0.0000370	- 0.0001663
15 WholesalTrad	-	- 0.0015404	- 0.0106243	- 0.0002624	- 0.0002402	- 0.0002174	- 0.0003858	- 0.0008462	- 0.0002617	- 0.0012512	- 0.0003518	- 0.0005476	- 0.0009481	- 0.0150504	- 0.0072988	- 0.0181008	- 0.0059772	- 0.0065785	- 0.0016087	- 0.0160633	- 0.0247674	- 0.1129687	- 0.0219201	- 0.0443189
16 RetailTrade	-	- 0.0000125	- 0.0000609	- 0.0000022	- 0.0000019	- 0.0000025	- 0.0000105	- 0.0000033	- 0.0000008	- 0.0000016	- 0.0000007	- 0.0000031	- 0.0000053	- 0.0001318	- 0.0003330	- 0.0010743	- 0.0001914	- 0.0005742	- 0.0001033	- 0.0008508	- 0.0010333	- 0.0017177	- 0.0003727	- 0.0013369
17 RecPersSrvc	-	- 0.0000265	- 0.0002336	- 0.0000040	- 0.0000032	- 0.0000034	- 0.0000208	- 0.0000139	- 0.0000037	- 0.0000088	- 0.0000088	- 0.0000121	- 0.0000092	- 0.0001313	- 0.0003288	- 0.0009380	- 0.0008801	- 0.0001584	- 0.0000919	- 0.0009599	- 0.0043366	- 0.0064703	- 0.0026554	- 0.0053195
18 Transport	-	- 0.0001187	- 0.0002433	- 0.0000141	- 0.0000082	- 0.0000113	- 0.0000263	- 0.0000170	- 0.0000106	- 0.0000269	- 0.0000084	- 0.0000226	- 0.0000062	- 0.0002757	- 0.0019041	- 0.0005056	- 0.0001266	- 0.0010900	- 0.0000869	- 0.0014365	- 0.0021985	- 0.0107337	- 0.0012113	- 0.0014254
19 PostalSrvcs	-	- 0.0000007	- 0.0000123	- 0.0000005	- 0.0000007	- 0.0000004	- 0.0000060	- 0.0000004	- 0.0000006	- 0.0000011	- 0.0000006	- 0.0000032	- 0.0000007	- 0.0000157	- 0.0000505	- 0.0002677	- 0.0000811	- 0.0000233	- 0.0000390	- 0.0003211	- 0.0004326	- 0.0014274	- 0.0003920	- 0.0010355
20 Telecomms	-	- 0.0056758	- 0.0391472	- 0.0009668	- 0.0008851	- 0.0008011	- 0.0014217	- 0.0031181	- 0.0009642	- 0.0046104	- 0.0012962	- 0.0020178	- 0.0034935	- 0.0554560	- 0.0268939	- 0.0666959	- 0.0220241	- 0.0242397	- 0.0059276	- 0.0591883	- 0.0912599	- 0.4162543	- 0.0807688	- 0.1633012
21 FinBusSrvces	-	- 0.0026993	- 0.0186180	- 0.0004598	- 0.0004209	- 0.0003810	- 0.0006761	- 0.0014830	- 0.0004586	- 0.0021926	- 0.0006164	- 0.0009597	- 0.0016615	- 0.0263743	- 0.0127905	- 0.0317199	- 0.0104744	- 0.0115281	- 0.0028191	- 0.0281493	- 0.0434023	- 0.1979662	- 0.0384128	- 0.0776644
22 PubAdmDef	-	- 0.0000094	- 0.0000197	- 0.0000005	- 0.0000005	- 0.0000010	- 0.0000071	- 0.0000032	- 0.0000004	- 0.0000017	- 0.0000021	- 0.0000013	- 0.0000014	- 0.0000836	- 0.0000328	- 0.0001501	- 0.0000180	- 0.0001574	- 0.0000084	- 0.0004187	- 0.0005728	- 0.0099503	- 0.0006500	- 0.0007022
23 Education	-	- 0.0000053	- 0.0000244	- 0.0000013	- 0.0000008	- 0.0000006	- 0.0000021	- 0.0000023	- 0.0000011	- 0.0000020	- 0.0000016	- 0.0000045	- 0.0000050	- 0.0000132	- 0.0000108	- 0.0000935	- 0.0000754	- 0.0000492	- 0.0000070	- 0.0000574	- 0.0009838	- 0.0014500	- 0.0017636	- 0.0005017
24 Community	-	- 0.0000000	- 0.0000094	- 0.0000007	- 0.0000001	- 0.0000001	- 0.0000020	- 0.0000022	- 0.0000000	- 0.0000000	- 0.0000009	- 0.0000002	- 0.0000001	- 0.0000015	- 0.0000045	- 0.0000160	- 0.0000133	- 0.0000130	- 0.0000020	- 0.0001007	- 0.0000280	- 0.0005223	- 0.0001024	- 0.0025277

Table C.6: Intermediate technical change through cloud computing in Rest of New South Wales, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	- 0.0000018	- 0.0026734	- 0.0000317	- 0.0000063	- 0.0000056	- 0.0000005	- 0.0000096	- 0.0000001	- 0.0000005	- 0.0000002	- 0.0000010	- 0.0000001	- 0.0000239	- 0.0000965	- 0.0002913	- 0.0002084	- 0.0000135	- 0.0000011	- 0.0000027	- 0.0001248	- 0.0002803	- 0.0000122	- 0.0000710
2 Mining	-	- 0.0004127	- 0.0000738	- 0.0000021	- 0.0000036	- 0.0000046	- 0.0000010	- 0.0003082	- 0.0000581	- 0.0004258	- 0.0000019	- 0.0000081	- 0.0000452	- 0.0001571	- 0.0000321	- 0.0002306	- 0.0000448	- 0.0000135	- 0.0000343	- 0.0000746	- 0.0001182	- 0.0001855	- 0.0000809	- 0.0004860
3 FoodDrinkTob	-	- 0.0000018	- 0.0013570	- 0.0000018	- 0.0000101	- 0.0000003	- 0.0000007	- 0.0000123	- 0.0000002	- 0.0000004	- 0.0000005	- 0.0000009	- 0.0000002	- 0.0000140	- 0.0001367	- 0.0027680	- 0.0009363	- 0.0000138	- 0.0000235	- 0.0000510	- 0.0001959	- 0.0005392	- 0.0002522	- 0.0003440
4 TCFs	-	- 0.0000035	- 0.0000218	- 0.0000700	- 0.0000072	- 0.0000345	- 0.0000045	- 0.0000021	- 0.0000011	- 0.0000095	- 0.0000043	- 0.0000057	- 0.0000005	- 0.0006950	- 0.0001650	- 0.0002498	- 0.0000624	- 0.0000690	- 0.0000181	- 0.0000394	- 0.0002301	- 0.0007577	- 0.0003015	- 0.0014584
5 MiscManuf	-	- 0.0000096	- 0.0002126	- 0.0000057	- 0.0000216	- 0.0000082	- 0.0000260	- 0.0000158	- 0.0000017	- 0.0000069	- 0.0000117	- 0.0000227	- 0.0000027	- 0.0003882	- 0.0002509	- 0.0002514	- 0.0000773	- 0.0001658	- 0.0001769	- 0.0003842	- 0.0001871	- 0.0015740	- 0.0002718	- 0.0007272
6 WoodProds	-	- 0.0000034	- 0.0002047	- 0.0000033	- 0.0000034	- 0.0000240	- 0.0000665	- 0.0000085	- 0.0000029	- 0.0000038	- 0.0000044	- 0.0000048	- 0.0000003	- 0.0001024	- 0.0001714	- 0.0002217	- 0.0000620	- 0.0000334	- 0.0000394	- 0.0000855	- 0.0001594	- 0.0013146	- 0.0004474	- 0.0010827
7 PaperPrint	-	- 0.0000034	- 0.0000261	- 0.0000019	- 0.0000029	- 0.0000047	- 0.0000488	- 0.0000029	- 0.0000011	- 0.0000033	- 0.0000021	- 0.0000079	- 0.0000007	- 0.0000805	- 0.0003434	- 0.0012667	- 0.0001450	- 0.0000544	- 0.0002221	- 0.0004826	- 0.0008816	- 0.0025256	- 0.0016516	- 0.0006225
8 ChemCoalPrds	-	- 0.0001785	- 0.0000636	- 0.0000141	- 0.0000590	- 0.0000176	- 0.0000258	- 0.0001281	- 0.0000177	- 0.0000213	- 0.0000115	- 0.0000243	- 0.0000160	- 0.0006777	- 0.0004617	- 0.0006610	- 0.0002285	- 0.0016373	- 0.0000304	- 0.0002997	- 0.0008694	- 0.0013728	- 0.0001892	- 0.0067707
9 NonMetMinPrd	-	- 0.0000041	- 0.0000501	- 0.0000017	- 0.0000019	- 0.0000012	- 0.0000003	- 0.0000023	- 0.0000552	- 0.0000086	- 0.0000052	- 0.0000077	- 0.0000026	- 0.0011756	- 0.0001021	- 0.0000986	- 0.0000146	- 0.0000027	- 0.0000004	- 0.0000008	- 0.0002016	- 0.0001382	- 0.0000178	- 0.0001095
10 MetalPrds	-	- 0.0000696	- 0.0001173	- 0.0000120	- 0.0000206	- 0.0000176	- 0.0000035	- 0.0000083	- 0.0000092	- 0.0002721	- 0.0000559	- 0.0002060	- 0.0000057	- 0.0014827	- 0.0002423	- 0.0002917	- 0.0000685	- 0.0001755	- 0.0001083	- 0.0002408	- 0.0005160	- 0.0014408	- 0.0002815	- 0.0004325
11 TransEqp	-	- 0.0000129	- 0.0000037	- 0.0000005	- 0.0000017	- 0.0000014	- 0.0000006	- 0.0000003	- 0.0000010	- 0.0000012	- 0.0001057	- 0.0000086	- 0.0000002	- 0.0001092	- 0.0001533	- 0.0022602	- 0.0000173	- 0.0010040	- 0.0000732	- 0.0001589	- 0.0001107	- 0.0043864	- 0.0000957	- 0.0000344
12 OthMachEqp	-	- 0.0002948	- 0.0015488	- 0.0000502	- 0.0000460	- 0.0000416	- 0.0000738	- 0.0001620	- 0.0000501	- 0.0002395	- 0.0000673	- 0.0001048	- 0.0000843	- 0.0034109	- 0.0016248	- 0.0035858	- 0.0008991	- 0.0019589	- 0.0004790	- 0.0012625	- 0.0036466	- 0.0103824	- 0.0024669	- 0.0066370
13 EGW	-	- 0.0000427	- 0.0000678	- 0.0000039	- 0.0000042	- 0.0000047	- 0.0000042	- 0.0000063	- 0.0000069	- 0.0000264	- 0.0000052	- 0.0000140	- 0.0001794	- 0.0001547	- 0.0001112	- 0.0004599	- 0.0001221	- 0.0002559	- 0.0000833	- 0.0001811	- 0.0008589	- 0.0008437	- 0.0009194	- 0.0011306
14 Construction	-	- 0.0001066	- 0.0000178	- 0.0000020	- 0.0000011	- 0.0000006	- 0.0000013	- 0.0000120	- 0.0000005	- 0.0000034	- 0.0000009	- 0.0000043	- 0.0000239	- 0.0059310	- 0.0004150	- 0.0003167	- 0.0000819	- 0.0002833	- 0.0003418	- 0.0007427	- 0.0011732	- 0.0058052	- 0.0000203	- 0.0001217
15 WholesalTrad	-	- 0.0014410	- 0.0075699	- 0.0002455	- 0.0002247	- 0.0002034	- 0.0003609	- 0.0007916	- 0.0002448	- 0.0011705	- 0.0003291	- 0.0005123	- 0.0004122	- 0.0166706	- 0.0079411	- 0.0175255	- 0.0043944	- 0.0095741	- 0.0023413	- 0.0061705	- 0.0178227	- 0.0507437	- 0.0120571	- 0.0324382
16 RetailTrade	-	- 0.0000117	- 0.0000434	- 0.0000021	- 0.0000018	- 0.0000023	- 0.0000099	- 0.0000031	- 0.0000008	- 0.0000015	- 0.0000006	- 0.0000029	- 0.0000023	- 0.0001460	- 0.0003623	- 0.0010401	- 0.0001407	- 0.0008357	- 0.0001504	- 0.0003268	- 0.0007436	- 0.0007716	- 0.0002050	- 0.0009785
17 RecPersSrvc	-	- 0.0000248	- 0.0001664	- 0.0000037	- 0.0000030	- 0.0000031	- 0.0000195	- 0.0000130	- 0.0000035	- 0.0000082	- 0.0000083	- 0.0000114	- 0.0000040	- 0.0001454	- 0.0003578	- 0.0009081	- 0.0006471	- 0.0002306	- 0.0001337	- 0.0003687	- 0.0031206	- 0.0029063	- 0.0014606	- 0.0038935
18 Transport	-	- 0.0001110	- 0.0001733	- 0.0000132	- 0.0000076	- 0.0000106	- 0.0000246	- 0.0000159	- 0.0000099	- 0.0000252	- 0.0000079	- 0.0000211	- 0.0000027	- 0.0003054	- 0.0020717	- 0.0004896	- 0.0000931	- 0.0015864	- 0.0001264	- 0.0005518	- 0.0015820	- 0.0048214	- 0.0006663	- 0.0010433
19 PostalSrvcs	-	- 0.0000007	- 0.0000088	- 0.0000005	- 0.0000007	- 0.0000003	- 0.0000056	- 0.0000004	- 0.0000006	- 0.0000010	- 0.0000005	- 0.0000030	- 0.0000003	- 0.0000174	- 0.0000549	- 0.0002592	- 0.0000596	- 0.0000339	- 0.0000568	- 0.0001233	- 0.0003113	- 0.0006412	- 0.0002156	- 0.0007579
20 Telecomms	-	- 0.0053096	- 0.0278929	- 0.0009044	- 0.0008280	- 0.0007494	- 0.0013299	- 0.0029170	- 0.0009020	- 0.0043129	- 0.0012125	- 0.0018876	- 0.0015187	- 0.0614259	- 0.0292606	- 0.0645758	- 0.0161922	- 0.0352776	- 0.0086268	- 0.0227362	- 0.0656711	- 0.1869747	- 0.0444266	- 0.1195246
21 FinBusSrvces	-	- 0.0025252	- 0.0132656	- 0.0004301	- 0.0003938	- 0.0003564	- 0.0006325	- 0.0013873	- 0.0004290	- 0.0020512	- 0.0005767	- 0.0008977	- 0.0007223	- 0.0292135	- 0.0139160	- 0.0307116	- 0.0077008	- 0.0167777	- 0.0041028	- 0.0108131	- 0.0312325	- 0.0889232	- 0.0211288	- 0.0568447
22 PubAdmDef	-	- 0.0000088	- 0.0000140	- 0.0000005	- 0.0000005	- 0.0000009	- 0.0000066	- 0.0000030	- 0.0000004	- 0.0000016	- 0.0000019	- 0.0000012	- 0.0000006	- 0.0000926	- 0.0000357	- 0.0001453	- 0.0000132	- 0.0002290	- 0.0000122	- 0.0001608	- 0.0004122	- 0.0044695	- 0.0003575	- 0.0005139
23 Education	-	- 0.0000050	- 0.0000174	- 0.0000012	- 0.0000007	- 0.0000005	- 0.0000019	- 0.0000021	- 0.0000011	- 0.0000019	- 0.0000015	- 0.0000042	- 0.0000022	- 0.0000146	- 0.0000118	- 0.0000905	- 0.0000554	- 0.0000716	- 0.0000102	- 0.0000221	- 0.0007079	- 0.0006513	- 0.0009700	- 0.0003672
24 Community	-	- 0.0000000	- 0.0000067	- 0.0000006	- 0.0000001	- 0.0000001	- 0.0000019	- 0.0000021	- 0.0000000	- 0.0000000	- 0.0000009	- 0.0000002	- 0.0000000	- 0.0000017	- 0.0000048	- 0.0000155	- 0.0000098	- 0.0000189	- 0.0000029	- 0.0000387	- 0.0000202	- 0.0002346	- 0.0000563	- 0.0018501

Table C.7: Intermediate technical change through cloud computing in Melbourne, Victoria, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000022	-0.0056170	-0.0000384	-0.0000076	-0.0000068	-0.0000006	-0.0000117	-0.0000001	-0.0000006	-0.0000002	-0.0000013	-0.0000001	-0.0000216	-0.0000905	-0.0003002	-0.0001677	-0.0000109	-0.0000009	-0.0000060	-0.0001875	-0.0004022	-0.0000195	-0.0000863
2 Mining	-	-0.0005002	-0.0001550	-0.0000025	-0.0000044	-0.0000056	-0.0000012	-0.0003736	-0.0000704	-0.0005161	-0.0000023	-0.0000098	-0.0000893	-0.0001419	-0.0000301	-0.0002376	-0.0000360	-0.0000110	-0.0000278	-0.0001643	-0.0001777	-0.0002662	-0.0001292	-0.0005907
3 FoodDrinkTob	-	-0.0000022	-0.0028512	-0.0000022	-0.0000123	-0.0000003	-0.0000009	-0.0000149	-0.0000002	-0.0000004	-0.0000007	-0.0000011	-0.0000004	-0.0000127	-0.0001282	-0.0028524	-0.0007536	-0.0000111	-0.0000190	-0.0001123	-0.0002944	-0.0007739	-0.0004026	-0.0004182
4 TCFs	-	-0.0000042	-0.0000459	-0.0000849	-0.0000087	-0.0000418	-0.0000054	-0.0000025	-0.0000014	-0.0000115	-0.0000052	-0.0000070	-0.0000011	-0.0006276	-0.0001547	-0.0002574	-0.0000502	-0.0000559	-0.0000147	-0.0000867	-0.0003458	-0.0010873	-0.0004813	-0.0017728
5 MiscManuf	-	-0.0000116	-0.0004467	-0.0000070	-0.0000262	-0.0000099	-0.0000316	-0.0000192	-0.0000021	-0.0000083	-0.0000142	-0.0000275	-0.0000054	-0.0003506	-0.0002352	-0.0002591	-0.0000623	-0.0001343	-0.0001433	-0.0008461	-0.0002812	-0.0022589	-0.0004339	-0.0008839
6 WoodProds	-	-0.0000041	-0.0004300	-0.0000040	-0.0000041	-0.0000290	-0.0000806	-0.0000103	-0.0000036	-0.0000046	-0.0000054	-0.0000059	-0.0000006	-0.0000925	-0.0001606	-0.0002284	-0.0000499	-0.0000271	-0.0000319	-0.0001884	-0.0002396	-0.0018866	-0.0007144	-0.0013161
7 PaperPrint	-	-0.0000042	-0.0000548	-0.0000024	-0.0000035	-0.0000057	-0.0000592	-0.0000035	-0.0000014	-0.0000040	-0.0000026	-0.0000096	-0.0000014	-0.0000727	-0.0003219	-0.0013053	-0.0001167	-0.0000441	-0.0001800	-0.0010626	-0.0013247	-0.0036246	-0.0026369	-0.0007566
8 ChemCoalPrds	-	-0.0002163	-0.0001336	-0.0000171	-0.0000715	-0.0000214	-0.0000313	-0.0001553	-0.0000215	-0.0000258	-0.0000140	-0.0000295	-0.0000317	-0.0006120	-0.0004328	-0.0006811	-0.0001839	-0.0013268	-0.0000246	-0.0006599	-0.0013064	-0.0019701	-0.0003021	-0.0082301
9 NonMetMinPrd	-	-0.0000050	-0.0001052	-0.0000021	-0.0000023	-0.0000015	-0.0000004	-0.0000028	-0.0000669	-0.0000104	-0.0000063	-0.0000093	-0.0000052	-0.0010616	-0.0000957	-0.0001017	-0.0000118	-0.0000022	-0.0000003	-0.0000018	-0.0003029	-0.0001984	-0.0000285	-0.0001331
10 MetalPrds	-	-0.0000844	-0.0002464	-0.0000146	-0.0000250	-0.0000214	-0.0000042	-0.0000100	-0.0000112	-0.0003298	-0.0000678	-0.0002497	-0.0000113	-0.0013389	-0.0002271	-0.0003005	-0.0000551	-0.0001422	-0.0000877	-0.0005302	-0.0007754	-0.0020677	-0.0004494	-0.0005258
11 TransEqp	-	-0.0000157	-0.0000078	-0.0000006	-0.0000020	-0.0000017	-0.0000007	-0.0000004	-0.0000012	-0.0000014	-0.0001281	-0.0000104	-0.0000003	-0.0000986	-0.0001437	-0.0023291	-0.0000139	-0.0008136	-0.0000593	-0.0003500	-0.0001664	-0.0062950	-0.0001527	-0.0000418
12 OthMachEqp	-	-0.0003574	-0.0032542	-0.0000609	-0.0000557	-0.0000504	-0.0000895	-0.0001963	-0.0000607	-0.0002903	-0.0000816	-0.0001270	-0.0001668	-0.0030801	-0.0015232	-0.0036951	-0.0007236	-0.0015875	-0.0003882	-0.0027801	-0.0054798	-0.0149000	-0.0039385	-0.0080676
13 EGW	-	-0.0000518	-0.0001424	-0.0000047	-0.0000050	-0.0000057	-0.0000051	-0.0000077	-0.0000084	-0.0000319	-0.0000063	-0.0000169	-0.0003548	-0.0001397	-0.0001042	-0.0004740	-0.0000982	-0.0002073	-0.0000675	-0.0003987	-0.0012907	-0.0012107	-0.0014678	-0.0013743
14 Construction	-	-0.0001292	-0.0000375	-0.0000024	-0.0000014	-0.0000007	-0.0000016	-0.0000145	-0.0000006	-0.0000041	-0.0000011	-0.0000052	-0.0000473	-0.0053558	-0.0003891	-0.0003263	-0.0000659	-0.0002296	-0.0002770	-0.0016355	-0.0017629	-0.0083311	-0.0000325	-0.0001480
15 WholesalTrad	-	-0.0017466	-0.0159047	-0.0002975	-0.0002724	-0.0002465	-0.0004375	-0.0009595	-0.0002967	-0.0014187	-0.0003989	-0.0006209	-0.0008151	-0.0150539	-0.0074448	-0.0180595	-0.0035368	-0.0077586	-0.0018973	-0.0135877	-0.0267825	-0.0728235	-0.0192492	-0.0394303
16 RetailTrade	-	-0.0000142	-0.0000911	-0.0000025	-0.0000021	-0.0000028	-0.0000119	-0.0000037	-0.0000009	-0.0000018	-0.0000007	-0.0000035	-0.0000046	-0.0001319	-0.0003397	-0.0010718	-0.0001132	-0.0006772	-0.0001219	-0.0007197	-0.0011174	-0.0011073	-0.0003273	-0.0011894
17 RecPersSrvc	-	-0.0000300	-0.0003497	-0.0000045	-0.0000036	-0.0000038	-0.0000236	-0.0000157	-0.0000042	-0.0000100	-0.0000100	-0.0000138	-0.0000079	-0.0001313	-0.0003354	-0.0009358	-0.0005208	-0.0001868	-0.0001083	-0.0008120	-0.0046894	-0.0041710	-0.0023319	-0.0047328
18 Transport	-	-0.0001346	-0.0003642	-0.0000160	-0.0000092	-0.0000129	-0.0000298	-0.0000193	-0.0000120	-0.0000305	-0.0000095	-0.0000256	-0.0000054	-0.0002758	-0.0019422	-0.0005045	-0.0000749	-0.0012856	-0.0001024	-0.0012151	-0.0023773	-0.0069193	-0.0010637	-0.0012682
19 PostalSrvcs	-	-0.0000008	-0.0000184	-0.0000006	-0.0000008	-0.0000004	-0.0000068	-0.0000005	-0.0000007	-0.0000012	-0.0000007	-0.0000036	-0.0000006	-0.0000157	-0.0000515	-0.0002671	-0.0000480	-0.0000275	-0.0000460	-0.0002716	-0.0004678	-0.0009202	-0.0003442	-0.0009213
20 Telecomms	-	-0.0064355	-0.0586040	-0.0010962	-0.0010036	-0.0009084	-0.0016120	-0.0035355	-0.0010933	-0.0052275	-0.0014697	-0.0022879	-0.0030034	-0.0554691	-0.0274317	-0.0665436	-0.0130321	-0.0285881	-0.0069910	-0.0500663	-0.0986851	-0.2683317	-0.0709272	-0.1452883
21 FinBusSrvces	-	-0.0030607	-0.0278714	-0.0005213	-0.0004773	-0.0004320	-0.0007666	-0.0016815	-0.0005199	-0.0024861	-0.0006990	-0.0010881	-0.0014284	-0.0263805	-0.0130462	-0.0316475	-0.0061979	-0.0135962	-0.0033248	-0.0238110	-0.0469336	-0.1276157	-0.0337322	-0.0690976
22 PubAdmDef	-	-0.0000106	-0.0000295	-0.0000006	-0.0000006	-0.0000011	-0.0000080	-0.0000036	-0.0000005	-0.0000019	-0.0000023	-0.0000014	-0.0000012	-0.0000836	-0.0000335	-0.0001497	-0.0000107	-0.0001856	-0.0000099	-0.0003542	-0.0006194	-0.0064143	-0.0005708	-0.0006247
23 Education	-	-0.0000060	-0.0000366	-0.0000015	-0.0000009	-0.0000007	-0.0000023	-0.0000026	-0.0000013	-0.0000023	-0.0000018	-0.0000050	-0.0000043	-0.0000132	-0.0000110	-0.0000932	-0.0000446	-0.0000581	-0.0000082	-0.0000486	-0.0010638	-0.0009347	-0.0015487	-0.0004464
24 Community	-	-0.0000000	-0.0000140	-0.0000008	-0.0000001	-0.0000001	-0.0000023	-0.0000025	-0.0000000	-0.0000001	-0.0000010	-0.0000002	-0.0000001	-0.0000015	-0.0000045	-0.0000160	-0.0000079	-0.0000153	-0.0000024	-0.0000852	-0.0000303	-0.0003367	-0.0000899	-0.0022489

Table C.8: Intermediate technical change through cloud computing in Rest of Victoria, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000021	-0.0034613	-0.0000363	-0.0000072	-0.0000064	-0.0000005	-0.0000110	-0.0000001	-0.0000006	-0.0000002	-0.0000012	-0.0000001	-0.0000263	-0.0000816	-0.0003217	-0.0001446	-0.0000169	-0.0000014	-0.0000035	-0.0001377	-0.0002683	-0.0000099	-0.0000613
2 Mining	-	-0.0004726	-0.0000955	-0.0000024	-0.0000042	-0.0000053	-0.0000011	-0.0003529	-0.0000665	-0.0004876	-0.0000022	-0.0000093	-0.0000541	-0.0001725	-0.0000272	-0.0002546	-0.0000311	-0.0000170	-0.0000430	-0.0000957	-0.0001305	-0.0001776	-0.0000658	-0.0004194
3 FoodDrinkTob	-	-0.0000020	-0.0017570	-0.0000020	-0.0000116	-0.0000003	-0.0000008	-0.0000141	-0.0000002	-0.0000004	-0.0000006	-0.0000011	-0.0000002	-0.0000154	-0.0001157	-0.0030566	-0.0006499	-0.0000172	-0.0000294	-0.0000654	-0.0002163	-0.0005163	-0.0002051	-0.0002969
4 TCFs	-	-0.0000040	-0.0000283	-0.0000802	-0.0000082	-0.0000395	-0.0000051	-0.0000024	-0.0000013	-0.0000109	-0.0000049	-0.0000066	-0.0000007	-0.0007630	-0.0001395	-0.0002758	-0.0000433	-0.0000865	-0.0000227	-0.0000505	-0.0002540	-0.0007254	-0.0002452	-0.0012586
5 MiscManuf	-	-0.0000110	-0.0002753	-0.0000066	-0.0000248	-0.0000094	-0.0000298	-0.0000181	-0.0000020	-0.0000079	-0.0000134	-0.0000260	-0.0000033	-0.0004262	-0.0002122	-0.0002776	-0.0000537	-0.0002077	-0.0002217	-0.0004931	-0.0002066	-0.0015069	-0.0002210	-0.0006275
6 WoodProds	-	-0.0000039	-0.0002650	-0.0000037	-0.0000039	-0.0000274	-0.0000762	-0.0000097	-0.0000034	-0.0000043	-0.0000051	-0.0000055	-0.0000004	-0.0001125	-0.0001449	-0.0002448	-0.0000430	-0.0000419	-0.0000493	-0.0001098	-0.0001760	-0.0012586	-0.0003639	-0.0009344
7 PaperPrint	-	-0.0000039	-0.0000338	-0.0000022	-0.0000033	-0.0000054	-0.0000559	-0.0000033	-0.0000013	-0.0000038	-0.0000025	-0.0000090	-0.0000009	-0.0000883	-0.0002905	-0.0013987	-0.0001007	-0.0000681	-0.0002783	-0.0006193	-0.0009730	-0.0024180	-0.0013432	-0.0005372
8 ChemCoalPrds	-	-0.0002044	-0.0000823	-0.0000162	-0.0000676	-0.0000202	-0.0000295	-0.0001467	-0.0000203	-0.0000244	-0.0000132	-0.0000279	-0.0000192	-0.0007441	-0.0003906	-0.0007299	-0.0001586	-0.0020517	-0.0000380	-0.0003846	-0.0009596	-0.0013143	-0.0001539	-0.0058428
9 NonMetMinPrd	-	-0.0000047	-0.0000648	-0.0000019	-0.0000021	-0.0000014	-0.0000004	-0.0000026	-0.0000632	-0.0000099	-0.0000059	-0.0000088	-0.0000031	-0.0012907	-0.0000864	-0.0001089	-0.0000102	-0.0000034	-0.0000005	-0.0000010	-0.0002225	-0.0001323	-0.0000145	-0.0000945
10 MetalPrds	-	-0.0000797	-0.0001518	-0.0000138	-0.0000236	-0.0000202	-0.0000040	-0.0000095	-0.0000106	-0.0003116	-0.0000640	-0.0002359	-0.0000068	-0.0016278	-0.0002049	-0.0003221	-0.0000475	-0.0002199	-0.0001357	-0.0003090	-0.0005695	-0.0013794	-0.0002289	-0.0003733
11 TransEqp	-	-0.0000148	-0.0000048	-0.0000005	-0.0000019	-0.0000016	-0.0000007	-0.0000004	-0.0000011	-0.0000013	-0.0001210	-0.0000099	-0.0000002	-0.0001199	-0.0001296	-0.0024958	-0.0000120	-0.0012581	-0.0000917	-0.0002040	-0.0001222	-0.0041995	-0.0000778	-0.0000297
12 OthMachEqp	-	-0.0003376	-0.0020053	-0.0000575	-0.0000526	-0.0000477	-0.0000846	-0.0001855	-0.0000574	-0.0002742	-0.0000771	-0.0001200	-0.0001011	-0.0037447	-0.0013744	-0.0039596	-0.0006240	-0.0024547	-0.0006003	-0.0016202	-0.0040249	-0.0099402	-0.0020062	-0.0057275
13 EGW	-	-0.0000489	-0.0000878	-0.0000044	-0.0000048	-0.0000054	-0.0000048	-0.0000073	-0.0000079	-0.0000302	-0.0000059	-0.0000160	-0.0002150	-0.0001698	-0.0000940	-0.0005079	-0.0000847	-0.0003206	-0.0001044	-0.0002324	-0.0009480	-0.0008077	-0.0007477	-0.0009757
14 Construction	-	-0.0001221	-0.0000231	-0.0000023	-0.0000013	-0.0000007	-0.0000015	-0.0000137	-0.0000006	-0.0000039	-0.0000010	-0.0000049	-0.0000286	-0.0065114	-0.0003510	-0.0003497	-0.0000569	-0.0003550	-0.0004283	-0.0009532	-0.0012949	-0.0055579	-0.0000165	-0.0001050
15 WholesalTrad	-	-0.0016501	-0.0098009	-0.0002811	-0.0002573	-0.0002329	-0.0004133	-0.0009065	-0.0002803	-0.0013404	-0.0003768	-0.0005867	-0.0004939	-0.0183020	-0.0067173	-0.0193526	-0.0030500	-0.0119972	-0.0029338	-0.0079187	-0.0196718	-0.0485826	-0.0098054	-0.0279928
16 RetailTrade	-	-0.0000134	-0.0000561	-0.0000024	-0.0000020	-0.0000026	-0.0000113	-0.0000035	-0.0000009	-0.0000017	-0.0000007	-0.0000033	-0.0000028	-0.0001603	-0.0003065	-0.0011485	-0.0000977	-0.0010472	-0.0001885	-0.0004194	-0.0008208	-0.0007387	-0.0001667	-0.0008444
17 RecPersSrvc	-	-0.0000284	-0.0002155	-0.0000042	-0.0000034	-0.0000036	-0.0000223	-0.0000148	-0.0000040	-0.0000094	-0.0000095	-0.0000130	-0.0000048	-0.0001597	-0.0003026	-0.0010028	-0.0004491	-0.0002889	-0.0001675	-0.0004732	-0.0034444	-0.0027826	-0.0011878	-0.0033599
18 Transport	-	-0.0001271	-0.0002244	-0.0000151	-0.0000087	-0.0000121	-0.0000281	-0.0000183	-0.0000113	-0.0000288	-0.0000090	-0.0000242	-0.0000032	-0.0003353	-0.0017524	-0.0005406	-0.0000646	-0.0019879	-0.0001584	-0.0007081	-0.0017462	-0.0046161	-0.0005418	-0.0009003
19 PostalSrvcs	-	-0.0000008	-0.0000113	-0.0000006	-0.0000008	-0.0000004	-0.0000064	-0.0000004	-0.0000006	-0.0000011	-0.0000006	-0.0000034	-0.0000003	-0.0000191	-0.0000465	-0.0002863	-0.0000414	-0.0000425	-0.0000711	-0.0001583	-0.0003436	-0.0006139	-0.0001753	-0.0006541
20 Telecomms	-	-0.0060802	-0.0361131	-0.0010357	-0.0009481	-0.0008582	-0.0015230	-0.0033403	-0.0010329	-0.0049389	-0.0013885	-0.0021616	-0.0018198	-0.0674373	-0.0247513	-0.0713081	-0.0112382	-0.0442061	-0.0108102	-0.0291779	-0.0724844	-0.1790115	-0.0361297	-0.1031448
21 FinBusSrvces	-	-0.0028917	-0.0171750	-0.0004926	-0.0004509	-0.0004082	-0.0007243	-0.0015886	-0.0004912	-0.0023489	-0.0006604	-0.0010280	-0.0008655	-0.0320725	-0.0117715	-0.0339134	-0.0053448	-0.0210239	-0.0051412	-0.0138767	-0.0344728	-0.0851360	-0.0171829	-0.0490546
22 PubAdmDef	-	-0.0000101	-0.0000182	-0.0000005	-0.0000005	-0.0000011	-0.0000076	-0.0000034	-0.0000005	-0.0000018	-0.0000022	-0.0000014	-0.0000007	-0.0001017	-0.0000302	-0.0001604	-0.0000092	-0.0002870	-0.0000153	-0.0002064	-0.0004549	-0.0042792	-0.0002907	-0.0004435
23 Education	-	-0.0000057	-0.0000225	-0.0000014	-0.0000008	-0.0000006	-0.0000022	-0.0000024	-0.0000012	-0.0000022	-0.0000017	-0.0000048	-0.0000026	-0.0000160	-0.0000100	-0.0000999	-0.0000385	-0.0000898	-0.0000127	-0.0000283	-0.0007814	-0.0006236	-0.0007889	-0.0003169
24 Community	-	-0.0000000	-0.0000086	-0.0000007	-0.0000001	-0.0000001	-0.0000022	-0.0000024	-0.0000000	-0.0000001	-0.0000010	-0.0000002	-0.0000001	-0.0000018	-0.0000041	-0.0000171	-0.0000068	-0.0000237	-0.0000037	-0.0000497	-0.0000223	-0.0002246	-0.0000458	-0.0015966

Table C.9: Intermediate technical change through cloud computing in Brisbane, Queensland, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000012	-0.0024946	-0.0000212	-0.0000042	-0.0000038	-0.0000003	-0.0000064	-0.0000001	-0.0000003	-0.0000001	-0.0000007	-0.0000001	-0.0000085	-0.0000523	-0.0001515	-0.0001431	-0.0000056	-0.0000005	-0.0000056	-0.0001018	-0.0003417	-0.0000116	-0.0000447
2 Mining	-	-0.0002756	-0.0000688	-0.0000014	-0.0000024	-0.0000031	-0.0000007	-0.0002058	-0.0000388	-0.0002844	-0.0000013	-0.0000054	-0.0000474	-0.0000555	-0.0000174	-0.0001199	-0.0000307	-0.0000056	-0.0000143	-0.0001554	-0.0000965	-0.0002262	-0.0000770	-0.0003062
3 FoodDrinkTob	-	-0.0000012	-0.0012663	-0.0000012	-0.0000068	-0.0000002	-0.0000005	-0.0000082	-0.0000001	-0.0000002	-0.0000004	-0.0000006	-0.0000002	-0.0000050	-0.0000741	-0.0014391	-0.0006428	-0.0000057	-0.0000098	-0.0001062	-0.0001599	-0.0006574	-0.0002401	-0.0002168
4 TCFs	-	-0.0000023	-0.0000204	-0.0000468	-0.0000048	-0.0000230	-0.0000030	-0.0000014	-0.0000007	-0.0000064	-0.0000029	-0.0000038	-0.0000006	-0.0002456	-0.0000894	-0.0001299	-0.0000428	-0.0000287	-0.0000075	-0.0000821	-0.0001878	-0.0009237	-0.0002870	-0.0009190
5 MiscManuf	-	-0.0000064	-0.0001984	-0.0000038	-0.0000144	-0.0000055	-0.0000174	-0.0000106	-0.0000012	-0.0000046	-0.0000078	-0.0000152	-0.0000029	-0.0001372	-0.0001359	-0.0001307	-0.0000531	-0.0000690	-0.0000736	-0.0008005	-0.0001527	-0.0019190	-0.0002588	-0.0004582
6 WoodProds	-	-0.0000023	-0.0001910	-0.0000022	-0.0000023	-0.0000160	-0.0000444	-0.0000057	-0.0000020	-0.0000025	-0.0000030	-0.0000032	-0.0000003	-0.0000362	-0.0000928	-0.0001153	-0.0000426	-0.0000139	-0.0000164	-0.0001782	-0.0001301	-0.0016028	-0.0004260	-0.0006823
7 PaperPrint	-	-0.0000023	-0.0000243	-0.0000013	-0.0000019	-0.0000031	-0.0000326	-0.0000019	-0.0000008	-0.0000022	-0.0000014	-0.0000053	-0.0000008	-0.0000284	-0.0001860	-0.0006585	-0.0000996	-0.0000226	-0.0000924	-0.0010053	-0.0007195	-0.0030792	-0.0015725	-0.0003922
8 ChemCoalPrds	-	-0.0001192	-0.0000593	-0.0000094	-0.0000394	-0.0000118	-0.0000172	-0.0000856	-0.0000118	-0.0000142	-0.0000077	-0.0000163	-0.0000168	-0.0002395	-0.0002501	-0.0003436	-0.0001569	-0.0006814	-0.0000126	-0.0006243	-0.0007096	-0.0016736	-0.0001802	-0.0042663
9 NonMetMinPrd	-	-0.0000027	-0.0000467	-0.0000011	-0.0000012	-0.0000008	-0.0000002	-0.0000015	-0.0000369	-0.0000057	-0.0000035	-0.0000051	-0.0000027	-0.0004155	-0.0000553	-0.0000513	-0.0000101	-0.0000011	-0.0000002	-0.0000017	-0.0001645	-0.0001685	-0.0000170	-0.0000690
10 MetalPrds	-	-0.0000465	-0.0001094	-0.0000080	-0.0000138	-0.0000118	-0.0000023	-0.0000055	-0.0000062	-0.0001817	-0.0000374	-0.0001376	-0.0000060	-0.0005240	-0.0001312	-0.0001516	-0.0000470	-0.0000730	-0.0000451	-0.0005016	-0.0004212	-0.0017566	-0.0002680	-0.0002726
11 TransEqp	-	-0.0000086	-0.0000035	-0.0000003	-0.0000011	-0.0000009	-0.0000004	-0.0000002	-0.0000007	-0.0000008	-0.0000706	-0.0000058	-0.0000002	-0.0000386	-0.0000830	-0.0011751	-0.0000119	-0.0004178	-0.0000305	-0.0003311	-0.0000904	-0.0053477	-0.0000911	-0.0000217
12 OthMachEqp	-	-0.0001969	-0.0014452	-0.0000335	-0.0000307	-0.0000278	-0.0000493	-0.0001082	-0.0000334	-0.0001599	-0.0000450	-0.0000700	-0.0000885	-0.0012055	-0.0008800	-0.0018643	-0.0006173	-0.0008152	-0.0001994	-0.0026301	-0.0029764	-0.0126580	-0.0023487	-0.0041821
13 EGW	-	-0.0000285	-0.0000633	-0.0000026	-0.0000028	-0.0000031	-0.0000028	-0.0000042	-0.0000046	-0.0000176	-0.0000035	-0.0000093	-0.0001882	-0.0000547	-0.0000602	-0.0002391	-0.0000838	-0.0001065	-0.0000347	-0.0003772	-0.0007010	-0.0010286	-0.0008753	-0.0007124
14 Construction	-	-0.0000712	-0.0000167	-0.0000013	-0.0000008	-0.0000004	-0.0000009	-0.0000080	-0.0000003	-0.0000023	-0.0000006	-0.0000029	-0.0000251	-0.0020962	-0.0002248	-0.0001646	-0.0000562	-0.0001179	-0.0001423	-0.0015473	-0.0009575	-0.0070775	-0.0000194	-0.0000767
15 WholesalTrad	-	-0.0009623	-0.0070636	-0.0001639	-0.0001501	-0.0001358	-0.0002410	-0.0005287	-0.0001635	-0.0007817	-0.0002198	-0.0003421	-0.0004324	-0.0058919	-0.0043012	-0.0091115	-0.0030170	-0.0039843	-0.0009743	-0.0128547	-0.0145469	-0.0618655	-0.0114790	-0.0204400
16 RetailTrade	-	-0.0000078	-0.0000405	-0.0000014	-0.0000012	-0.0000015	-0.0000066	-0.0000021	-0.0000005	-0.0000010	-0.0000004	-0.0000019	-0.0000024	-0.0000516	-0.0001962	-0.0005408	-0.0000966	-0.0003478	-0.0000626	-0.0006809	-0.0006069	-0.0009407	-0.0001952	-0.0006166
17 RecPersSrvc	-	-0.0000165	-0.0001553	-0.0000025	-0.0000020	-0.0000021	-0.0000130	-0.0000087	-0.0000023	-0.0000055	-0.0000055	-0.0000076	-0.0000042	-0.0000514	-0.0001938	-0.0004721	-0.0004442	-0.0000959	-0.0000556	-0.0007682	-0.0025471	-0.0035433	-0.0013906	-0.0024534
18 Transport	-	-0.0000741	-0.0001617	-0.0000088	-0.0000051	-0.0000071	-0.0000164	-0.0000106	-0.0000066	-0.0000168	-0.0000052	-0.0000141	-0.0000028	-0.0001079	-0.0011221	-0.0002545	-0.0000639	-0.0006602	-0.0000526	-0.0011495	-0.0012912	-0.0058781	-0.0006343	-0.0006574
19 PostalSrvcs	-	-0.0000005	-0.0000082	-0.0000003	-0.0000005	-0.0000002	-0.0000038	-0.0000003	-0.0000004	-0.0000007	-0.0000004	-0.0000020	-0.0000003	-0.0000061	-0.0000298	-0.0001348	-0.0000409	-0.0000141	-0.0000236	-0.0002569	-0.0002541	-0.0007817	-0.0002053	-0.0004776
20 Telecomms	-	-0.0035458	-0.0260272	-0.0006040	-0.0005529	-0.0005005	-0.0008881	-0.0019480	-0.0006024	-0.0028802	-0.0008098	-0.0012606	-0.0015932	-0.0217099	-0.0158486	-0.0335730	-0.0111166	-0.0146810	-0.0035901	-0.0473654	-0.0536007	-0.2279551	-0.0422967	-0.0753150
21 FinBusSrvces	-	-0.0016863	-0.0123783	-0.0002872	-0.0002630	-0.0002380	-0.0004224	-0.0009264	-0.0002865	-0.0013698	-0.0003851	-0.0005995	-0.0007577	-0.0103250	-0.0075374	-0.0159670	-0.0052869	-0.0069821	-0.0017074	-0.0225265	-0.0254919	-0.1084131	-0.0201159	-0.0358190
22 PubAdmDef	-	-0.0000059	-0.0000131	-0.0000003	-0.0000003	-0.0000006	-0.0000044	-0.0000020	-0.0000003	-0.0000011	-0.0000013	-0.0000008	-0.0000006	-0.0000327	-0.0000193	-0.0000755	-0.0000091	-0.0000953	-0.0000051	-0.0003351	-0.0003364	-0.0054491	-0.0003404	-0.0003238
23 Education	-	-0.0000033	-0.0000162	-0.0000008	-0.0000005	-0.0000004	-0.0000013	-0.0000014	-0.0000007	-0.0000013	-0.0000010	-0.0000028	-0.0000023	-0.0000052	-0.0000064	-0.0000470	-0.0000380	-0.0000298	-0.0000042	-0.0000459	-0.0005778	-0.0007941	-0.0009235	-0.0002314
24 Community	-	-0.0000000	-0.0000062	-0.0000004	-0.0000000	-0.0000001	-0.0000013	-0.0000014	-0.0000000	-0.0000000	-0.0000006	-0.0000001	-0.0000000	-0.0000006	-0.0000026	-0.0000081	-0.0000067	-0.0000079	-0.0000012	-0.0000806	-0.0000165	-0.0002860	-0.0000536	-0.0011658

Table C.10: Intermediate technical change through cloud computing in Rest of Queensland, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000028	-0.0033215	-0.0000477	-0.0000094	-0.0000085	-0.0000007	-0.0000145	-0.0000001	-0.0000008	-0.0000002	-0.0000016	-0.0000001	-0.0000314	-0.0001540	-0.0004282	-0.0003929	-0.0000153	-0.0000013	-0.0000132	-0.0002976	-0.0007379	-0.0000217	-0.0001089
2 Mining	-	-0.0006212	-0.0000916	-0.0000031	-0.0000055	-0.0000070	-0.0000015	-0.0004639	-0.0000874	-0.0006410	-0.0000029	-0.0000122	-0.0000635	-0.0002059	-0.0000513	-0.0003388	-0.0000844	-0.0000153	-0.0000389	-0.0003647	-0.0002820	-0.0004884	-0.0001438	-0.0007451
3 FoodDrinkTob	-	-0.0000027	-0.0016860	-0.0000027	-0.0000152	-0.0000004	-0.0000011	-0.0000185	-0.0000002	-0.0000005	-0.0000008	-0.0000014	-0.0000003	-0.0000184	-0.0002183	-0.0040682	-0.0017654	-0.0000156	-0.0000266	-0.0002492	-0.0004674	-0.0014197	-0.0004483	-0.0005274
4 TCFs	-	-0.0000053	-0.0000271	-0.0001054	-0.0000108	-0.0000519	-0.0000067	-0.0000031	-0.0000017	-0.0000143	-0.0000064	-0.0000086	-0.0000008	-0.0009109	-0.0002633	-0.0003671	-0.0001177	-0.0000781	-0.0000205	-0.0001926	-0.0005490	-0.0019947	-0.0005358	-0.0022360
5 MiscManuf	-	-0.0000144	-0.0002642	-0.0000086	-0.0000326	-0.0000123	-0.0000392	-0.0000238	-0.0000026	-0.0000103	-0.0000176	-0.0000342	-0.0000038	-0.0005089	-0.0004005	-0.0003695	-0.0001458	-0.0001877	-0.0002003	-0.0018784	-0.0004464	-0.0041439	-0.0004831	-0.0011148
6 WoodProds	-	-0.0000051	-0.0002543	-0.0000049	-0.0000052	-0.0000361	-0.0001001	-0.0000128	-0.0000044	-0.0000057	-0.0000067	-0.0000073	-0.0000004	-0.0001343	-0.0002735	-0.0003258	-0.0001169	-0.0000378	-0.0000446	-0.0004182	-0.0003803	-0.0034610	-0.0007953	-0.0016600
7 PaperPrint	-	-0.0000052	-0.0000324	-0.0000029	-0.0000044	-0.0000071	-0.0000735	-0.0000044	-0.0000017	-0.0000050	-0.0000032	-0.0000119	-0.0000010	-0.0001055	-0.0005481	-0.0018617	-0.0002735	-0.0000616	-0.0002515	-0.0023591	-0.0021030	-0.0066492	-0.0029356	-0.0009543
8 ChemCoalPrds	-	-0.0002687	-0.0000790	-0.0000213	-0.0000888	-0.0000266	-0.0000388	-0.0001929	-0.0000267	-0.0000321	-0.0000174	-0.0000366	-0.0000226	-0.0008883	-0.0007369	-0.0009715	-0.0004309	-0.0018541	-0.0000344	-0.0014650	-0.0020739	-0.0036141	-0.0003364	-0.0103805
9 NonMetMinPrd	-	-0.0000062	-0.0000622	-0.0000026	-0.0000028	-0.0000018	-0.0000005	-0.0000034	-0.0000831	-0.0000130	-0.0000078	-0.0000116	-0.0000037	-0.0015409	-0.0001630	-0.0001450	-0.0000276	-0.0000031	-0.0000004	-0.0000039	-0.0004809	-0.0003639	-0.0000317	-0.0001679
10 MetalPrds	-	-0.0001048	-0.0001457	-0.0000181	-0.0000310	-0.0000266	-0.0000053	-0.0000125	-0.0000139	-0.0004096	-0.0000842	-0.0003101	-0.0000080	-0.0019434	-0.0003867	-0.0004286	-0.0001291	-0.0001988	-0.0001226	-0.0011770	-0.0012309	-0.0037932	-0.0005004	-0.0006632
11 TransEqp	-	-0.0000195	-0.0000046	-0.0000007	-0.0000025	-0.0000021	-0.0000009	-0.0000005	-0.0000015	-0.0000017	-0.0001591	-0.0000130	-0.0000002	-0.0001431	-0.0002446	-0.0033219	-0.0000326	-0.0011369	-0.0000829	-0.0007770	-0.0002641	-0.0115481	-0.0001700	-0.0000527
12 OthMachEqp	-	-0.0004438	-0.0019243	-0.0000756	-0.0000692	-0.0000626	-0.0001112	-0.0002438	-0.0000754	-0.0003605	-0.0001014	-0.0001578	-0.0001186	-0.0044708	-0.0025934	-0.0052701	-0.0016952	-0.0022182	-0.0005424	-0.0061720	-0.0086993	-0.0273340	-0.0043847	-0.0101755
13 EGW	-	-0.0000643	-0.0000842	-0.0000058	-0.0000063	-0.0000071	-0.0000063	-0.0000095	-0.0000104	-0.0000397	-0.0000078	-0.0000210	-0.0002524	-0.0002027	-0.0001775	-0.0006760	-0.0002301	-0.0002897	-0.0000944	-0.0008853	-0.0020489	-0.0022211	-0.0016341	-0.0017334
14 Construction	-	-0.0001605	-0.0000222	-0.0000030	-0.0000017	-0.0000009	-0.0000020	-0.0000180	-0.0000008	-0.0000051	-0.0000014	-0.0000065	-0.0000336	-0.0077739	-0.0006624	-0.0004654	-0.0001545	-0.0003208	-0.0003871	-0.0036310	-0.0027986	-0.0152834	-0.0000362	-0.0001866
15 WholesalTrad	-	-0.0021691	-0.0094051	-0.0003695	-0.0003383	-0.0003062	-0.0005433	-0.0011917	-0.0003685	-0.0017620	-0.0004954	-0.0007712	-0.0005798	-0.0218508	-0.0126751	-0.0257574	-0.0082854	-0.0108416	-0.0026512	-0.0301657	-0.0425174	-0.1335944	-0.0214302	-0.0497327
16 RetailTrade	-	-0.0000176	-0.0000539	-0.0000031	-0.0000026	-0.0000035	-0.0000148	-0.0000046	-0.0000011	-0.0000022	-0.0000009	-0.0000043	-0.0000032	-0.0001914	-0.0005783	-0.0015287	-0.0002653	-0.0009463	-0.0001703	-0.0015977	-0.0017739	-0.0020313	-0.0003643	-0.0015002
17 RecPersSrvc	-	-0.0000373	-0.0002068	-0.0000056	-0.0000045	-0.0000047	-0.0000293	-0.0000195	-0.0000052	-0.0000124	-0.0000124	-0.0000171	-0.0000056	-0.0001906	-0.0005711	-0.0013347	-0.0012200	-0.0002611	-0.0001514	-0.0018027	-0.0074445	-0.0076516	-0.0025961	-0.0059693
18 Transport	-	-0.0001671	-0.0002154	-0.0000198	-0.0000115	-0.0000160	-0.0000370	-0.0000240	-0.0000149	-0.0000379	-0.0000118	-0.0000318	-0.0000038	-0.0004003	-0.0033067	-0.0007195	-0.0001755	-0.0017964	-0.0001432	-0.0026976	-0.0037740	-0.0126934	-0.0011842	-0.0015995
19 PostalSrvcs	-	-0.0000010	-0.0000109	-0.0000008	-0.0000010	-0.0000005	-0.0000085	-0.0000006	-0.0000008	-0.0000015	-0.0000008	-0.0000045	-0.0000004	-0.0000228	-0.0000877	-0.0003810	-0.0001124	-0.0000384	-0.0000643	-0.0006029	-0.0007427	-0.0016880	-0.0003832	-0.0011620
20 Telecomms	-	-0.0079926	-0.0346548	-0.0013614	-0.0012464	-0.0011282	-0.0020020	-0.0043910	-0.0013578	-0.0064923	-0.0018253	-0.0028415	-0.0021365	-0.0805133	-0.0467037	-0.0949080	-0.0305291	-0.0399479	-0.0097689	-0.1111511	-0.1566633	-0.4922534	-0.0789635	-0.1832494
21 FinBusSrvces	-	-0.0038012	-0.0164815	-0.0006475	-0.0005928	-0.0005365	-0.0009521	-0.0020883	-0.0006457	-0.0030877	-0.0008681	-0.0013514	-0.0010161	-0.0382913	-0.0222118	-0.0451373	-0.0145193	-0.0189988	-0.0046460	-0.0528623	-0.0745074	-0.2341106	-0.0375542	-0.0871515
22 PubAdmDef	-	-0.0000132	-0.0000174	-0.0000007	-0.0000007	-0.0000014	-0.0000099	-0.0000045	-0.0000006	-0.0000024	-0.0000029	-0.0000018	-0.0000008	-0.0001214	-0.0000570	-0.0002135	-0.0000250	-0.0002593	-0.0000138	-0.0007863	-0.0009833	-0.0117670	-0.0006354	-0.0007879
23 Education	-	-0.0000075	-0.0000216	-0.0000018	-0.0000011	-0.0000008	-0.0000029	-0.0000032	-0.0000016	-0.0000028	-0.0000023	-0.0000063	-0.0000030	-0.0000191	-0.0000188	-0.0001330	-0.0001045	-0.0000811	-0.0000115	-0.0001078	-0.0016889	-0.0017147	-0.0017242	-0.0005630
24 Community	-	-0.0000001	-0.0000083	-0.0000009	-0.0000001	-0.0000002	-0.0000028	-0.0000031	-0.0000000	-0.0000001	-0.0000013	-0.0000002	-0.0000001	-0.0000022	-0.0000077	-0.0000228	-0.0000185	-0.0000214	-0.0000033	-0.0001892	-0.0000481	-0.0006177	-0.0001001	-0.0028365

Table C.11: Intermediate technical change through cloud computing in Adelaide, South Australia, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000020	-0.0048132	-0.0000346	-0.0000068	-0.0000062	-0.0000005	-0.0000105	-0.0000001	-0.0000006	-0.0000002	-0.0000011	-0.0000001	-0.0000241	-0.0001037	-0.0002989	-0.0002344	-0.0000121	-0.0000010	-0.0000058	-0.0001921	-0.0005239	-0.0000154	-0.0000803
2 Mining	-	-0.0004510	-0.0001328	-0.0000023	-0.0000040	-0.0000051	-0.0000011	-0.0003369	-0.0000635	-0.0004654	-0.0000021	-0.0000088	-0.0000489	-0.0001580	-0.0000345	-0.0002365	-0.0000503	-0.0000121	-0.0000307	-0.0001589	-0.0001820	-0.0003468	-0.0001021	-0.0005498
3 FoodDrinkTob	-	-0.0000019	-0.0024432	-0.0000020	-0.0000110	-0.0000003	-0.0000008	-0.0000134	-0.0000002	-0.0000004	-0.0000006	-0.0000010	-0.0000002	-0.0000141	-0.0001469	-0.0028398	-0.0010533	-0.0000123	-0.0000210	-0.0001086	-0.0003017	-0.0010080	-0.0003181	-0.0003892
4 TCFs	-	-0.0000038	-0.0000393	-0.0000765	-0.0000079	-0.0000377	-0.0000049	-0.0000023	-0.0000012	-0.0000104	-0.0000047	-0.0000063	-0.0000006	-0.0006989	-0.0001772	-0.0002563	-0.0000702	-0.0000618	-0.0000162	-0.0000839	-0.0003544	-0.0014163	-0.0003802	-0.0016498
5 MiscManuf	-	-0.0000105	-0.0003828	-0.0000063	-0.0000236	-0.0000089	-0.0000285	-0.0000173	-0.0000019	-0.0000075	-0.0000128	-0.0000248	-0.0000030	-0.0003904	-0.0002695	-0.0002579	-0.0000870	-0.0001485	-0.0001584	-0.0008185	-0.0002881	-0.0029422	-0.0003428	-0.0008226
6 WoodProds	-	-0.0000037	-0.0003685	-0.0000036	-0.0000037	-0.0000262	-0.0000727	-0.0000093	-0.0000032	-0.0000041	-0.0000049	-0.0000053	-0.0000003	-0.0001030	-0.0001841	-0.0002274	-0.0000697	-0.0000299	-0.0000353	-0.0001822	-0.0002455	-0.0024574	-0.0005644	-0.0012248
7 PaperPrint	-	-0.0000037	-0.0000470	-0.0000021	-0.0000032	-0.0000051	-0.0000534	-0.0000032	-0.0000012	-0.0000036	-0.0000023	-0.0000086	-0.0000008	-0.0000809	-0.0003689	-0.0012995	-0.0001632	-0.0000487	-0.0001989	-0.0010279	-0.0013574	-0.0047211	-0.0020832	-0.0007042
8 ChemCoalPrds	-	-0.0001951	-0.0001145	-0.0000155	-0.0000645	-0.0000193	-0.0000282	-0.0001400	-0.0000194	-0.0000233	-0.0000126	-0.0000266	-0.0000174	-0.0006816	-0.0004959	-0.0006781	-0.0002571	-0.0014663	-0.0000272	-0.0006383	-0.0013386	-0.0025661	-0.0002387	-0.0076593
9 NonMetMinPrd	-	-0.0000045	-0.0000901	-0.0000019	-0.0000020	-0.0000013	-0.0000004	-0.0000025	-0.0000603	-0.0000094	-0.0000057	-0.0000084	-0.0000028	-0.0011823	-0.0001097	-0.0001012	-0.0000165	-0.0000024	-0.0000003	-0.0000017	-0.0003104	-0.0002584	-0.0000225	-0.0001239
10 MetalPrds	-	-0.0000761	-0.0002111	-0.0000131	-0.0000225	-0.0000193	-0.0000038	-0.0000090	-0.0000101	-0.0002974	-0.0000611	-0.0002252	-0.0000062	-0.0014910	-0.0002602	-0.0002992	-0.0000771	-0.0001572	-0.0000970	-0.0005128	-0.0007945	-0.0026932	-0.0003551	-0.0004893
11 TransEqp	-	-0.0000142	-0.0000067	-0.0000005	-0.0000018	-0.0000015	-0.0000006	-0.0000004	-0.0000011	-0.0000013	-0.0001155	-0.0000094	-0.0000002	-0.0001098	-0.0001646	-0.0023188	-0.0000195	-0.0008992	-0.0000655	-0.0003386	-0.0001705	-0.0081993	-0.0001207	-0.0000389
12 OthMachEqp	-	-0.0003223	-0.0027885	-0.0000549	-0.0000503	-0.0000455	-0.0000807	-0.0001770	-0.0000547	-0.0002618	-0.0000736	-0.0001146	-0.0000914	-0.0034301	-0.0017453	-0.0036787	-0.0010114	-0.0017544	-0.0004290	-0.0026893	-0.0056147	-0.0194076	-0.0031115	-0.0075081
13 EGW	-	-0.0000467	-0.0001220	-0.0000042	-0.0000045	-0.0000051	-0.0000046	-0.0000069	-0.0000075	-0.0000288	-0.0000057	-0.0000153	-0.0001944	-0.0001555	-0.0001194	-0.0004719	-0.0001373	-0.0002291	-0.0000746	-0.0003857	-0.0013224	-0.0015770	-0.0011596	-0.0012790
14 Construction	-	-0.0001165	-0.0000321	-0.0000022	-0.0000012	-0.0000006	-0.0000014	-0.0000131	-0.0000006	-0.0000037	-0.0000010	-0.0000047	-0.0000259	-0.0059645	-0.0004458	-0.0003249	-0.0000922	-0.0002537	-0.0003061	-0.0015821	-0.0018063	-0.0108515	-0.0000257	-0.0001377
15 WholesalTrad	-	-0.0015750	-0.0136288	-0.0002683	-0.0002456	-0.0002223	-0.0003945	-0.0008653	-0.0002676	-0.0012793	-0.0003597	-0.0005599	-0.0004465	-0.0167648	-0.0085299	-0.0179797	-0.0049434	-0.0085744	-0.0020968	-0.0131438	-0.0274419	-0.0948545	-0.0152075	-0.0366957
16 RetailTrade	-	-0.0000128	-0.0000781	-0.0000023	-0.0000019	-0.0000025	-0.0000108	-0.0000034	-0.0000008	-0.0000016	-0.0000007	-0.0000031	-0.0000025	-0.0001468	-0.0003892	-0.0010671	-0.0001583	-0.0007484	-0.0001347	-0.0006962	-0.0011449	-0.0014422	-0.0002585	-0.0011069
17 RecPersSrvc	-	-0.0000271	-0.0002996	-0.0000041	-0.0000033	-0.0000034	-0.0000213	-0.0000142	-0.0000038	-0.0000090	-0.0000090	-0.0000124	-0.0000043	-0.0001463	-0.0003843	-0.0009317	-0.0007279	-0.0002065	-0.0001197	-0.0007855	-0.0048049	-0.0054328	-0.0018423	-0.0044045
18 Transport	-	-0.0001213	-0.0003121	-0.0000144	-0.0000083	-0.0000116	-0.0000269	-0.0000174	-0.0000108	-0.0000275	-0.0000086	-0.0000231	-0.0000029	-0.0003071	-0.0022253	-0.0005023	-0.0001047	-0.0014207	-0.0001132	-0.0011754	-0.0024359	-0.0090126	-0.0008404	-0.0011802
19 PostalSrvcs	-	-0.0000008	-0.0000158	-0.0000005	-0.0000008	-0.0000004	-0.0000062	-0.0000004	-0.0000006	-0.0000011	-0.0000006	-0.0000032	-0.0000003	-0.0000175	-0.0000590	-0.0002660	-0.0000671	-0.0000304	-0.0000508	-0.0002627	-0.0004794	-0.0011985	-0.0002719	-0.0008574
20 Telecomms	-	-0.0058034	-0.0502180	-0.0009885	-0.0009050	-0.0008191	-0.0014536	-0.0031882	-0.0009859	-0.0047140	-0.0013253	-0.0020632	-0.0016453	-0.0617730	-0.0314301	-0.0662495	-0.0182147	-0.0315940	-0.0077260	-0.0484309	-0.1011148	-0.3495089	-0.0560350	-0.1352121
21 FinBusSrvces	-	-0.0027600	-0.0238832	-0.0004701	-0.0004304	-0.0003896	-0.0006913	-0.0015163	-0.0004689	-0.0022419	-0.0006303	-0.0009812	-0.0007825	-0.0293786	-0.0149478	-0.0315076	-0.0086627	-0.0150258	-0.0036744	-0.0230332	-0.0480891	-0.1662228	-0.0266497	-0.0643055
22 PubAdmDef	-	-0.0000096	-0.0000253	-0.0000005	-0.0000005	-0.0000010	-0.0000072	-0.0000033	-0.0000004	-0.0000017	-0.0000021	-0.0000013	-0.0000006	-0.0000931	-0.0000383	-0.0001491	-0.0000149	-0.0002051	-0.0000109	-0.0003426	-0.0006346	-0.0083548	-0.0004509	-0.0005814
23 Education	-	-0.0000054	-0.0000314	-0.0000013	-0.0000008	-0.0000006	-0.0000021	-0.0000023	-0.0000012	-0.0000021	-0.0000017	-0.0000046	-0.0000023	-0.0000147	-0.0000126	-0.0000928	-0.0000623	-0.0000642	-0.0000091	-0.0000470	-0.0010900	-0.0012175	-0.0012235	-0.0004154
24 Community	-	-0.0000000	-0.0000120	-0.0000007	-0.0000001	-0.0000001	-0.0000021	-0.0000023	-0.0000000	-0.0000001	-0.0000009	-0.0000002	-0.0000000	-0.0000017	-0.0000052	-0.0000159	-0.0000110	-0.0000169	-0.0000026	-0.0000824	-0.0000311	-0.0004386	-0.0000710	-0.0020929

Table C.12: Intermediate technical change through cloud computing in Rest of South Australia, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000014	-0.0019408	-0.0000243	-0.0000048	-0.0000043	-0.0000004	-0.0000074	-0.0000001	-0.0000004	-0.0000001	-0.0000008	-0.0000001	-0.0000204	-0.0000826	-0.0003672	-0.0001557	-0.0000223	-0.0000019	-0.0000034	-0.0001227	-0.0005109	-0.0000071	-0.0000545
2 Mining	-	-0.0003160	-0.0000535	-0.0000016	-0.0000028	-0.0000036	-0.0000007	-0.0002360	-0.0000445	-0.0003261	-0.0000015	-0.0000062	-0.0000410	-0.0001335	-0.0000275	-0.0002906	-0.0000334	-0.0000224	-0.0000568	-0.0000933	-0.0001163	-0.0003382	-0.0000469	-0.0003731
3 FoodDrinkTob	-	-0.0000014	-0.0009852	-0.0000014	-0.0000077	-0.0000002	-0.0000005	-0.0000094	-0.0000001	-0.0000003	-0.0000004	-0.0000007	-0.0000002	-0.0000119	-0.0001170	-0.0034891	-0.0006995	-0.0000227	-0.0000388	-0.0000637	-0.0001928	-0.0009831	-0.0001463	-0.0002641
4 TCFs	-	-0.0000027	-0.0000158	-0.0000536	-0.0000055	-0.0000264	-0.0000034	-0.0000016	-0.0000009	-0.0000073	-0.0000033	-0.0000044	-0.0000005	-0.0005907	-0.0001411	-0.0003149	-0.0000466	-0.0001141	-0.0000300	-0.0000492	-0.0002264	-0.0013812	-0.0001748	-0.0011197
5 MiscManuf	-	-0.0000073	-0.0001544	-0.0000044	-0.0000166	-0.0000063	-0.0000199	-0.0000121	-0.0000013	-0.0000053	-0.0000090	-0.0000174	-0.0000025	-0.0003300	-0.0002147	-0.0003169	-0.0000578	-0.0002742	-0.0002926	-0.0004804	-0.0001841	-0.0028694	-0.0001576	-0.0005583
6 WoodProds	-	-0.0000026	-0.0001486	-0.0000025	-0.0000026	-0.0000184	-0.0000509	-0.0000065	-0.0000023	-0.0000029	-0.0000034	-0.0000037	-0.0000003	-0.0000871	-0.0001466	-0.0002794	-0.0000463	-0.0000553	-0.0000652	-0.0001070	-0.0001568	-0.0023966	-0.0002595	-0.0008312
7 PaperPrint	-	-0.0000026	-0.0000189	-0.0000015	-0.0000022	-0.0000036	-0.0000374	-0.0000022	-0.0000009	-0.0000026	-0.0000016	-0.0000060	-0.0000007	-0.0000684	-0.0002938	-0.0015966	-0.0001084	-0.0000899	-0.0003675	-0.0006034	-0.0008672	-0.0046042	-0.0009578	-0.0004779
8 ChemCoalPrds	-	-0.0001367	-0.0000462	-0.0000108	-0.0000452	-0.0000135	-0.0000198	-0.0000981	-0.0000136	-0.0000163	-0.0000088	-0.0000186	-0.0000146	-0.0005761	-0.0003950	-0.0008332	-0.0001707	-0.0027087	-0.0000502	-0.0003747	-0.0008552	-0.0025026	-0.0001097	-0.0051980
9 NonMetMinPrd	-	-0.0000031	-0.0000363	-0.0000013	-0.0000014	-0.0000009	-0.0000003	-0.0000017	-0.0000423	-0.0000066	-0.0000040	-0.0000059	-0.0000024	-0.0009992	-0.0000874	-0.0001243	-0.0000109	-0.0000045	-0.0000006	-0.0000010	-0.0001983	-0.0002520	-0.0000103	-0.0000841
10 MetalPrds	-	-0.0000533	-0.0000851	-0.0000092	-0.0000158	-0.0000135	-0.0000027	-0.0000063	-0.0000071	-0.0002084	-0.0000428	-0.0001578	-0.0000052	-0.0012602	-0.0002073	-0.0003676	-0.0000512	-0.0002904	-0.0001791	-0.0003010	-0.0005076	-0.0026266	-0.0001633	-0.0003321
11 TransEqp	-	-0.0000099	-0.0000027	-0.0000004	-0.0000013	-0.0000010	-0.0000004	-0.0000003	-0.0000008	-0.0000009	-0.0000809	-0.0000066	-0.0000002	-0.0000928	-0.0001311	-0.0028490	-0.0000129	-0.0016610	-0.0001211	-0.0001987	-0.0001089	-0.0079964	-0.0000555	-0.0000264
12 OthMachEqp	-	-0.0002258	-0.0011244	-0.0000385	-0.0000352	-0.0000319	-0.0000566	-0.0001240	-0.0000384	-0.0001834	-0.0000516	-0.0000803	-0.0000765	-0.0028992	-0.0013901	-0.0045198	-0.0006717	-0.0032407	-0.0007925	-0.0015785	-0.0035873	-0.0189273	-0.0014306	-0.0050954
13 EGW	-	-0.0000327	-0.0000492	-0.0000030	-0.0000032	-0.0000036	-0.0000032	-0.0000049	-0.0000053	-0.0000202	-0.0000040	-0.0000107	-0.0001627	-0.0001315	-0.0000951	-0.0005797	-0.0000912	-0.0004233	-0.0001379	-0.0002264	-0.0008449	-0.0015380	-0.0005332	-0.0008680
14 Construction	-	-0.0000816	-0.0000130	-0.0000015	-0.0000009	-0.0000004	-0.0000010	-0.0000092	-0.0000004	-0.0000026	-0.0000007	-0.0000033	-0.0000217	-0.0050412	-0.0003551	-0.0003991	-0.0000612	-0.0004687	-0.0005655	-0.0009287	-0.0011541	-0.0105829	-0.0000118	-0.0000934
15 WholesalTrad	-	-0.0011035	-0.0054955	-0.0001880	-0.0001721	-0.0001558	-0.0002764	-0.0006062	-0.0001875	-0.0008963	-0.0002520	-0.0003923	-0.0003738	-0.0141696	-0.0067943	-0.0220907	-0.0032830	-0.0158389	-0.0038732	-0.0077151	-0.0175330	-0.0925069	-0.0069922	-0.0249037
16 RetailTrade	-	-0.0000090	-0.0000315	-0.0000016	-0.0000013	-0.0000018	-0.0000075	-0.0000024	-0.0000006	-0.0000011	-0.0000005	-0.0000022	-0.0000021	-0.0001241	-0.0003100	-0.0013110	-0.0001051	-0.0013825	-0.0002488	-0.0004086	-0.0007315	-0.0014066	-0.0001189	-0.0007512
17 RecPersSrvc	-	-0.0000190	-0.0001208	-0.0000028	-0.0000023	-0.0000024	-0.0000149	-0.0000099	-0.0000027	-0.0000063	-0.0000063	-0.0000087	-0.0000036	-0.0001236	-0.0003061	-0.0011447	-0.0004834	-0.0003814	-0.0002211	-0.0004611	-0.0030699	-0.0052983	-0.0008470	-0.0029891
18 Transport	-	-0.0000850	-0.0001258	-0.0000101	-0.0000058	-0.0000081	-0.0000188	-0.0000122	-0.0000076	-0.0000193	-0.0000060	-0.0000162	-0.0000025	-0.0002596	-0.0017725	-0.0006171	-0.0000695	-0.0026244	-0.0002091	-0.0006899	-0.0015563	-0.0087895	-0.0003864	-0.0008010
19 PostalSrvcs	-	-0.0000005	-0.0000064	-0.0000004	-0.0000005	-0.0000003	-0.0000043	-0.0000003	-0.0000004	-0.0000008	-0.0000004	-0.0000023	-0.0000003	-0.0000148	-0.0000470	-0.0003268	-0.0000445	-0.0000561	-0.0000939	-0.0001542	-0.0003063	-0.0011689	-0.0001250	-0.0005819
20 Telecomms	-	-0.0040659	-0.0202493	-0.0006926	-0.0006340	-0.0005739	-0.0010184	-0.0022337	-0.0006907	-0.0033027	-0.0009285	-0.0014455	-0.0013775	-0.0522105	-0.0250348	-0.0813971	-0.0120968	-0.0583613	-0.0142717	-0.0284278	-0.0646037	-0.3408587	-0.0257640	-0.0917621
21 FinBusSrvces	-	-0.0019337	-0.0096304	-0.0003294	-0.0003015	-0.0002729	-0.0004843	-0.0010623	-0.0003285	-0.0015707	-0.0004416	-0.0006875	-0.0006551	-0.0248308	-0.0119063	-0.0387116	-0.0057531	-0.0277560	-0.0067875	-0.0135200	-0.0307248	-0.1621088	-0.0122531	-0.0436411
22 PubAdmDef	-	-0.0000067	-0.0000102	-0.0000004	-0.0000004	-0.0000007	-0.0000051	-0.0000023	-0.0000003	-0.0000012	-0.0000015	-0.0000009	-0.0000005	-0.0000787	-0.0000305	-0.0001831	-0.0000099	-0.0003789	-0.0000201	-0.0002011	-0.0004055	-0.0081480	-0.0002073	-0.0003946
23 Education	-	-0.0000038	-0.0000126	-0.0000009	-0.0000006	-0.0000004	-0.0000015	-0.0000016	-0.0000008	-0.0000014	-0.0000012	-0.0000032	-0.0000020	-0.0000124	-0.0000101	-0.0001141	-0.0000414	-0.0001185	-0.0000168	-0.0000276	-0.0006964	-0.0011873	-0.0005626	-0.0002819
24 Community	-	-0.0000000	-0.0000048	-0.0000005	-0.0000000	-0.0000001	-0.0000014	-0.0000016	-0.0000000	-0.0000000	-0.0000007	-0.0000001	-0.0000000	-0.0000014	-0.0000041	-0.0000195	-0.0000073	-0.0000312	-0.0000048	-0.0000484	-0.0000198	-0.0004277	-0.0000327	-0.0014204

Table C.13: Intermediate technical change through cloud computing in Perth, Western Australia, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	- 0.0000014	- 0.0030856	- 0.0000248	- 0.0000049	- 0.0000044	- 0.0000004	- 0.0000075	- 0.0000001	- 0.0000004	- 0.0000001	- 0.0000008	- 0.0000001	- 0.0000115	- 0.0000613	- 0.0002486	- 0.0002119	- 0.0000087	- 0.0000007	- 0.0000090	- 0.0001578	- 0.0003735	- 0.0000139	- 0.0000687
2 Mining	-	- 0.0003226	- 0.0000851	- 0.0000016	- 0.0000028	- 0.0000036	- 0.0000008	- 0.0002410	- 0.0000454	- 0.0003329	- 0.0000015	- 0.0000063	- 0.0000628	- 0.0000755	- 0.0000204	- 0.0001968	- 0.0000455	- 0.0000088	- 0.0000222	- 0.0002480	- 0.0001496	- 0.0002472	- 0.0000919	- 0.0004701
3 FoodDrinkTob	-	- 0.0000014	- 0.0015663	- 0.0000014	- 0.0000079	- 0.0000002	- 0.0000006	- 0.0000096	- 0.0000001	- 0.0000003	- 0.0000004	- 0.0000007	- 0.0000003	- 0.0000067	- 0.0000868	- 0.0023622	- 0.0009522	- 0.0000089	- 0.0000152	- 0.0001695	- 0.0002479	- 0.0007187	- 0.0002866	- 0.0003327
4 TCFs	-	- 0.0000027	- 0.0000252	- 0.0000547	- 0.0000056	- 0.0000269	- 0.0000035	- 0.0000016	- 0.0000009	- 0.0000074	- 0.0000033	- 0.0000045	- 0.0000008	- 0.0003339	- 0.0001048	- 0.0002132	- 0.0000635	- 0.0000447	- 0.0000117	- 0.0001310	- 0.0002911	- 0.0010098	- 0.0003426	- 0.0014107
5 MiscManuf	-	- 0.0000075	- 0.0002454	- 0.0000045	- 0.0000169	- 0.0000064	- 0.0000204	- 0.0000124	- 0.0000014	- 0.0000054	- 0.0000092	- 0.0000178	- 0.0000038	- 0.0001865	- 0.0001594	- 0.0002145	- 0.0000787	- 0.0001073	- 0.0001145	- 0.0012775	- 0.0002367	- 0.0020977	- 0.0003088	- 0.0007033
6 WoodProds	-	- 0.0000027	- 0.0002362	- 0.0000025	- 0.0000027	- 0.0000187	- 0.0000520	- 0.0000067	- 0.0000023	- 0.0000029	- 0.0000035	- 0.0000038	- 0.0000004	- 0.0000492	- 0.0001088	- 0.0001892	- 0.0000631	- 0.0000216	- 0.0000255	- 0.0002844	- 0.0002017	- 0.0017521	- 0.0005084	- 0.0010473
7 PaperPrint	-	- 0.0000027	- 0.0000301	- 0.0000015	- 0.0000023	- 0.0000037	- 0.0000382	- 0.0000023	- 0.0000009	- 0.0000026	- 0.0000017	- 0.0000062	- 0.0000010	- 0.0000387	- 0.0002181	- 0.0010810	- 0.0001475	- 0.0000352	- 0.0001438	- 0.0016045	- 0.0011152	- 0.0033660	- 0.0018768	- 0.0006021
8 ChemCoalPrds	-	- 0.0001395	- 0.0000734	- 0.0000111	- 0.0000461	- 0.0000138	- 0.0000202	- 0.0001002	- 0.0000139	- 0.0000167	- 0.0000090	- 0.0000190	- 0.0000223	- 0.0003256	- 0.0002932	- 0.0005641	- 0.0002324	- 0.0010599	- 0.0000196	- 0.0009963	- 0.0010998	- 0.0018295	- 0.0002150	- 0.0065489
9 NonMetMinPrd	-	- 0.0000032	- 0.0000578	- 0.0000013	- 0.0000015	- 0.0000009	- 0.0000003	- 0.0000018	- 0.0000432	- 0.0000067	- 0.0000041	- 0.0000060	- 0.0000036	- 0.0005648	- 0.0000648	- 0.0000842	- 0.0000149	- 0.0000017	- 0.0000002	- 0.0000027	- 0.0002550	- 0.0001842	- 0.0000203	- 0.0001059
10 MetalPrds	-	- 0.0000544	- 0.0001354	- 0.0000094	- 0.0000161	- 0.0000138	- 0.0000027	- 0.0000065	- 0.0000072	- 0.0002127	- 0.0000437	- 0.0001611	- 0.0000079	- 0.0007123	- 0.0001539	- 0.0002489	- 0.0000697	- 0.0001136	- 0.0000701	- 0.0008005	- 0.0006528	- 0.0019202	- 0.0003199	- 0.0004184
11 TransEqp	-	- 0.0000101	- 0.0000043	- 0.0000004	- 0.0000013	- 0.0000011	- 0.0000004	- 0.0000003	- 0.0000008	- 0.0000009	- 0.0000826	- 0.0000067	- 0.0000002	- 0.0000525	- 0.0000973	- 0.0019288	- 0.0000176	- 0.0006500	- 0.0000474	- 0.0005284	- 0.0001401	- 0.0058459	- 0.0001087	- 0.0000332
12 OthMachEqp	-	- 0.0002305	- 0.0017877	- 0.0000393	- 0.0000359	- 0.0000325	- 0.0000577	- 0.0001266	- 0.0000392	- 0.0001872	- 0.0000526	- 0.0000819	- 0.0001173	- 0.0016387	- 0.0010319	- 0.0030601	- 0.0009143	- 0.0012681	- 0.0003101	- 0.0041977	- 0.0046131	- 0.0138371	- 0.0028032	- 0.0064196
13 EGW	-	- 0.0000334	- 0.0000782	- 0.0000030	- 0.0000032	- 0.0000037	- 0.0000033	- 0.0000050	- 0.0000054	- 0.0000206	- 0.0000041	- 0.0000109	- 0.0002494	- 0.0000743	- 0.0000706	- 0.0003925	- 0.0001241	- 0.0001656	- 0.0000540	- 0.0006021	- 0.0010865	- 0.0011244	- 0.0010447	- 0.0010936
14 Construction	-	- 0.0000833	- 0.0000206	- 0.0000016	- 0.0000009	- 0.0000004	- 0.0000010	- 0.0000094	- 0.0000004	- 0.0000027	- 0.0000007	- 0.0000034	- 0.0000332	- 0.0028495	- 0.0002636	- 0.0002702	- 0.0000833	- 0.0001834	- 0.0002213	- 0.0024695	- 0.0014841	- 0.0077368	- 0.0000231	- 0.0001177
15 WholesalTrad	-	- 0.0011266	- 0.0087371	- 0.0001919	- 0.0001757	- 0.0001590	- 0.0002822	- 0.0006189	- 0.0001914	- 0.0009151	- 0.0002573	- 0.0004005	- 0.0005731	- 0.0080093	- 0.0050436	- 0.0149560	- 0.0044689	- 0.0061978	- 0.0015156	- 0.0205164	- 0.0225463	- 0.0676285	- 0.0137005	- 0.0313759
16 RetailTrade	-	- 0.0000091	- 0.0000500	- 0.0000016	- 0.0000014	- 0.0000018	- 0.0000077	- 0.0000024	- 0.0000006	- 0.0000012	- 0.0000005	- 0.0000022	- 0.0000032	- 0.0000702	- 0.0002301	- 0.0008876	- 0.0001431	- 0.0005410	- 0.0000974	- 0.0010867	- 0.0009407	- 0.0010283	- 0.0002329	- 0.0009465
17 RecPersSrvc	-	- 0.0000194	- 0.0001921	- 0.0000029	- 0.0000023	- 0.0000025	- 0.0000152	- 0.0000101	- 0.0000027	- 0.0000064	- 0.0000065	- 0.0000089	- 0.0000056	- 0.0000699	- 0.0002272	- 0.0007750	- 0.0006580	- 0.0001492	- 0.0000865	- 0.0012261	- 0.0039477	- 0.0038734	- 0.0016597	- 0.0037660
18 Transport	-	- 0.0000868	- 0.0002001	- 0.0000103	- 0.0000060	- 0.0000083	- 0.0000192	- 0.0000125	- 0.0000077	- 0.0000197	- 0.0000061	- 0.0000165	- 0.0000038	- 0.0001467	- 0.0013158	- 0.0004178	- 0.0000947	- 0.0010269	- 0.0000818	- 0.0018347	- 0.0020013	- 0.0064257	- 0.0007571	- 0.0010091
19 PostalSrvcs	-	- 0.0000005	- 0.0000101	- 0.0000004	- 0.0000005	- 0.0000003	- 0.0000044	- 0.0000003	- 0.0000004	- 0.0000008	- 0.0000004	- 0.0000023	- 0.0000004	- 0.0000084	- 0.0000349	- 0.0002212	- 0.0000606	- 0.0000219	- 0.0000367	- 0.0004101	- 0.0003938	- 0.0008545	- 0.0002450	- 0.0007331
20 Telecomms	-	- 0.0041510	- 0.0321935	- 0.0007071	- 0.0006473	- 0.0005859	- 0.0010397	- 0.0022805	- 0.0007052	- 0.0033718	- 0.0009480	- 0.0014758	- 0.0021116	- 0.0295116	- 0.0185840	- 0.0551081	- 0.0164663	- 0.0228368	- 0.0055845	- 0.0755964	- 0.0830760	- 0.2491898	- 0.0504822	- 0.1156103
21 FinBusSrvces	-	- 0.0019742	- 0.0153109	- 0.0003363	- 0.0003079	- 0.0002787	- 0.0004945	- 0.0010846	- 0.0003354	- 0.0016036	- 0.0004508	- 0.0007019	- 0.0010042	- 0.0140354	- 0.0088384	- 0.0262088	- 0.0078312	- 0.0108609	- 0.0026559	- 0.0359529	- 0.0395101	- 0.1185121	- 0.0240088	- 0.0549831
22 PubAdmDef	-	- 0.0000069	- 0.0000162	- 0.0000004	- 0.0000004	- 0.0000007	- 0.0000052	- 0.0000023	- 0.0000003	- 0.0000012	- 0.0000015	- 0.0000009	- 0.0000008	- 0.0000445	- 0.0000227	- 0.0001240	- 0.0000135	- 0.0001482	- 0.0000079	- 0.0005348	- 0.0005214	- 0.0059567	- 0.0004062	- 0.0004971
23 Education	-	- 0.0000039	- 0.0000201	- 0.0000010	- 0.0000006	- 0.0000004	- 0.0000015	- 0.0000017	- 0.0000008	- 0.0000015	- 0.0000012	- 0.0000033	- 0.0000030	- 0.0000070	- 0.0000075	- 0.0000772	- 0.0000564	- 0.0000464	- 0.0000066	- 0.0000733	- 0.0008956	- 0.0008680	- 0.0011023	- 0.0003552
24 Community	-	- 0.0000000	- 0.0000077	- 0.0000005	- 0.0000001	- 0.0000001	- 0.0000015	- 0.0000016	- 0.0000000	- 0.0000000	- 0.0000007	- 0.0000001	- 0.0000001	- 0.0000008	- 0.0000031	- 0.0000132	- 0.0000100	- 0.0000122	- 0.0000019	- 0.0001287	- 0.0000255	- 0.0003127	- 0.0000640	- 0.0017895

Table C.14: Intermediate technical change through cloud computing in Rest of Western Australia, when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	- 0.0000012	- 0.0027367	- 0.0000205	- 0.0000041	- 0.0000036	- 0.0000003	- 0.0000062	- 0.0000001	- 0.0000003	- 0.0000001	- 0.0000007	- 0.0000001	- 0.0000144	- 0.0000553	- 0.0002924	- 0.0001701	- 0.0000148	- 0.0000012	- 0.0000058	- 0.0001055	- 0.0002481	- 0.0000094	- 0.0000605
2 Mining	-	- 0.0002673	- 0.0000755	- 0.0000013	- 0.0000024	- 0.0000030	- 0.0000006	- 0.0001997	- 0.0000376	- 0.0002759	- 0.0000013	- 0.0000052	- 0.0000782	- 0.0000942	- 0.0000184	- 0.0002314	- 0.0000365	- 0.0000148	- 0.0000376	- 0.0001592	- 0.0001000	- 0.0001642	- 0.0000621	- 0.0004139
3 FoodDrinkTob	-	- 0.0000012	- 0.0013891	- 0.0000012	- 0.0000065	- 0.0000002	- 0.0000005	- 0.0000080	- 0.0000001	- 0.0000002	- 0.0000003	- 0.0000006	- 0.0000003	- 0.0000084	- 0.0000783	- 0.0027784	- 0.0007644	- 0.0000151	- 0.0000257	- 0.0001088	- 0.0001657	- 0.0004773	- 0.0001935	- 0.0002930
4 TCFs	-	- 0.0000023	- 0.0000223	- 0.0000454	- 0.0000047	- 0.0000223	- 0.0000029	- 0.0000013	- 0.0000007	- 0.0000062	- 0.0000028	- 0.0000037	- 0.0000009	- 0.0004169	- 0.0000945	- 0.0002507	- 0.0000509	- 0.0000756	- 0.0000199	- 0.0000841	- 0.0001946	- 0.0006706	- 0.0002313	- 0.0012423
5 MiscManuf	-	- 0.0000062	- 0.0002176	- 0.0000037	- 0.0000140	- 0.0000053	- 0.0000169	- 0.0000103	- 0.0000011	- 0.0000044	- 0.0000076	- 0.0000147	- 0.0000047	- 0.0002329	- 0.0001437	- 0.0002523	- 0.0000631	- 0.0001815	- 0.0001937	- 0.0008200	- 0.0001582	- 0.0013931	- 0.0002085	- 0.0006194
6 WoodProds	-	- 0.0000022	- 0.0002095	- 0.0000021	- 0.0000022	- 0.0000155	- 0.0000431	- 0.0000055	- 0.0000019	- 0.0000024	- 0.0000029	- 0.0000031	- 0.0000005	- 0.0000615	- 0.0000981	- 0.0002225	- 0.0000506	- 0.0000366	- 0.0000431	- 0.0001826	- 0.0001348	- 0.0011635	- 0.0003433	- 0.0009223
7 PaperPrint	-	- 0.0000022	- 0.0000267	- 0.0000013	- 0.0000019	- 0.0000030	- 0.0000316	- 0.0000019	- 0.0000007	- 0.0000022	- 0.0000014	- 0.0000051	- 0.0000012	- 0.0000483	- 0.0001966	- 0.0012714	- 0.0001184	- 0.0000595	- 0.0002432	- 0.0010298	- 0.0007454	- 0.0022353	- 0.0012673	- 0.0005302
8 ChemCoalPrds	-	- 0.0001156	- 0.0000651	- 0.0000092	- 0.0000382	- 0.0000114	- 0.0000167	- 0.0000830	- 0.0000115	- 0.0000138	- 0.0000075	- 0.0000158	- 0.0000278	- 0.0004066	- 0.0002644	- 0.0006635	- 0.0001866	- 0.0017929	- 0.0000332	- 0.0006395	- 0.0007351	- 0.0012150	- 0.0001452	- 0.0057672
9 NonMetMinPrd	-	- 0.0000027	- 0.0000512	- 0.0000011	- 0.0000012	- 0.0000008	- 0.0000002	- 0.0000015	- 0.0000358	- 0.0000056	- 0.0000034	- 0.0000050	- 0.0000045	- 0.0007053	- 0.0000585	- 0.0000990	- 0.0000120	- 0.0000030	- 0.0000004	- 0.0000017	- 0.0001704	- 0.0001223	- 0.0000137	- 0.0000933
10 MetalPrds	-	- 0.0000451	- 0.0001201	- 0.0000078	- 0.0000133	- 0.0000114	- 0.0000023	- 0.0000054	- 0.0000060	- 0.0001763	- 0.0000362	- 0.0001335	- 0.0000099	- 0.0008895	- 0.0001387	- 0.0002927	- 0.0000559	- 0.0001922	- 0.0001186	- 0.0005138	- 0.0004363	- 0.0012752	- 0.0002160	- 0.0003684
11 TransEqp	-	- 0.0000084	- 0.0000038	- 0.0000003	- 0.0000011	- 0.0000009	- 0.0000004	- 0.0000002	- 0.0000006	- 0.0000007	- 0.0000685	- 0.0000056	- 0.0000003	- 0.0000655	- 0.0000878	- 0.0022687	- 0.0000141	- 0.0010994	- 0.0000801	- 0.0003392	- 0.0000936	- 0.0038822	- 0.0000734	- 0.0000293
12 OthMachEqp	-	- 0.0001910	- 0.0015855	- 0.0000325	- 0.0000298	- 0.0000270	- 0.0000478	- 0.0001049	- 0.0000324	- 0.0001551	- 0.0000436	- 0.0000679	- 0.0001460	- 0.0020463	- 0.0009305	- 0.0035993	- 0.0007340	- 0.0021450	- 0.0005245	- 0.0026943	- 0.0030833	- 0.0091892	- 0.0018928	- 0.0056534
13 EGW	-	- 0.0000277	- 0.0000694	- 0.0000025	- 0.0000027	- 0.0000030	- 0.0000027	- 0.0000041	- 0.0000045	- 0.0000171	- 0.0000034	- 0.0000090	- 0.0003105	- 0.0000928	- 0.0000637	- 0.0004617	- 0.0000996	- 0.0002802	- 0.0000913	- 0.0003864	- 0.0007262	- 0.0007467	- 0.0007054	- 0.0009630
14 Construction	-	- 0.0000690	- 0.0000183	- 0.0000013	- 0.0000007	- 0.0000004	- 0.0000008	- 0.0000077	- 0.0000003	- 0.0000022	- 0.0000006	- 0.0000028	- 0.0000414	- 0.0035581	- 0.0002377	- 0.0003178	- 0.0000669	- 0.0003103	- 0.0003743	- 0.0015851	- 0.0009919	- 0.0051380	- 0.0000156	- 0.0001037
15 WholesalTrad	-	- 0.0009335	- 0.0077491	- 0.0001590	- 0.0001456	- 0.0001318	- 0.0002338	- 0.0005128	- 0.0001586	- 0.0007583	- 0.0002132	- 0.0003319	- 0.0007133	- 0.0100011	- 0.0045476	- 0.0175913	- 0.0035876	- 0.0104837	- 0.0025637	- 0.0131684	- 0.0150694	- 0.0449118	- 0.0092512	- 0.0276306
16 RetailTrade	-	- 0.0000076	- 0.0000444	- 0.0000013	- 0.0000011	- 0.0000015	- 0.0000064	- 0.0000020	- 0.0000005	- 0.0000010	- 0.0000004	- 0.0000019	- 0.0000040	- 0.0000876	- 0.0002075	- 0.0010440	- 0.0001149	- 0.0009151	- 0.0001647	- 0.0006975	- 0.0006287	- 0.0006829	- 0.0001573	- 0.0008335
17 RecPersSrvc	-	- 0.0000160	- 0.0001704	- 0.0000024	- 0.0000019	- 0.0000020	- 0.0000126	- 0.0000084	- 0.0000022	- 0.0000053	- 0.0000053	- 0.0000074	- 0.0000069	- 0.0000873	- 0.0002049	- 0.0009115	- 0.0005283	- 0.0002525	- 0.0001464	- 0.0007869	- 0.0026386	- 0.0025723	- 0.0011207	- 0.0033165
18 Transport	-	- 0.0000719	- 0.0001774	- 0.0000085	- 0.0000049	- 0.0000069	- 0.0000159	- 0.0000103	- 0.0000064	- 0.0000163	- 0.0000051	- 0.0000137	- 0.0000047	- 0.0001832	- 0.0011864	- 0.0004914	- 0.0000760	- 0.0017371	- 0.0001384	- 0.0011776	- 0.0013376	- 0.0042673	- 0.0005112	- 0.0008887
19 PostalSrvcs	-	- 0.0000005	- 0.0000090	- 0.0000003	- 0.0000004	- 0.0000002	- 0.0000036	- 0.0000002	- 0.0000004	- 0.0000006	- 0.0000004	- 0.0000019	- 0.0000005	- 0.0000104	- 0.0000315	- 0.0002602	- 0.0000487	- 0.0000371	- 0.0000622	- 0.0002632	- 0.0002632	- 0.0005675	- 0.0001654	- 0.0006456
20 Telecomms	-	- 0.0034396	- 0.0285529	- 0.0005859	- 0.0005364	- 0.0004855	- 0.0008615	- 0.0018896	- 0.0005843	- 0.0027939	- 0.0007855	- 0.0012228	- 0.0026284	- 0.0368510	- 0.0167563	- 0.0648183	- 0.0132192	- 0.0386293	- 0.0094464	- 0.0485214	- 0.0555259	- 0.1654859	- 0.0340879	- 0.1018102
21 FinBusSrvces	-	- 0.0016358	- 0.0135794	- 0.0002786	- 0.0002551	- 0.0002309	- 0.0004097	- 0.0008987	- 0.0002779	- 0.0013288	- 0.0003736	- 0.0005816	- 0.0012501	- 0.0175259	- 0.0079691	- 0.0308269	- 0.0062869	- 0.0183717	- 0.0044926	- 0.0230763	- 0.0264075	- 0.0787034	- 0.0162119	- 0.0484199
22 PubAdmDef	-	- 0.0000057	- 0.0000144	- 0.0000003	- 0.0000003	- 0.0000006	- 0.0000043	- 0.0000019	- 0.0000003	- 0.0000010	- 0.0000012	- 0.0000008	- 0.0000010	- 0.0000556	- 0.0000204	- 0.0001458	- 0.0000108	- 0.0002508	- 0.0000133	- 0.0003432	- 0.0003485	- 0.0039558	- 0.0002743	- 0.0004378
23 Education	-	- 0.0000032	- 0.0000178	- 0.0000008	- 0.0000005	- 0.0000004	- 0.0000012	- 0.0000014	- 0.0000007	- 0.0000012	- 0.0000010	- 0.0000027	- 0.0000037	- 0.0000088	- 0.0000067	- 0.0000908	- 0.0000452	- 0.0000784	- 0.0000111	- 0.0000471	- 0.0005986	- 0.0005765	- 0.0007443	- 0.0003128
24 Community	-	- 0.0000000	- 0.0000068	- 0.0000004	- 0.0000000	- 0.0000001	- 0.0000012	- 0.0000013	- 0.0000000	- 0.0000000	- 0.0000006	- 0.0000001	- 0.0000001	- 0.0000010	- 0.0000028	- 0.0000155	- 0.0000080	- 0.0000207	- 0.0000032	- 0.0000826	- 0.0000171	- 0.0002077	- 0.0000432	- 0.0015759

Table C.15: Intermediate technical change through cloud computing in Tasmania when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000016	-0.0035427	-0.0000280	-0.0000055	-0.0000050	-0.0000004	-0.0000085	-0.0000001	-0.0000005	-0.0000001	-0.0000009	-0.0000000	-0.0000287	-0.0000830	-0.0002844	-0.0000911	-0.0000085	-0.0000007	-0.0000016	-0.0001144	-0.0004748	-0.0000132	-0.0000566
2 Mining	-	-0.0003641	-0.0000977	-0.0000018	-0.0000032	-0.0000041	-0.0000009	-0.0002719	-0.0000513	-0.0003757	-0.0000017	-0.0000071	-0.0000265	-0.0001882	-0.0000276	-0.0002251	-0.0000196	-0.0000085	-0.0000216	-0.0000430	-0.0001084	-0.0003143	-0.0000874	-0.0003875
3 FoodDrinkTob	-	-0.0000016	-0.0017983	-0.0000016	-0.0000089	-0.0000002	-0.0000006	-0.0000109	-0.0000001	-0.0000003	-0.0000005	-0.0000008	-0.0000001	-0.0000168	-0.0001175	-0.0027023	-0.0004095	-0.0000086	-0.0000148	-0.0000294	-0.0001797	-0.0009136	-0.0002724	-0.0002743
4 TCFs	-	-0.0000031	-0.0000289	-0.0000618	-0.0000064	-0.0000304	-0.0000039	-0.0000018	-0.0000010	-0.0000084	-0.0000038	-0.0000051	-0.0000003	-0.0008324	-0.0001418	-0.0002439	-0.0000273	-0.0000434	-0.0000114	-0.0000227	-0.0002111	-0.0012836	-0.0003257	-0.0011630
5 MiscManuf	-	-0.0000085	-0.0002817	-0.0000051	-0.0000191	-0.0000072	-0.0000230	-0.0000140	-0.0000015	-0.0000061	-0.0000103	-0.0000200	-0.0000016	-0.0004650	-0.0002157	-0.0002454	-0.0000338	-0.0001043	-0.0001113	-0.0002214	-0.0001717	-0.0026666	-0.0002936	-0.0005799
6 WoodProds	-	-0.0000030	-0.0002712	-0.0000029	-0.0000030	-0.0000211	-0.0000587	-0.0000075	-0.0000026	-0.0000033	-0.0000039	-0.0000043	-0.0000002	-0.0001227	-0.0001473	-0.0002164	-0.0000271	-0.0000210	-0.0000248	-0.0000493	-0.0001462	-0.0022272	-0.0004834	-0.0008634
7 PaperPrint	-	-0.0000030	-0.0000346	-0.0000017	-0.0000026	-0.0000041	-0.0000431	-0.0000026	-0.0000010	-0.0000029	-0.0000019	-0.0000070	-0.0000004	-0.0000964	-0.0002952	-0.0012366	-0.0000634	-0.0000342	-0.0001397	-0.0002781	-0.0008086	-0.0042789	-0.0017842	-0.0004964
8 ChemCoalPrds	-	-0.0001575	-0.0000843	-0.0000125	-0.0000521	-0.0000156	-0.0000228	-0.0001131	-0.0000156	-0.0000188	-0.0000102	-0.0000215	-0.0000094	-0.0008118	-0.0003969	-0.0006453	-0.0000999	-0.0010299	-0.0000191	-0.0001727	-0.0007974	-0.0023257	-0.0002044	-0.0053993
9 NonMetMinPrd	-	-0.0000036	-0.0000663	-0.0000015	-0.0000016	-0.0000011	-0.0000003	-0.0000020	-0.0000487	-0.0000076	-0.0000046	-0.0000068	-0.0000015	-0.0014081	-0.0000878	-0.0000963	-0.0000064	-0.0000017	-0.0000002	-0.0000005	-0.0001849	-0.0002342	-0.0000193	-0.0000873
10 MetalPrds	-	-0.0000614	-0.0001554	-0.0000106	-0.0000182	-0.0000156	-0.0000031	-0.0000073	-0.0000082	-0.0002401	-0.0000493	-0.0001818	-0.0000033	-0.0017759	-0.0002083	-0.0002847	-0.0000300	-0.0001104	-0.0000681	-0.0001387	-0.0004733	-0.0024410	-0.0003041	-0.0003449
11 TransEqp	-	-0.0000114	-0.0000049	-0.0000004	-0.0000015	-0.0000012	-0.0000005	-0.0000003	-0.0000009	-0.0000010	-0.0000933	-0.0000076	-0.0000001	-0.0001308	-0.0001317	-0.0022065	-0.0000076	-0.0006315	-0.0000460	-0.0000916	-0.0001015	-0.0074314	-0.0001033	-0.0000274
12 OthMachEqp	-	-0.0002601	-0.0020525	-0.0000443	-0.0000406	-0.0000367	-0.0000652	-0.0001429	-0.0000442	-0.0002113	-0.0000594	-0.0000925	-0.0000495	-0.0040854	-0.0013967	-0.0035007	-0.0003932	-0.0012322	-0.0003013	-0.0007275	-0.0033448	-0.0175898	-0.0026649	-0.0052927
13 EGW	-	-0.0000377	-0.0000898	-0.0000034	-0.0000037	-0.0000042	-0.0000037	-0.0000056	-0.0000061	-0.0000233	-0.0000046	-0.0000123	-0.0001053	-0.0001852	-0.0000956	-0.0004490	-0.0000534	-0.0001609	-0.0000524	-0.0001043	-0.0007878	-0.0014293	-0.0009932	-0.0009016
14 Construction	-	-0.0000941	-0.0000237	-0.0000018	-0.0000010	-0.0000005	-0.0000012	-0.0000106	-0.0000005	-0.0000030	-0.0000008	-0.0000038	-0.0000140	-0.0071039	-0.0003567	-0.0003091	-0.0000358	-0.0001782	-0.0002150	-0.0004280	-0.0010761	-0.0098351	-0.0000220	-0.0000971
15 WholesalTrad	-	-0.0012715	-0.0100315	-0.0002166	-0.0001983	-0.0001795	-0.0003185	-0.0006985	-0.0002160	-0.0010328	-0.0002904	-0.0004520	-0.0002418	-0.0199674	-0.0068262	-0.0171094	-0.0019216	-0.0060222	-0.0014727	-0.0035558	-0.0163477	-0.0859700	-0.0130248	-0.0258681
16 RetailTrade	-	-0.0000103	-0.0000575	-0.0000018	-0.0000016	-0.0000020	-0.0000087	-0.0000027	-0.0000007	-0.0000013	-0.0000005	-0.0000025	-0.0000014	-0.0001749	-0.0003114	-0.0010154	-0.0000615	-0.0005257	-0.0000946	-0.0001883	-0.0006821	-0.0013072	-0.0002214	-0.0007803
17 RecPersSrvc	-	-0.0000218	-0.0002205	-0.0000033	-0.0000026	-0.0000028	-0.0000172	-0.0000114	-0.0000031	-0.0000072	-0.0000073	-0.0000100	-0.0000024	-0.0001742	-0.0003075	-0.0008866	-0.0002830	-0.0001450	-0.0000841	-0.0002125	-0.0028624	-0.0049239	-0.0015778	-0.0031049
18 Transport	-	-0.0000980	-0.0002297	-0.0000116	-0.0000067	-0.0000094	-0.0000217	-0.0000141	-0.0000087	-0.0000222	-0.0000069	-0.0000186	-0.0000016	-0.0003658	-0.0017808	-0.0004779	-0.0000407	-0.0009979	-0.0000795	-0.0003180	-0.0014511	-0.0081684	-0.0007197	-0.0008320
19 PostalSrvcs	-	-0.0000006	-0.0000116	-0.0000004	-0.0000006	-0.0000003	-0.0000050	-0.0000003	-0.0000005	-0.0000009	-0.0000005	-0.0000026	-0.0000002	-0.0000208	-0.0000472	-0.0002531	-0.0000261	-0.0000213	-0.0000357	-0.0000711	-0.0002856	-0.0010863	-0.0002329	-0.0006044
20 Telecomms	-	-0.0046849	-0.0369628	-0.0007980	-0.0007306	-0.0006613	-0.0011735	-0.0025738	-0.0007959	-0.0038055	-0.0010699	-0.0016656	-0.0008911	-0.0735734	-0.0251523	-0.0630426	-0.0070807	-0.0221901	-0.0054264	-0.0131019	-0.0602361	-0.3167723	-0.0479921	-0.0953158
21 FinBusSrvces	-	-0.0022281	-0.0175791	-0.0003795	-0.0003474	-0.0003145	-0.0005581	-0.0012241	-0.0003785	-0.0018099	-0.0005088	-0.0007921	-0.0004238	-0.0349908	-0.0119622	-0.0299824	-0.0033675	-0.0105534	-0.0025807	-0.0062311	-0.0286477	-0.1506536	-0.0228246	-0.0453312
22 PubAdmDef	-	-0.0000077	-0.0000186	-0.0000004	-0.0000004	-0.0000008	-0.0000058	-0.0000026	-0.0000004	-0.0000014	-0.0000017	-0.0000010	-0.0000003	-0.0001109	-0.0000307	-0.0001418	-0.0000058	-0.0001441	-0.0000077	-0.0000927	-0.0003781	-0.0075722	-0.0003862	-0.0004098
23 Education	-	-0.0000044	-0.0000231	-0.0000011	-0.0000006	-0.0000005	-0.0000017	-0.0000019	-0.0000009	-0.0000017	-0.0000013	-0.0000037	-0.0000013	-0.0000175	-0.0000101	-0.0000883	-0.0000242	-0.0000451	-0.0000064	-0.0000127	-0.0006494	-0.0011034	-0.0010479	-0.0002929
24 Community	-	-0.0000000	-0.0000088	-0.0000005	-0.0000001	-0.0000001	-0.0000017	-0.0000018	-0.0000000	-0.0000000	-0.0000008	-0.0000001	-0.0000000	-0.0000020	-0.0000042	-0.0000151	-0.0000043	-0.0000119	-0.0000018	-0.0000223	-0.0000185	-0.0003975	-0.0000608	-0.0014754

Table C.16: Intermediate technical change through cloud computing in Northern Territory when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000008	-0.0015402	-0.0000144	-0.0000028	-0.0000026	-0.0000002	-0.0000044	-0.0000000	-0.0000002	-0.0000001	-0.0000005	-0.0000001	-0.0000117	-0.0000468	-0.0001701	-0.0000914	-0.0000059	-0.0000005	-0.0000063	-0.0001030	-0.0004681	-0.0000133	-0.0000408
2 Mining	-	-0.0001874	-0.0000425	-0.0000009	-0.0000017	-0.0000021	-0.0000004	-0.0001400	-0.0000264	-0.0001934	-0.0000009	-0.0000037	-0.0000884	-0.0000765	-0.0000156	-0.0001346	-0.0000196	-0.0000060	-0.0000151	-0.0001748	-0.0000976	-0.0003098	-0.0000880	-0.0002789
3 FoodDrinkTob	-	-0.0000008	-0.0007818	-0.0000008	-0.0000046	-0.0000001	-0.0000003	-0.0000056	-0.0000001	-0.0000002	-0.0000002	-0.0000004	-0.0000004	-0.0000068	-0.0000664	-0.0016160	-0.0004107	-0.0000061	-0.0000103	-0.0001195	-0.0001617	-0.0009006	-0.0002742	-0.0001974
4 TCFs	-	-0.0000016	-0.0000126	-0.0000318	-0.0000033	-0.0000156	-0.0000020	-0.0000009	-0.0000005	-0.0000043	-0.0000019	-0.0000026	-0.0000011	-0.0003384	-0.0000801	-0.0001458	-0.0000274	-0.0000304	-0.0000080	-0.0000923	-0.0001899	-0.0012654	-0.0003278	-0.0008370
5 MiscManuf	-	-0.0000044	-0.0001225	-0.0000026	-0.0000098	-0.0000037	-0.0000118	-0.0000072	-0.0000008	-0.0000031	-0.0000053	-0.0000103	-0.0000053	-0.0001890	-0.0001218	-0.0001468	-0.0000339	-0.0000730	-0.0000779	-0.0009003	-0.0001544	-0.0026287	-0.0002955	-0.0004173
6 WoodProds	-	-0.0000015	-0.0001179	-0.0000015	-0.0000016	-0.0000109	-0.0000302	-0.0000039	-0.0000013	-0.0000017	-0.0000020	-0.0000022	-0.0000006	-0.0000499	-0.0000832	-0.0001294	-0.0000272	-0.0000147	-0.0000173	-0.0002004	-0.0001316	-0.0021956	-0.0004865	-0.0006214
7 PaperPrint	-	-0.0000016	-0.0000150	-0.0000009	-0.0000013	-0.0000021	-0.0000222	-0.0000013	-0.0000005	-0.0000015	-0.0000010	-0.0000036	-0.0000014	-0.0000392	-0.0001666	-0.0007395	-0.0000636	-0.0000239	-0.0000978	-0.0011307	-0.0007275	-0.0042181	-0.0017957	-0.0003573
8 ChemCoalPrds	-	-0.0000811	-0.0000366	-0.0000064	-0.0000268	-0.0000080	-0.0000117	-0.0000582	-0.0000080	-0.0000097	-0.0000052	-0.0000111	-0.0000314	-0.0003300	-0.0002241	-0.0003859	-0.0001002	-0.0007206	-0.0000134	-0.0007022	-0.0007174	-0.0022927	-0.0002058	-0.0038859
9 NonMetMinPrd	-	-0.0000019	-0.0000288	-0.0000008	-0.0000008	-0.0000006	-0.0000002	-0.0000010	-0.0000251	-0.0000039	-0.0000024	-0.0000035	-0.0000051	-0.0005724	-0.0000495	-0.0000576	-0.0000064	-0.0000012	-0.0000002	-0.0000019	-0.0001664	-0.0002309	-0.0000194	-0.0000629
10 MetalPrds	-	-0.0000316	-0.0000676	-0.0000055	-0.0000094	-0.0000080	-0.0000016	-0.0000038	-0.0000042	-0.0001236	-0.0000254	-0.0000936	-0.0000112	-0.0007219	-0.0001176	-0.0001703	-0.0000300	-0.0000773	-0.0000477	-0.0005641	-0.0004258	-0.0024063	-0.0003061	-0.0002483
11 TransEqp	-	-0.0000059	-0.0000022	-0.0000002	-0.0000008	-0.0000006	-0.0000003	-0.0000002	-0.0000005	-0.0000005	-0.0000480	-0.0000039	-0.0000003	-0.0000532	-0.0000744	-0.0013195	-0.0000076	-0.0004419	-0.0000322	-0.0003724	-0.0000914	-0.0073257	-0.0001040	-0.0000197
12 OthMachEqp	-	-0.0001339	-0.0008923	-0.0000228	-0.0000209	-0.0000189	-0.0000335	-0.0000736	-0.0000227	-0.0001088	-0.0000306	-0.0000476	-0.0001650	-0.0016607	-0.0007885	-0.0020934	-0.0003944	-0.0008622	-0.0002108	-0.0029583	-0.0030094	-0.0173399	-0.0026822	-0.0038092
13 EGW	-	-0.0000194	-0.0000391	-0.0000018	-0.0000019	-0.0000021	-0.0000019	-0.0000029	-0.0000031	-0.0000120	-0.0000024	-0.0000063	-0.0003510	-0.0000753	-0.0000540	-0.0002685	-0.0000535	-0.0001126	-0.0000367	-0.0004243	-0.0007088	-0.0014090	-0.0009996	-0.0006489
14 Construction	-	-0.0000484	-0.0000103	-0.0000009	-0.0000005	-0.0000003	-0.0000006	-0.0000054	-0.0000002	-0.0000016	-0.0000004	-0.0000020	-0.0000468	-0.0028877	-0.0002014	-0.0001849	-0.0000359	-0.0001247	-0.0001504	-0.0017404	-0.0009681	-0.0096953	-0.0000221	-0.0000699
15 WholesalTrad	-	-0.0006544	-0.0043613	-0.0001115	-0.0001020	-0.0000924	-0.0001639	-0.0003595	-0.0001112	-0.0005315	-0.0001494	-0.0002326	-0.0008063	-0.0081166	-0.0038538	-0.0102315	-0.0019275	-0.0042138	-0.0010305	-0.0144587	-0.0147082	-0.0847482	-0.0131090	-0.0186172
16 RetailTrade	-	-0.0000053	-0.0000250	-0.0000009	-0.0000008	-0.0000011	-0.0000045	-0.0000014	-0.0000003	-0.0000007	-0.0000003	-0.0000013	-0.0000045	-0.0000711	-0.0001758	-0.0006072	-0.0000617	-0.0003678	-0.0000662	-0.0007658	-0.0006137	-0.0012886	-0.0002229	-0.0005616
17 RecPersSrvc	-	-0.0000112	-0.0000959	-0.0000017	-0.0000014	-0.0000014	-0.0000088	-0.0000059	-0.0000016	-0.0000037	-0.0000037	-0.0000052	-0.0000078	-0.0000708	-0.0001736	-0.0005302	-0.0002838	-0.0001015	-0.0000588	-0.0008641	-0.0025753	-0.0048540	-0.0015880	-0.0022346
18 Transport	-	-0.0000504	-0.0000999	-0.0000060	-0.0000035	-0.0000048	-0.0000112	-0.0000072	-0.0000045	-0.0000114	-0.0000036	-0.0000096	-0.0000053	-0.0001487	-0.0010054	-0.0002858	-0.0000408	-0.0006982	-0.0000556	-0.0012930	-0.0013056	-0.0080523	-0.0007244	-0.0005988
19 PostalSrvcs	-	-0.0000003	-0.0000051	-0.0000002	-0.0000003	-0.0000001	-0.0000026	-0.0000002	-0.0000003	-0.0000005	-0.0000002	-0.0000013	-0.0000006	-0.0000085	-0.0000267	-0.0001513	-0.0000262	-0.0000149	-0.0000250	-0.0002890	-0.0002569	-0.0010708	-0.0002344	-0.0004350
20 Telecomms	-	-0.0024111	-0.0160699	-0.0004107	-0.0003760	-0.0003403	-0.0006039	-0.0013246	-0.0004096	-0.0019586	-0.0005506	-0.0008572	-0.0029711	-0.0299071	-0.0141999	-0.0377000	-0.0071023	-0.0155267	-0.0037969	-0.0532758	-0.0541953	-0.3122704	-0.0483026	-0.0685987
21 FinBusSrvces	-	-0.0011467	-0.0076427	-0.0001953	-0.0001788	-0.0001619	-0.0002872	-0.0006300	-0.0001948	-0.0009315	-0.0002619	-0.0004077	-0.0014130	-0.0142235	-0.0067533	-0.0179297	-0.0033778	-0.0073843	-0.0018058	-0.0253374	-0.0257747	-0.1485125	-0.0229722	-0.0326248
22 PubAdmDef	-	-0.0000040	-0.0000081	-0.0000002	-0.0000002	-0.0000004	-0.0000030	-0.0000014	-0.0000002	-0.0000007	-0.0000009	-0.0000005	-0.0000012	-0.0000451	-0.0000173	-0.0000848	-0.0000058	-0.0001008	-0.0000054	-0.0003769	-0.0003402	-0.0074646	-0.0003887	-0.0002950
23 Education	-	-0.0000023	-0.0000100	-0.0000006	-0.0000003	-0.0000002	-0.0000009	-0.0000010	-0.0000005	-0.0000009	-0.0000007	-0.0000019	-0.0000042	-0.0000071	-0.0000057	-0.0000528	-0.0000243	-0.0000315	-0.0000045	-0.0000517	-0.0005842	-0.0010878	-0.0010547	-0.0002108
24 Community	-	-0.0000000	-0.0000038	-0.0000003	-0.0000000	-0.0000000	-0.0000009	-0.0000009	-0.0000000	-0.0000000	-0.0000004	-0.0000001	-0.0000001	-0.0000008	-0.0000024	-0.0000090	-0.0000043	-0.0000083	-0.0000013	-0.0000907	-0.0000166	-0.0003918	-0.0000612	-0.0010618

Table C.17: Intermediate technical change through cloud computing in Australian Capital Territory when services require modest access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000012	-0.0008368	-0.0000214	-0.0000042	-0.0000038	-0.0000003	-0.0000065	-0.0000001	-0.0000003	-0.0000001	-0.0000007	-0.0000000	-0.0000012	-0.0000494	-0.0000729	-0.0001030	-0.0000021	-0.0000002	-0.0000014	-0.0000359	-0.0001015	-0.0000053	-0.0000105
2 Mining	-	-0.0002782	-0.0000231	-0.0000014	-0.0000024	-0.0000031	-0.0000007	-0.0002077	-0.0000392	-0.0002870	-0.0000013	-0.0000055	-0.0000120	-0.0000079	-0.0000164	-0.0000577	-0.0000221	-0.0000021	-0.0000054	-0.0000382	-0.0000340	-0.0000672	-0.0000351	-0.0000719
3 FoodDrinkTob	-	-0.0000012	-0.0004247	-0.0000012	-0.0000068	-0.0000002	-0.0000005	-0.0000083	-0.0000001	-0.0000002	-0.0000004	-0.0000006	-0.0000001	-0.0000007	-0.0000699	-0.0006929	-0.0004628	-0.0000022	-0.0000037	-0.0000261	-0.0000564	-0.0001953	-0.0001094	-0.0000509
4 TCFs	-	-0.0000024	-0.0000068	-0.0000472	-0.0000049	-0.0000232	-0.0000030	-0.0000014	-0.0000008	-0.0000064	-0.0000029	-0.0000039	-0.0000001	-0.0000348	-0.0000844	-0.0000625	-0.0000308	-0.0000108	-0.0000028	-0.0000202	-0.0000662	-0.0002744	-0.0001308	-0.0002159
5 MiscManuf	-	-0.0000065	-0.0000665	-0.0000039	-0.0000146	-0.0000055	-0.0000176	-0.0000107	-0.0000012	-0.0000046	-0.0000079	-0.0000153	-0.0000007	-0.0000194	-0.0001283	-0.0000629	-0.0000382	-0.0000260	-0.0000278	-0.0001970	-0.0000538	-0.0005701	-0.0001179	-0.0001076
6 WoodProds	-	-0.0000023	-0.0000641	-0.0000022	-0.0000023	-0.0000162	-0.0000448	-0.0000057	-0.0000020	-0.0000025	-0.0000030	-0.0000033	-0.0000001	-0.0000051	-0.0000876	-0.0000555	-0.0000306	-0.0000052	-0.0000062	-0.0000439	-0.0000459	-0.0004762	-0.0001941	-0.0001603
7 PaperPrint	-	-0.0000023	-0.0000082	-0.0000013	-0.0000020	-0.0000032	-0.0000329	-0.0000020	-0.0000008	-0.0000023	-0.0000014	-0.0000053	-0.0000002	-0.0000040	-0.0001756	-0.0003171	-0.0000717	-0.0000085	-0.0000349	-0.0002474	-0.0002536	-0.0009148	-0.0007164	-0.0000921
8 ChemCoalPrds	-	-0.0001203	-0.0000199	-0.0000095	-0.0000398	-0.0000119	-0.0000174	-0.0000864	-0.0000119	-0.0000144	-0.0000078	-0.0000164	-0.0000043	-0.0000340	-0.0002362	-0.0001654	-0.0001130	-0.0002569	-0.0000048	-0.0001536	-0.0002501	-0.0004972	-0.0000821	-0.0010021
9 NonMetMinPrd	-	-0.0000028	-0.0000157	-0.0000011	-0.0000013	-0.0000008	-0.0000002	-0.0000015	-0.0000372	-0.0000058	-0.0000035	-0.0000052	-0.0000007	-0.0000589	-0.0000522	-0.0000247	-0.0000072	-0.0000004	-0.0000001	-0.0000004	-0.0000580	-0.0000501	-0.0000077	-0.0000162
10 MetalPrds	-	-0.0000469	-0.0000367	-0.0000081	-0.0000139	-0.0000119	-0.0000024	-0.0000056	-0.0000062	-0.0001834	-0.0000377	-0.0001389	-0.0000015	-0.0000743	-0.0001239	-0.0000730	-0.0000339	-0.0000275	-0.0000170	-0.0001234	-0.0001485	-0.0005219	-0.0001221	-0.0000640
11 TransEqp	-	-0.0000087	-0.0000012	-0.0000003	-0.0000011	-0.0000009	-0.0000004	-0.0000002	-0.0000007	-0.0000008	-0.0000712	-0.0000058	-0.0000000	-0.0000055	-0.0000784	-0.0005657	-0.0000086	-0.0001575	-0.0000115	-0.0000815	-0.0000319	-0.0015889	-0.0000415	-0.0000051
12 OthMachEqp	-	-0.0001987	-0.0004848	-0.0000339	-0.0000310	-0.0000281	-0.0000498	-0.0001092	-0.0000338	-0.0001614	-0.0000454	-0.0000707	-0.0000225	-0.0001709	-0.0008311	-0.0008975	-0.0004444	-0.0003074	-0.0000752	-0.0006472	-0.0010492	-0.0037608	-0.0010701	-0.0009823
13 EGW	-	-0.0000288	-0.0000212	-0.0000026	-0.0000028	-0.0000032	-0.0000028	-0.0000043	-0.0000047	-0.0000178	-0.0000035	-0.0000094	-0.0000478	-0.0000077	-0.0000569	-0.0001151	-0.0000603	-0.0000401	-0.0000131	-0.0000928	-0.0002471	-0.0003056	-0.0003988	-0.0001673
14 Construction	-	-0.0000718	-0.0000056	-0.0000013	-0.0000008	-0.0000004	-0.0000009	-0.0000081	-0.0000004	-0.0000023	-0.0000006	-0.0000029	-0.0000064	-0.0002971	-0.0002123	-0.0000793	-0.0000405	-0.0000445	-0.0000536	-0.0003807	-0.0003375	-0.0021028	-0.0000088	-0.0000180
15 WholesalTrad	-	-0.0009713	-0.0023693	-0.0001654	-0.0001515	-0.0001371	-0.0002433	-0.0005336	-0.0001650	-0.0007890	-0.0002218	-0.0003453	-0.0001098	-0.0008351	-0.0040618	-0.0043867	-0.0021719	-0.0015022	-0.0003673	-0.0031631	-0.0051279	-0.0183808	-0.0052299	-0.0048011
16 RetailTrade	-	-0.0000079	-0.0000136	-0.0000014	-0.0000012	-0.0000016	-0.0000066	-0.0000021	-0.0000005	-0.0000010	-0.0000004	-0.0000019	-0.0000006	-0.0000073	-0.0001853	-0.0002603	-0.0000695	-0.0001311	-0.0000236	-0.0001675	-0.0002139	-0.0002795	-0.0000889	-0.0001448
17 RecPersSrvc	-	-0.0000167	-0.0000521	-0.0000025	-0.0000020	-0.0000021	-0.0000131	-0.0000087	-0.0000023	-0.0000055	-0.0000056	-0.0000077	-0.0000011	-0.0000073	-0.0001830	-0.0002273	-0.0003198	-0.0000362	-0.0000210	-0.0001890	-0.0008979	-0.0010528	-0.0006336	-0.0005763
18 Transport	-	-0.0000748	-0.0000543	-0.0000089	-0.0000051	-0.0000071	-0.0000166	-0.0000107	-0.0000067	-0.0000170	-0.0000053	-0.0000142	-0.0000007	-0.0000153	-0.0010597	-0.0001225	-0.0000460	-0.0002489	-0.0000198	-0.0002829	-0.0004552	-0.0017464	-0.0002890	-0.0001544
19 PostalSrvcs	-	-0.0000005	-0.0000027	-0.0000003	-0.0000005	-0.0000002	-0.0000038	-0.0000003	-0.0000004	-0.0000007	-0.0000004	-0.0000020	-0.0000001	-0.0000009	-0.0000281	-0.0000649	-0.0000295	-0.0000053	-0.0000089	-0.0000632	-0.0000896	-0.0002323	-0.0000935	-0.0001122
20 Telecomms	-	-0.0035789	-0.0087303	-0.0006096	-0.0005581	-0.0005052	-0.0008964	-0.0019661	-0.0006080	-0.0029071	-0.0008173	-0.0012723	-0.0004047	-0.0030771	-0.0149665	-0.0161638	-0.0080028	-0.0055351	-0.0013536	-0.0116551	-0.0188947	-0.0677273	-0.0192707	-0.0176904
21 FinBusSrvces	-	-0.0017021	-0.0041520	-0.0002899	-0.0002654	-0.0002402	-0.0004263	-0.0009351	-0.0002891	-0.0013826	-0.0003887	-0.0006051	-0.0001925	-0.0014634	-0.0071179	-0.0076873	-0.0038060	-0.0026324	-0.0006437	-0.0055430	-0.0089861	-0.0322104	-0.0091649	-0.0084134
22 PubAdmDef	-	-0.0000059	-0.0000044	-0.0000003	-0.0000003	-0.0000006	-0.0000045	-0.0000020	-0.0000003	-0.0000011	-0.0000013	-0.0000008	-0.0000002	-0.0000046	-0.0000183	-0.0000364	-0.0000065	-0.0000359	-0.0000019	-0.0000824	-0.0001186	-0.0016190	-0.0001551	-0.0000761
23 Education	-	-0.0000034	-0.0000055	-0.0000008	-0.0000005	-0.0000004	-0.0000013	-0.0000014	-0.0000007	-0.0000013	-0.0000010	-0.0000028	-0.0000006	-0.0000007	-0.0000060	-0.0000227	-0.0000274	-0.0000112	-0.0000016	-0.0000113	-0.0002037	-0.0002359	-0.0004208	-0.0000544
24 Community	-	-0.0000000	-0.0000021	-0.0000004	-0.0000000	-0.0000001	-0.0000013	-0.0000014	-0.0000000	-0.0000000	-0.0000006	-0.0000001	-0.0000000	-0.0000001	-0.0000025	-0.0000039	-0.0000048	-0.0000030	-0.0000005	-0.0000198	-0.0000058	-0.0000850	-0.0000244	-0.0002738

Table C.18: Intermediate technical change through cloud computing in Sydney, New South Wales, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000017	-0.0024582	-0.0000287	-0.0000057	-0.0000051	-0.0000004	-0.0000087	-0.0000001	-0.0000005	-0.0000002	-0.0000009	-0.0000001	-0.0000175	-0.0000664	-0.0002197	-0.0001908	-0.0000068	-0.0000006	-0.0000042	-0.0001083	-0.0004442	-0.0000155	-0.0000736
2 Mining	-	-0.0003741	-0.0000678	-0.0000019	-0.0000033	-0.0000042	-0.0000009	-0.0002794	-0.0000527	-0.0003861	-0.0000018	-0.0000073	-0.0000757	-0.0001147	-0.0000221	-0.0001738	-0.0000410	-0.0000068	-0.0000173	-0.0001170	-0.0001026	-0.0002940	-0.0001026	-0.0005040
3 FoodDrinkTob	-	-0.0000016	-0.0012478	-0.0000016	-0.0000092	-0.0000002	-0.0000006	-0.0000111	-0.0000001	-0.0000003	-0.0000005	-0.0000009	-0.0000003	-0.0000102	-0.0000942	-0.0020871	-0.0008575	-0.0000069	-0.0000119	-0.0000799	-0.0001700	-0.0008547	-0.0003198	-0.0003568
4 TCFs	-	-0.0000032	-0.0000201	-0.0000635	-0.0000065	-0.0000312	-0.0000040	-0.0000019	-0.0000010	-0.0000086	-0.0000039	-0.0000052	-0.0000009	-0.0005074	-0.0001136	-0.0001883	-0.0000571	-0.0000348	-0.0000092	-0.0000618	-0.0001997	-0.0012008	-0.0003823	-0.0015127
5 MiscManuf	-	-0.0000087	-0.0001955	-0.0000052	-0.0000196	-0.0000074	-0.0000236	-0.0000143	-0.0000016	-0.0000062	-0.0000106	-0.0000206	-0.0000046	-0.0002835	-0.0001728	-0.0001896	-0.0000708	-0.0000837	-0.0000893	-0.0006025	-0.0001624	-0.0024947	-0.0003447	-0.0007542
6 WoodProds	-	-0.0000031	-0.0001882	-0.0000030	-0.0000031	-0.0000217	-0.0000603	-0.0000077	-0.0000027	-0.0000034	-0.0000040	-0.0000044	-0.0000005	-0.0000748	-0.0001180	-0.0001671	-0.0000568	-0.0000169	-0.0000199	-0.0001341	-0.0001383	-0.0020836	-0.0005674	-0.0011230
7 PaperPrint	-	-0.0000031	-0.0000240	-0.0000018	-0.0000026	-0.0000043	-0.0000443	-0.0000026	-0.0000010	-0.0000030	-0.0000019	-0.0000071	-0.0000012	-0.0000587	-0.0002364	-0.0009551	-0.0001328	-0.0000275	-0.0001122	-0.0007567	-0.0007650	-0.0040029	-0.0020945	-0.0006456
8 ChemCoalPrds	-	-0.0001618	-0.0000585	-0.0000128	-0.0000535	-0.0000160	-0.0000234	-0.0001162	-0.0000161	-0.0000193	-0.0000105	-0.0000221	-0.0000269	-0.0004948	-0.0003179	-0.0004984	-0.0002093	-0.0008269	-0.0000153	-0.0004699	-0.0007544	-0.0021757	-0.0002400	-0.0070225
9 NonMetMinPrd	-	-0.0000037	-0.0000460	-0.0000015	-0.0000017	-0.0000011	-0.0000003	-0.0000021	-0.0000500	-0.0000078	-0.0000047	-0.0000070	-0.0000044	-0.0008583	-0.0000703	-0.0000744	-0.0000134	-0.0000014	-0.0000002	-0.0000013	-0.0001749	-0.0002191	-0.0000226	-0.0001136
10 MetalPrds	-	-0.0000631	-0.0001078	-0.0000109	-0.0000187	-0.0000160	-0.0000032	-0.0000075	-0.0000084	-0.0002467	-0.0000507	-0.0001868	-0.0000096	-0.0010825	-0.0001668	-0.0002199	-0.0000627	-0.0000886	-0.0000547	-0.0003775	-0.0004478	-0.0022835	-0.0003570	-0.0004486
11 TransEqp	-	-0.0000117	-0.0000034	-0.0000004	-0.0000015	-0.0000012	-0.0000005	-0.0000003	-0.0000009	-0.0000010	-0.0000958	-0.0000078	-0.0000003	-0.0000797	-0.0001055	-0.0017042	-0.0000158	-0.0005070	-0.0000370	-0.0002492	-0.0000961	-0.0069521	-0.0001213	-0.0000357
12 OthMachEqp	-	-0.0002673	-0.0014241	-0.0000455	-0.0000417	-0.0000377	-0.0000670	-0.0001468	-0.0000454	-0.0002171	-0.0000610	-0.0000950	-0.0001414	-0.0024902	-0.0011187	-0.0027037	-0.0008234	-0.0009893	-0.0002419	-0.0019797	-0.0031644	-0.0164553	-0.0031284	-0.0068838
13 EGW	-	-0.0000387	-0.0000623	-0.0000035	-0.0000038	-0.0000043	-0.0000038	-0.0000057	-0.0000063	-0.0000239	-0.0000047	-0.0000127	-0.0003007	-0.0001129	-0.0000766	-0.0003468	-0.0001118	-0.0001292	-0.0000421	-0.0002839	-0.0007453	-0.0013371	-0.0011659	-0.0011726
14 Construction	-	-0.0000966	-0.0000164	-0.0000018	-0.0000010	-0.0000005	-0.0000012	-0.0000108	-0.0000005	-0.0000031	-0.0000008	-0.0000039	-0.0000401	-0.0043300	-0.0002857	-0.0002388	-0.0000750	-0.0001431	-0.0001726	-0.0011646	-0.0010180	-0.0092008	-0.0000258	-0.0001262
15 WholesalTrad	-	-0.0013064	-0.0069604	-0.0002225	-0.0002037	-0.0001844	-0.0003272	-0.0007177	-0.0002219	-0.0010612	-0.0002983	-0.0004644	-0.0006910	-0.0121708	-0.0054677	-0.0132143	-0.0040244	-0.0048350	-0.0011824	-0.0096755	-0.0154660	-0.0804251	-0.0152899	-0.0336446
16 RetailTrade	-	-0.0000106	-0.0000399	-0.0000019	-0.0000016	-0.0000021	-0.0000089	-0.0000028	-0.0000007	-0.0000014	-0.0000006	-0.0000026	-0.0000039	-0.0001066	-0.0002495	-0.0007842	-0.0001288	-0.0004220	-0.0000760	-0.0005125	-0.0006453	-0.0012229	-0.0002599	-0.0010149
17 RecPersSrvc	-	-0.0000224	-0.0001530	-0.0000034	-0.0000027	-0.0000028	-0.0000177	-0.0000117	-0.0000031	-0.0000074	-0.0000075	-0.0000103	-0.0000067	-0.0001062	-0.0002463	-0.0006847	-0.0005926	-0.0001164	-0.0000675	-0.0005782	-0.0027080	-0.0046064	-0.0018522	-0.0040383
18 Transport	-	-0.0001006	-0.0001594	-0.0000120	-0.0000069	-0.0000096	-0.0000223	-0.0000145	-0.0000090	-0.0000228	-0.0000071	-0.0000191	-0.0000045	-0.0002230	-0.0014264	-0.0003691	-0.0000852	-0.0008011	-0.0000638	-0.0008652	-0.0013728	-0.0076416	-0.0008449	-0.0010821
19 PostalSrvcs	-	-0.0000006	-0.0000081	-0.0000005	-0.0000006	-0.0000003	-0.0000051	-0.0000003	-0.0000005	-0.0000009	-0.0000005	-0.0000027	-0.0000005	-0.0000127	-0.0000378	-0.0001955	-0.0000546	-0.0000171	-0.0000287	-0.0001934	-0.0002702	-0.0010162	-0.0002734	-0.0007861
20 Telecomms	-	-0.0048136	-0.0256470	-0.0008199	-0.0007506	-0.0006794	-0.0012057	-0.0026445	-0.0008177	-0.0039100	-0.0010993	-0.0017113	-0.0025460	-0.0448455	-0.0201467	-0.0486906	-0.0148287	-0.0178155	-0.0043566	-0.0356513	-0.0569872	-0.2963414	-0.0563386	-0.1239697
21 FinBusSrvces	-	-0.0022893	-0.0121974	-0.0003899	-0.0003570	-0.0003231	-0.0005734	-0.0012577	-0.0003889	-0.0018596	-0.0005228	-0.0008139	-0.0012109	-0.0213280	-0.0095816	-0.0231567	-0.0070524	-0.0084729	-0.0020720	-0.0169554	-0.0271025	-0.1409369	-0.0267940	-0.0589587
22 PubAdmDef	-	-0.0000080	-0.0000129	-0.0000004	-0.0000004	-0.0000008	-0.0000060	-0.0000027	-0.0000004	-0.0000014	-0.0000017	-0.0000011	-0.0000010	-0.0000676	-0.0000246	-0.0001096	-0.0000121	-0.0001157	-0.0000061	-0.0002522	-0.0003577	-0.0070839	-0.0004534	-0.0005330
23 Education	-	-0.0000045	-0.0000160	-0.0000011	-0.0000007	-0.0000005	-0.0000017	-0.0000019	-0.0000010	-0.0000017	-0.0000014	-0.0000038	-0.0000036	-0.0000107	-0.0000081	-0.0000682	-0.0000507	-0.0000362	-0.0000051	-0.0000346	-0.0006143	-0.0010323	-0.0012301	-0.0003809
24 Community	-	-0.0000000	-0.0000061	-0.0000006	-0.0000001	-0.0000001	-0.0000017	-0.0000019	-0.0000000	-0.0000000	-0.0000008	-0.0000001	-0.0000001	-0.0000012	-0.0000033	-0.0000117	-0.0000090	-0.0000095	-0.0000015	-0.0000607	-0.0000175	-0.0003719	-0.0000714	-0.0019189

Table C.19: Intermediate technical change through cloud computing in Rest of New South Wales, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000001	-0.0001663	-0.0000015	-0.0000003	-0.0000003	-0.0000000	-0.0000004	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000010	-0.0000056	-0.0000186	-0.0000113	-0.0000006	-0.0000001	-0.0000001	-0.0000097	-0.0000125	-0.0000010	-0.0000063
2 Mining	-	-0.0000191	-0.0000046	-0.0000001	-0.0000002	-0.0000002	-0.0000000	-0.0000142	-0.0000027	-0.0000197	-0.0000001	-0.0000004	-0.0000000	-0.0000067	-0.0000019	-0.0000147	-0.0000024	-0.0000006	-0.0000016	-0.0000033	-0.0000092	-0.0000083	-0.0000066	-0.0000431
3 FoodDrinkTob	-	-0.0000001	-0.0000844	-0.0000001	-0.0000005	-0.0000000	-0.0000000	-0.0000006	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000006	-0.0000080	-0.0001763	-0.0000508	-0.0000006	-0.0000011	-0.0000023	-0.0000152	-0.0000241	-0.0000206	-0.0000305
4 TCFs	-	-0.0000002	-0.0000014	-0.0000032	-0.0000003	-0.0000016	-0.0000002	-0.0000001	-0.0000001	-0.0000004	-0.0000002	-0.0000003	-0.0000000	-0.0000297	-0.0000096	-0.0000159	-0.0000034	-0.0000032	-0.0000008	-0.0000018	-0.0000178	-0.0000339	-0.0000246	-0.0001292
5 MiscManuf	-	-0.0000004	-0.0000132	-0.0000003	-0.0000010	-0.0000004	-0.0000012	-0.0000007	-0.0000001	-0.0000003	-0.0000005	-0.0000010	-0.0000000	-0.0000166	-0.0000146	-0.0000160	-0.0000042	-0.0000077	-0.0000082	-0.0000172	-0.0000145	-0.0000704	-0.0000222	-0.0000644
6 WoodProds	-	-0.0000002	-0.0000127	-0.0000002	-0.0000002	-0.0000011	-0.0000031	-0.0000004	-0.0000001	-0.0000002	-0.0000002	-0.0000002	-0.0000000	-0.0000044	-0.0000100	-0.0000141	-0.0000034	-0.0000016	-0.0000018	-0.0000038	-0.0000124	-0.0000588	-0.0000365	-0.0000959
7 PaperPrint	-	-0.0000002	-0.0000016	-0.0000001	-0.0000001	-0.0000002	-0.0000023	-0.0000001	-0.0000001	-0.0000002	-0.0000001	-0.0000004	-0.0000000	-0.0000034	-0.0000200	-0.0000807	-0.0000079	-0.0000025	-0.0000103	-0.0000216	-0.0000683	-0.0001130	-0.0001347	-0.0000552
8 ChemCoalPrds	-	-0.0000082	-0.0000040	-0.0000007	-0.0000027	-0.0000008	-0.0000012	-0.0000059	-0.0000008	-0.0000010	-0.0000005	-0.0000011	-0.0000000	-0.0000290	-0.0000269	-0.0000421	-0.0000124	-0.0000760	-0.0000014	-0.0000134	-0.0000674	-0.0000614	-0.0000154	-0.0006000
9 NonMetMinPrd	-	-0.0000002	-0.0000031	-0.0000001	-0.0000001	-0.0000001	-0.0000000	-0.0000001	-0.0000026	-0.0000004	-0.0000002	-0.0000004	-0.0000000	-0.0000503	-0.0000059	-0.0000063	-0.0000008	-0.0000001	-0.0000000	-0.0000000	-0.0000156	-0.0000062	-0.0000015	-0.0000097
10 MetalPrds	-	-0.0000032	-0.0000073	-0.0000006	-0.0000010	-0.0000008	-0.0000002	-0.0000004	-0.0000004	-0.0000126	-0.0000026	-0.0000095	-0.0000000	-0.0000634	-0.0000141	-0.0000186	-0.0000037	-0.0000081	-0.0000050	-0.0000108	-0.0000400	-0.0000644	-0.0000230	-0.0000383
11 TransEqp	-	-0.0000006	-0.0000002	-0.0000000	-0.0000001	-0.0000001	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000049	-0.0000004	-0.0000000	-0.0000047	-0.0000089	-0.0001440	-0.0000009	-0.0000466	-0.0000034	-0.0000071	-0.0000086	-0.0001962	-0.0000078	-0.0000030
12 OthMachEqp	-	-0.0000136	-0.0000963	-0.0000023	-0.0000021	-0.0000019	-0.0000034	-0.0000075	-0.0000023	-0.0000111	-0.0000031	-0.0000048	-0.0000001	-0.0001459	-0.0000946	-0.0002284	-0.0000488	-0.0000909	-0.0000222	-0.0000566	-0.0002826	-0.0004643	-0.0002012	-0.0005881
13 EGW	-	-0.0000020	-0.0000042	-0.0000002	-0.0000002	-0.0000002	-0.0000002	-0.0000003	-0.0000003	-0.0000012	-0.0000002	-0.0000006	-0.0000001	-0.0000066	-0.0000065	-0.0000293	-0.0000066	-0.0000119	-0.0000039	-0.0000081	-0.0000666	-0.0000377	-0.0000750	-0.0001002
14 Construction	-	-0.0000049	-0.0000011	-0.0000001	-0.0000001	-0.0000000	-0.0000001	-0.0000006	-0.0000000	-0.0000002	-0.0000000	-0.0000002	-0.0000000	-0.0002536	-0.0000242	-0.0000202	-0.0000044	-0.0000131	-0.0000159	-0.0000333	-0.0000909	-0.0002596	-0.0000017	-0.0000108
15 WholesalTrad	-	-0.0000666	-0.0004708	-0.0000113	-0.0000104	-0.0000094	-0.0000167	-0.0000366	-0.0000113	-0.0000541	-0.0000152	-0.0000237	-0.0000003	-0.0007129	-0.0004625	-0.0011165	-0.0002383	-0.0004443	-0.0001086	-0.0002765	-0.0013811	-0.0022694	-0.0009834	-0.0028745
16 RetailTrade	-	-0.0000005	-0.0000027	-0.0000001	-0.0000001	-0.0000001	-0.0000005	-0.0000001	-0.0000000	-0.0000001	-0.0000000	-0.0000001	-0.0000000	-0.0000062	-0.0000211	-0.0000663	-0.0000076	-0.0000388	-0.0000070	-0.0000146	-0.0000576	-0.0000345	-0.0000167	-0.0000867
17 RecPersSrvc	-	-0.0000011	-0.0000103	-0.0000002	-0.0000001	-0.0000001	-0.0000009	-0.0000006	-0.0000002	-0.0000004	-0.0000004	-0.0000005	-0.0000000	-0.0000062	-0.0000208	-0.0000579	-0.0000351	-0.0000107	-0.0000062	-0.0000165	-0.0002418	-0.0001300	-0.0001191	-0.0003450
18 Transport	-	-0.0000051	-0.0000108	-0.0000006	-0.0000004	-0.0000005	-0.0000011	-0.0000007	-0.0000005	-0.0000012	-0.0000004	-0.0000010	-0.0000000	-0.0000131	-0.0001207	-0.0000312	-0.0000050	-0.0000736	-0.0000059	-0.0000247	-0.0001226	-0.0002156	-0.0000543	-0.0000925
19 PostalSrvcs	-	-0.0000000	-0.0000005	-0.0000000	-0.0000000	-0.0000000	-0.0000003	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000000	-0.0000007	-0.0000032	-0.0000165	-0.0000032	-0.0000016	-0.0000026	-0.0000055	-0.0000241	-0.0000287	-0.0000176	-0.0000672
20 Telecomms	-	-0.0002454	-0.0017346	-0.0000418	-0.0000383	-0.0000346	-0.0000615	-0.0001348	-0.0000417	-0.0001993	-0.0000560	-0.0000872	-0.0000010	-0.0026267	-0.0017042	-0.0041141	-0.0008780	-0.0016370	-0.0004003	-0.0010186	-0.0050889	-0.0083620	-0.0036234	-0.0105918
21 FinBusSrvces	-	-0.0001167	-0.0008250	-0.0000199	-0.0000182	-0.0000165	-0.0000292	-0.0000641	-0.0000198	-0.0000948	-0.0000267	-0.0000415	-0.0000005	-0.0012493	-0.0008105	-0.0019566	-0.0004176	-0.0007786	-0.0001904	-0.0004845	-0.0024202	-0.0039769	-0.0017233	-0.0050374
22 PubAdmDef	-	-0.0000004	-0.0000009	-0.0000000	-0.0000000	-0.0000000	-0.0000003	-0.0000001	-0.0000000	-0.0000001	-0.0000001	-0.0000001	-0.0000000	-0.0000040	-0.0000021	-0.0000093	-0.0000007	-0.0000106	-0.0000006	-0.0000072	-0.0000319	-0.0001999	-0.0000292	-0.0000455
23 Education	-	-0.0000002	-0.0000011	-0.0000001	-0.0000000	-0.0000000	-0.0000001	-0.0000001	-0.0000000	-0.0000001	-0.0000001	-0.0000002	-0.0000000	-0.0000006	-0.0000007	-0.0000058	-0.0000030	-0.0000033	-0.0000005	-0.0000010	-0.0000549	-0.0000291	-0.0000791	-0.0000325
24 Community	-	-0.0000000	-0.0000004	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000001	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000003	-0.0000010	-0.0000005	-0.0000009	-0.0000001	-0.0000017	-0.0000016	-0.0000105	-0.0000046	-0.0001639

Table C.20: Intermediate technical change through cloud computing in Melbourne, Victoria, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000016	-0.0034200	-0.0000281	-0.0000055	-0.0000050	-0.0000004	-0.0000085	-0.0000001	-0.0000005	-0.0000001	-0.0000009	-0.0000001	-0.0000147	-0.0000636	-0.0001999	-0.0001058	-0.0000069	-0.0000006	-0.0000036	-0.0001125	-0.0002554	-0.0000119	-0.0000541
2 Mining	-	-0.0003652	-0.0000944	-0.0000018	-0.0000032	-0.0000041	-0.0000009	-0.0002727	-0.0000514	-0.0003768	-0.0000017	-0.0000072	-0.0000602	-0.0000961	-0.0000212	-0.0001582	-0.0000227	-0.0000069	-0.0000176	-0.0000995	-0.0001066	-0.0001691	-0.0000786	-0.0003702
3 FoodDrinkTob	-	-0.0000016	-0.0017360	-0.0000016	-0.0000089	-0.0000002	-0.0000006	-0.0000109	-0.0000001	-0.0000003	-0.0000005	-0.0000008	-0.0000003	-0.0000086	-0.0000901	-0.0018991	-0.0004755	-0.0000071	-0.0000120	-0.0000680	-0.0001767	-0.0004914	-0.0002449	-0.0002620
4 TCFs	-	-0.0000031	-0.0000279	-0.0000620	-0.0000064	-0.0000305	-0.0000039	-0.0000018	-0.0000010	-0.0000084	-0.0000038	-0.0000051	-0.0000007	-0.0004253	-0.0001087	-0.0001714	-0.0000317	-0.0000354	-0.0000093	-0.0000525	-0.0002075	-0.0006905	-0.0002928	-0.0011110
5 MiscManuf	-	-0.0000085	-0.0002720	-0.0000051	-0.0000191	-0.0000072	-0.0000230	-0.0000140	-0.0000015	-0.0000061	-0.0000104	-0.0000201	-0.0000036	-0.0002376	-0.0001653	-0.0001725	-0.0000393	-0.0000850	-0.0000907	-0.0005125	-0.0001687	-0.0014344	-0.0002639	-0.0005539
6 WoodProds	-	-0.0000030	-0.0002618	-0.0000029	-0.0000030	-0.0000212	-0.0000589	-0.0000075	-0.0000026	-0.0000033	-0.0000039	-0.0000043	-0.0000004	-0.0000627	-0.0001129	-0.0001521	-0.0000315	-0.0000171	-0.0000202	-0.0001141	-0.0001437	-0.0011980	-0.0004345	-0.0008248
7 PaperPrint	-	-0.0000030	-0.0000334	-0.0000017	-0.0000026	-0.0000042	-0.0000432	-0.0000026	-0.0000010	-0.0000030	-0.0000019	-0.0000070	-0.0000010	-0.0000492	-0.0002262	-0.0008691	-0.0000737	-0.0000279	-0.0001139	-0.0006436	-0.0007948	-0.0023016	-0.0016039	-0.0004742
8 ChemCoalPrds	-	-0.0001580	-0.0000814	-0.0000125	-0.0000522	-0.0000156	-0.0000228	-0.0001134	-0.0000157	-0.0000189	-0.0000102	-0.0000215	-0.0000214	-0.0004147	-0.0003041	-0.0004535	-0.0001161	-0.0008399	-0.0000156	-0.0003997	-0.0007838	-0.0012510	-0.0001838	-0.0051576
9 NonMetMinPrd	-	-0.0000036	-0.0000640	-0.0000015	-0.0000016	-0.0000011	-0.0000003	-0.0000020	-0.0000489	-0.0000076	-0.0000046	-0.0000068	-0.0000035	-0.0007194	-0.0000673	-0.0000677	-0.0000074	-0.0000014	-0.0000002	-0.0000011	-0.0001817	-0.0001260	-0.0000173	-0.0000834
10 MetalPrds	-	-0.0000616	-0.0001500	-0.0000106	-0.0000182	-0.0000156	-0.0000031	-0.0000073	-0.0000082	-0.0002408	-0.0000495	-0.0001823	-0.0000076	-0.0009073	-0.0001596	-0.0002001	-0.0000348	-0.0000900	-0.0000555	-0.0003211	-0.0004652	-0.0013130	-0.0002734	-0.0003295
11 TransEqp	-	-0.0000115	-0.0000048	-0.0000004	-0.0000015	-0.0000012	-0.0000005	-0.0000003	-0.0000009	-0.0000010	-0.0000935	-0.0000076	-0.0000002	-0.0000668	-0.0001010	-0.0015507	-0.0000088	-0.0005150	-0.0000375	-0.0002120	-0.0000998	-0.0039973	-0.0000929	-0.0000262
12 OthMachEqp	-	-0.0002609	-0.0019814	-0.0000444	-0.0000407	-0.0000368	-0.0000654	-0.0001433	-0.0000443	-0.0002119	-0.0000596	-0.0000928	-0.0001124	-0.0020873	-0.0010703	-0.0024602	-0.0004566	-0.0010048	-0.0002457	-0.0016838	-0.0032877	-0.0094615	-0.0023956	-0.0050558
13 EGW	-	-0.0000378	-0.0000867	-0.0000034	-0.0000037	-0.0000042	-0.0000037	-0.0000056	-0.0000061	-0.0000233	-0.0000046	-0.0000124	-0.0002391	-0.0000946	-0.0000732	-0.0003156	-0.0000620	-0.0001312	-0.0000428	-0.0002415	-0.0007743	-0.0007688	-0.0008928	-0.0008612
14 Construction	-	-0.0000943	-0.0000228	-0.0000018	-0.0000010	-0.0000005	-0.0000012	-0.0000106	-0.0000005	-0.0000030	-0.0000008	-0.0000038	-0.0000319	-0.0036295	-0.0002734	-0.0002173	-0.0000416	-0.0001453	-0.0001753	-0.0009906	-0.0010577	-0.0052903	-0.0000198	-0.0000927
15 WholesalTrad	-	-0.0012752	-0.0096839	-0.0002172	-0.0001989	-0.0001800	-0.0003194	-0.0007006	-0.0002166	-0.0010358	-0.0002912	-0.0004534	-0.0005494	-0.0102018	-0.0052310	-0.0120242	-0.0022318	-0.0049111	-0.0012010	-0.0082297	-0.0160685	-0.0462429	-0.0117083	-0.0247100
16 RetailTrade	-	-0.0000103	-0.0000555	-0.0000018	-0.0000016	-0.0000020	-0.0000087	-0.0000027	-0.0000007	-0.0000013	-0.0000005	-0.0000025	-0.0000031	-0.0000894	-0.0002387	-0.0007136	-0.0000715	-0.0004287	-0.0000772	-0.0004359	-0.0006704	-0.0007031	-0.0001991	-0.0007454
17 RecPersSrvc	-	-0.0000219	-0.0002129	-0.0000033	-0.0000026	-0.0000028	-0.0000172	-0.0000115	-0.0000031	-0.0000073	-0.0000073	-0.0000101	-0.0000053	-0.0000890	-0.0002357	-0.0006231	-0.0003286	-0.0001183	-0.0000686	-0.0004918	-0.0028135	-0.0026486	-0.0014183	-0.0029659
18 Transport	-	-0.0000982	-0.0002218	-0.0000117	-0.0000068	-0.0000094	-0.0000217	-0.0000141	-0.0000088	-0.0000223	-0.0000070	-0.0000187	-0.0000036	-0.0001869	-0.0013647	-0.0003359	-0.0000473	-0.0008137	-0.0000648	-0.0007359	-0.0014263	-0.0043938	-0.0006470	-0.0007947
19 PostalSrvcs	-	-0.0000006	-0.0000112	-0.0000004	-0.0000006	-0.0000003	-0.0000050	-0.0000003	-0.0000005	-0.0000009	-0.0000005	-0.0000026	-0.0000004	-0.0000106	-0.0000362	-0.0001779	-0.0000303	-0.0000174	-0.0000291	-0.0001645	-0.0002807	-0.0005843	-0.0002094	-0.0005774
20 Telecomms	-	-0.0046987	-0.0356821	-0.0008004	-0.0007327	-0.0006632	-0.0011769	-0.0025814	-0.0007982	-0.0038167	-0.0010730	-0.0016705	-0.0020243	-0.0375904	-0.0192747	-0.0443053	-0.0082233	-0.0180958	-0.0044251	-0.0303238	-0.0592074	-0.1703906	-0.0431413	-0.0910485
21 FinBusSrvces	-	-0.0022347	-0.0169700	-0.0003806	-0.0003485	-0.0003154	-0.0005597	-0.0012277	-0.0003796	-0.0018152	-0.0005103	-0.0007945	-0.0009627	-0.0178776	-0.0091668	-0.0210711	-0.0039109	-0.0086062	-0.0021046	-0.0144217	-0.0281584	-0.0810360	-0.0205176	-0.0433017
22 PubAdmDef	-	-0.0000078	-0.0000180	-0.0000004	-0.0000004	-0.0000008	-0.0000058	-0.0000026	-0.0000004	-0.0000014	-0.0000017	-0.0000010	-0.0000008	-0.0000567	-0.0000235	-0.0000997	-0.0000067	-0.0001175	-0.0000062	-0.0002145	-0.0003716	-0.0040731	-0.0003472	-0.0003915
23 Education	-	-0.0000044	-0.0000223	-0.0000011	-0.0000006	-0.0000005	-0.0000017	-0.0000019	-0.0000009	-0.0000017	-0.0000013	-0.0000037	-0.0000029	-0.0000089	-0.0000078	-0.0000621	-0.0000281	-0.0000367	-0.0000052	-0.0000294	-0.0006383	-0.0005935	-0.0009420	-0.0002797
24 Community	-	-0.0000000	-0.0000085	-0.0000006	-0.0000001	-0.0000001	-0.0000017	-0.0000018	-0.0000000	-0.0000000	-0.0000008	-0.0000001	-0.0000001	-0.0000010	-0.0000032	-0.0000106	-0.0000050	-0.0000097	-0.0000015	-0.0000516	-0.0000182	-0.0002138	-0.0000547	-0.0014093

Table C.21: Intermediate technical change through cloud computing in Rest of Victoria, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000001	-0.0001820	-0.0000014	-0.0000003	-0.0000002	-0.0000000	-0.0000004	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000009	-0.0000033	-0.0000157	-0.0000073	-0.0000006	-0.0000000	-0.0000002	-0.0000100	-0.0000141	-0.0000003	-0.0000058
2 Mining	-	-0.0000181	-0.0000050	-0.0000001	-0.0000002	-0.0000002	-0.0000000	-0.0000135	-0.0000026	-0.0000187	-0.0000001	-0.0000004	-0.0000002	-0.0000058	-0.0000011	-0.0000125	-0.0000016	-0.0000006	-0.0000015	-0.0000064	-0.0000095	-0.0000093	-0.0000023	-0.0000396
3 FoodDrinkTob	-	-0.0000001	-0.0000924	-0.0000001	-0.0000004	-0.0000000	-0.0000000	-0.0000005	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000005	-0.0000047	-0.0001496	-0.0000327	-0.0000006	-0.0000010	-0.0000044	-0.0000157	-0.0000271	-0.0000071	-0.0000280
4 TCFs	-	-0.0000002	-0.0000015	-0.0000031	-0.0000003	-0.0000015	-0.0000002	-0.0000001	-0.0000000	-0.0000004	-0.0000002	-0.0000003	-0.0000000	-0.0000257	-0.0000057	-0.0000135	-0.0000022	-0.0000030	-0.0000008	-0.0000034	-0.0000185	-0.0000381	-0.0000085	-0.0001187
5 MiscManuf	-	-0.0000004	-0.0000145	-0.0000003	-0.0000010	-0.0000004	-0.0000011	-0.0000007	-0.0000001	-0.0000003	-0.0000005	-0.0000010	-0.0000000	-0.0000143	-0.0000086	-0.0000136	-0.0000027	-0.0000072	-0.0000077	-0.0000331	-0.0000150	-0.0000791	-0.0000077	-0.0000592
6 WoodProds	-	-0.0000001	-0.0000139	-0.0000001	-0.0000002	-0.0000011	-0.0000029	-0.0000004	-0.0000001	-0.0000002	-0.0000002	-0.0000002	-0.0000000	-0.0000038	-0.0000059	-0.0000120	-0.0000022	-0.0000015	-0.0000017	-0.0000074	-0.0000128	-0.0000661	-0.0000126	-0.0000881
7 PaperPrint	-	-0.0000002	-0.0000018	-0.0000001	-0.0000001	-0.0000002	-0.0000021	-0.0000001	-0.0000000	-0.0000001	-0.0000001	-0.0000003	-0.0000000	-0.0000030	-0.0000118	-0.0000685	-0.0000051	-0.0000024	-0.0000097	-0.0000415	-0.0000708	-0.0001269	-0.0000465	-0.0000507
8 ChemCoalPrds	-	-0.0000078	-0.0000043	-0.0000006	-0.0000026	-0.0000008	-0.0000011	-0.0000056	-0.0000008	-0.0000009	-0.0000005	-0.0000011	-0.0000001	-0.0000250	-0.0000158	-0.0000357	-0.0000080	-0.0000715	-0.0000013	-0.0000258	-0.0000698	-0.0000690	-0.0000053	-0.0005511
9 NonMetMinPrd	-	-0.0000002	-0.0000034	-0.0000001	-0.0000001	-0.0000001	-0.0000000	-0.0000001	-0.0000024	-0.0000004	-0.0000002	-0.0000003	-0.0000000	-0.0000434	-0.0000035	-0.0000053	-0.0000005	-0.0000001	-0.0000000	-0.0000001	-0.0000162	-0.0000069	-0.0000005	-0.0000089
10 MetalPrds	-	-0.0000031	-0.0000080	-0.0000005	-0.0000009	-0.0000008	-0.0000002	-0.0000004	-0.0000004	-0.0000120	-0.0000025	-0.0000090	-0.0000000	-0.0000547	-0.0000083	-0.0000158	-0.0000024	-0.0000077	-0.0000047	-0.0000207	-0.0000414	-0.0000724	-0.0000079	-0.0000352
11 TransEqp	-	-0.0000006	-0.0000003	-0.0000000	-0.0000001	-0.0000001	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000046	-0.0000004	-0.0000000	-0.0000040	-0.0000053	-0.0001222	-0.0000006	-0.0000438	-0.0000032	-0.0000137	-0.0000089	-0.0002204	-0.0000027	-0.0000028
12 OthMachEqp	-	-0.0000130	-0.0001054	-0.0000022	-0.0000020	-0.0000018	-0.0000032	-0.0000071	-0.0000022	-0.0000105	-0.0000030	-0.0000046	-0.0000004	-0.0001259	-0.0000557	-0.0001938	-0.0000314	-0.0000855	-0.0000209	-0.0001087	-0.0002928	-0.0005217	-0.0000695	-0.0005402
13 EGW	-	-0.0000019	-0.0000046	-0.0000002	-0.0000002	-0.0000002	-0.0000002	-0.0000003	-0.0000003	-0.0000012	-0.0000002	-0.0000006	-0.0000009	-0.0000057	-0.0000038	-0.0000249	-0.0000043	-0.0000112	-0.0000036	-0.0000156	-0.0000690	-0.0000424	-0.0000259	-0.0000920
14 Construction	-	-0.0000047	-0.0000012	-0.0000001	-0.0000000	-0.0000000	-0.0000001	-0.0000005	-0.0000000	-0.0000002	-0.0000000	-0.0000002	-0.0000001	-0.0002190	-0.0000142	-0.0000171	-0.0000029	-0.0000124	-0.0000149	-0.0000639	-0.0000942	-0.0002917	-0.0000006	-0.0000099
15 WholesalTrad	-	-0.0000633	-0.0005152	-0.0000108	-0.0000099	-0.0000089	-0.0000159	-0.0000348	-0.0000108	-0.0000514	-0.0000145	-0.0000225	-0.0000020	-0.0006155	-0.0002724	-0.0009474	-0.0001537	-0.0004178	-0.0001022	-0.0005312	-0.0014309	-0.0025498	-0.0003396	-0.0026403
16 RetailTrade	-	-0.0000005	-0.0000030	-0.0000001	-0.0000001	-0.0000001	-0.0000004	-0.0000001	-0.0000000	-0.0000001	-0.0000000	-0.0000001	-0.0000000	-0.0000054	-0.0000124	-0.0000562	-0.0000049	-0.0000365	-0.0000066	-0.0000281	-0.0000597	-0.0000388	-0.0000058	-0.0000796
17 RecPersSrvc	-	-0.0000011	-0.0000113	-0.0000002	-0.0000001	-0.0000001	-0.0000009	-0.0000006	-0.0000002	-0.0000004	-0.0000004	-0.0000005	-0.0000000	-0.0000054	-0.0000123	-0.0000491	-0.0000226	-0.0000101	-0.0000058	-0.0000317	-0.0002506	-0.0001460	-0.0000411	-0.0003169
18 Transport	-	-0.0000049	-0.0000118	-0.0000006	-0.0000003	-0.0000005	-0.0000011	-0.0000007	-0.0000004	-0.0000011	-0.0000003	-0.0000009	-0.0000000	-0.0000113	-0.0000711	-0.0000265	-0.0000033	-0.0000692	-0.0000055	-0.0000475	-0.0001270	-0.0002423	-0.0000188	-0.0000849
19 PostalSrvcs	-	-0.0000000	-0.0000006	-0.0000000	-0.0000000	-0.0000000	-0.0000002	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000000	-0.0000006	-0.0000019	-0.0000140	-0.0000021	-0.0000015	-0.0000025	-0.0000106	-0.0000250	-0.0000322	-0.0000061	-0.0000617
20 Telecomms	-	-0.0002332	-0.0018984	-0.0000397	-0.0000364	-0.0000329	-0.0000584	-0.0001281	-0.0000396	-0.0001894	-0.0000533	-0.0000829	-0.0000074	-0.0022681	-0.0010038	-0.0034910	-0.0005663	-0.0015395	-0.0003765	-0.0019572	-0.0052726	-0.0093954	-0.0012512	-0.0097286
21 FinBusSrvces	-	-0.0001109	-0.0009029	-0.0000189	-0.0000173	-0.0000157	-0.0000278	-0.0000609	-0.0000188	-0.0000901	-0.0000253	-0.0000394	-0.0000035	-0.0010787	-0.0004774	-0.0016603	-0.0002693	-0.0007322	-0.0001790	-0.0009308	-0.0025076	-0.0044683	-0.0005951	-0.0046268
22 PubAdmDef	-	-0.0000004	-0.0000010	-0.0000000	-0.0000000	-0.0000000	-0.0000003	-0.0000001	-0.0000000	-0.0000001	-0.0000001	-0.0000001	-0.0000000	-0.0000034	-0.0000012	-0.0000079	-0.0000005	-0.0000100	-0.0000005	-0.0000138	-0.0000331	-0.0002246	-0.0000101	-0.0000418
23 Education	-	-0.0000002	-0.0000012	-0.0000001	-0.0000000	-0.0000000	-0.0000001	-0.0000001	-0.0000000	-0.0000001	-0.0000001	-0.0000002	-0.0000000	-0.0000005	-0.0000004	-0.0000049	-0.0000019	-0.0000031	-0.0000004	-0.0000019	-0.0000568	-0.0000327	-0.0000273	-0.0000299
24 Community	-	-0.0000000	-0.0000005	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000001	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000002	-0.0000008	-0.0000003	-0.0000008	-0.0000001	-0.0000033	-0.0000016	-0.0000118	-0.0000016	-0.0001506

Table C.22: Intermediate technical change through cloud computing in Brisbane, Queensland, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000006	-0.0017564	-0.0000111	-0.0000022	-0.0000020	-0.0000002	-0.0000034	-0.0000000	-0.0000002	-0.0000001	-0.0000004	-0.0000000	-0.0000044	-0.0000312	-0.0000927	-0.0000889	-0.0000026	-0.0000002	-0.0000045	-0.0000740	-0.0002174	-0.0000080	-0.0000325
2 Mining	-	-0.0001441	-0.0000485	-0.0000007	-0.0000013	-0.0000016	-0.0000003	-0.0001076	-0.0000203	-0.0001487	-0.0000007	-0.0000028	-0.0000226	-0.0000289	-0.0000104	-0.0000733	-0.0000191	-0.0000026	-0.0000067	-0.0001230	-0.0000702	-0.0001439	-0.0000527	-0.0002222
3 FoodDrinkTob	-	-0.0000006	-0.0008915	-0.0000006	-0.0000035	-0.0000001	-0.0000002	-0.0000043	-0.0000001	-0.0000001	-0.0000002	-0.0000003	-0.0000001	-0.0000026	-0.0000441	-0.0008804	-0.0003992	-0.0000027	-0.0000045	-0.0000840	-0.0001163	-0.0004182	-0.0001643	-0.0001573
4 TCFs	-	-0.0000012	-0.0000143	-0.0000245	-0.0000025	-0.0000120	-0.0000016	-0.0000007	-0.0000004	-0.0000033	-0.0000015	-0.0000020	-0.0000003	-0.0001276	-0.0000533	-0.0000794	-0.0000266	-0.0000134	-0.0000035	-0.0000649	-0.0001366	-0.0005876	-0.0001963	-0.0006669
5 MiscManuf	-	-0.0000033	-0.0001397	-0.0000020	-0.0000076	-0.0000029	-0.0000091	-0.0000055	-0.0000006	-0.0000024	-0.0000041	-0.0000079	-0.0000014	-0.0000713	-0.0000810	-0.0000800	-0.0000330	-0.0000321	-0.0000343	-0.0006335	-0.0001111	-0.0012207	-0.0001770	-0.0003325
6 WoodProds	-	-0.0000012	-0.0001345	-0.0000011	-0.0000012	-0.0000084	-0.0000232	-0.0000030	-0.0000010	-0.0000013	-0.0000016	-0.0000017	-0.0000001	-0.0000188	-0.0000553	-0.0000705	-0.0000264	-0.0000065	-0.0000076	-0.0001410	-0.0000946	-0.0010196	-0.0002914	-0.0004951
7 PaperPrint	-	-0.0000012	-0.0000171	-0.0000007	-0.0000010	-0.0000016	-0.0000171	-0.0000010	-0.0000004	-0.0000012	-0.0000007	-0.0000028	-0.0000004	-0.0000148	-0.0001109	-0.0004029	-0.0000618	-0.0000105	-0.0000430	-0.0007956	-0.0005232	-0.0019587	-0.0010757	-0.0002846
8 ChemCoalPrds	-	-0.0000623	-0.0000418	-0.0000049	-0.0000206	-0.0000062	-0.0000090	-0.0000447	-0.0000062	-0.0000074	-0.0000040	-0.0000085	-0.0000080	-0.0001245	-0.0001490	-0.0002102	-0.0000974	-0.0003172	-0.0000059	-0.0004940	-0.0005159	-0.0010646	-0.0001232	-0.0030960
9 NonMetMinPrd	-	-0.0000014	-0.0000329	-0.0000006	-0.0000006	-0.0000004	-0.0000001	-0.0000008	-0.0000193	-0.0000030	-0.0000018	-0.0000027	-0.0000013	-0.0002159	-0.0000330	-0.0000314	-0.0000062	-0.0000005	-0.0000001	-0.0000013	-0.0001196	-0.0001072	-0.0000116	-0.0000501
10 MetalPrds	-	-0.0000243	-0.0000770	-0.0000042	-0.0000072	-0.0000062	-0.0000012	-0.0000029	-0.0000032	-0.0000950	-0.0000195	-0.0000719	-0.0000029	-0.0002723	-0.0000782	-0.0000928	-0.0000292	-0.0000340	-0.0000210	-0.0003969	-0.0003062	-0.0011174	-0.0001833	-0.0001978
11 TransEqp	-	-0.0000045	-0.0000025	-0.0000002	-0.0000006	-0.0000005	-0.0000002	-0.0000001	-0.0000003	-0.0000004	-0.0000369	-0.0000030	-0.0000001	-0.0000201	-0.0000495	-0.0007189	-0.0000074	-0.0001945	-0.0000142	-0.0002620	-0.0000657	-0.0034019	-0.0000623	-0.0000157
12 OthMachEqp	-	-0.0001030	-0.0010175	-0.0000175	-0.0000161	-0.0000145	-0.0000258	-0.0000566	-0.0000175	-0.0000836	-0.0000235	-0.0000366	-0.0000422	-0.0006264	-0.0005245	-0.0011405	-0.0003834	-0.0003795	-0.0000928	-0.0020814	-0.0021641	-0.0080521	-0.0016066	-0.0030349
13 EGW	-	-0.0000149	-0.0000445	-0.0000013	-0.0000015	-0.0000016	-0.0000015	-0.0000022	-0.0000024	-0.0000092	-0.0000018	-0.0000049	-0.0000898	-0.0000284	-0.0000359	-0.0001463	-0.0000520	-0.0000496	-0.0000161	-0.0002985	-0.0005097	-0.0006543	-0.0005988	-0.0005170
14 Construction	-	-0.0000372	-0.0000117	-0.0000007	-0.0000004	-0.0000002	-0.0000005	-0.0000042	-0.0000002	-0.0000012	-0.0000003	-0.0000015	-0.0000120	-0.0010892	-0.0001340	-0.0001007	-0.0000349	-0.0000549	-0.0000662	-0.0012245	-0.0006962	-0.0045022	-0.0000133	-0.0000557
15 WholesalTrad	-	-0.0005032	-0.0049732	-0.0000857	-0.0000785	-0.0000710	-0.0001260	-0.0002765	-0.0000855	-0.0004088	-0.0001149	-0.0001789	-0.0002064	-0.0030616	-0.0025636	-0.0055740	-0.0018737	-0.0018549	-0.0004536	-0.0101730	-0.0105770	-0.0393545	-0.0078524	-0.0148329
16 RetailTrade	-	-0.0000041	-0.0000285	-0.0000007	-0.0000006	-0.0000008	-0.0000034	-0.0000011	-0.0000003	-0.0000005	-0.0000002	-0.0000010	-0.0000012	-0.0000268	-0.0001170	-0.0003308	-0.0000600	-0.0001619	-0.0000291	-0.0005388	-0.0004413	-0.0005984	-0.0001335	-0.0004474
17 RecPersSrvc	-	-0.0000086	-0.0001093	-0.0000013	-0.0000010	-0.0000011	-0.0000068	-0.0000045	-0.0000012	-0.0000029	-0.0000029	-0.0000040	-0.0000020	-0.0000267	-0.0001155	-0.0002888	-0.0002759	-0.0000447	-0.0000259	-0.0006079	-0.0018520	-0.0022540	-0.0009512	-0.0017804
18 Transport	-	-0.0000388	-0.0001139	-0.0000046	-0.0000027	-0.0000037	-0.0000086	-0.0000056	-0.0000035	-0.0000088	-0.0000027	-0.0000074	-0.0000014	-0.0000561	-0.0006688	-0.0001557	-0.0000397	-0.0003074	-0.0000245	-0.0009097	-0.0009389	-0.0037393	-0.0004339	-0.0004771
19 PostalSrvcs	-	-0.0000002	-0.0000058	-0.0000002	-0.0000002	-0.0000001	-0.0000020	-0.0000001	-0.0000002	-0.0000003	-0.0000002	-0.0000010	-0.0000001	-0.0000032	-0.0000177	-0.0000825	-0.0000254	-0.0000066	-0.0000110	-0.0002033	-0.0001848	-0.0004973	-0.0001404	-0.0003466
20 Telecomms	-	-0.0018542	-0.0183248	-0.0003158	-0.0002891	-0.0002617	-0.0004644	-0.0010187	-0.0003150	-0.0015062	-0.0004234	-0.0006592	-0.0007605	-0.0112811	-0.0094459	-0.0205386	-0.0069042	-0.0068349	-0.0016714	-0.0374843	-0.0389728	-0.1450091	-0.0289336	-0.0546546
21 FinBusSrvces	-	-0.0008819	-0.0087151	-0.0001502	-0.0001375	-0.0001245	-0.0002209	-0.0004845	-0.0001498	-0.0007163	-0.0002014	-0.0003135	-0.0003617	-0.0053652	-0.0044924	-0.0097679	-0.0032835	-0.0032506	-0.0007949	-0.0178271	-0.0185351	-0.0689648	-0.0137605	-0.0259932
22 PubAdmDef	-	-0.0000031	-0.0000092	-0.0000002	-0.0000002	-0.0000003	-0.0000023	-0.0000010	-0.0000001	-0.0000006	-0.0000007	-0.0000004	-0.0000003	-0.0000170	-0.0000115	-0.0000462	-0.0000056	-0.0000444	-0.0000024	-0.0002652	-0.0002446	-0.0034664	-0.0002328	-0.0002350
23 Education	-	-0.0000017	-0.0000114	-0.0000004	-0.0000003	-0.0000002	-0.0000007	-0.0000007	-0.0000004	-0.0000007	-0.0000005	-0.0000015	-0.0000011	-0.0000027	-0.0000038	-0.0000288	-0.0000236	-0.0000139	-0.0000020	-0.0000364	-0.0004201	-0.0005051	-0.0006318	-0.0001679
24 Community	-	-0.0000000	-0.0000044	-0.0000002	-0.0000000	-0.0000000	-0.0000007	-0.0000007	-0.0000000	-0.0000000	-0.0000003	-0.0000001	-0.0000000	-0.0000003	-0.0000016	-0.0000049	-0.0000042	-0.0000037	-0.0000006	-0.0000638	-0.0000120	-0.0001820	-0.0000367	-0.0008460

Table C.23: Intermediate technical change through cloud computing in Rest of Queensland, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	- 0.0000011	- 0.0013391	- 0.0000193	- 0.0000038	- 0.0000034	- 0.0000003	- 0.0000059	- 0.0000001	- 0.0000003	- 0.0000001	- 0.0000006	- 0.0000000	- 0.0000104	- 0.0000727	- 0.0001576	- 0.0001974	- 0.0000041	- 0.0000003	- 0.0000063	- 0.0001429	- 0.0003569	- 0.0000095	- 0.0000489
2 Mining	-	- 0.0002511	- 0.0000369	- 0.0000013	- 0.0000022	- 0.0000028	- 0.0000006	- 0.0001875	- 0.0000353	- 0.0002591	- 0.0000012	- 0.0000049	- 0.0000208	- 0.0000683	- 0.0000242	- 0.0001247	- 0.0000424	- 0.0000041	- 0.0000103	- 0.0001745	- 0.0001354	- 0.0002362	- 0.0000626	- 0.0003348
3 FoodDrinkTob	-	- 0.0000011	- 0.0006797	- 0.0000011	- 0.0000062	- 0.0000002	- 0.0000004	- 0.0000075	- 0.0000001	- 0.0000002	- 0.0000003	- 0.0000006	- 0.0000001	- 0.0000061	- 0.0001031	- 0.0014973	- 0.0008871	- 0.0000041	- 0.0000071	- 0.0001193	- 0.0002244	- 0.0006867	- 0.0001952	- 0.0002370
4 TCFs	-	- 0.0000021	- 0.0000109	- 0.0000426	- 0.0000044	- 0.0000210	- 0.0000027	- 0.0000013	- 0.0000007	- 0.0000058	- 0.0000026	- 0.0000035	- 0.0000002	- 0.0003024	- 0.0001243	- 0.0001351	- 0.0000591	- 0.0000208	- 0.0000055	- 0.0000922	- 0.0002635	- 0.0009648	- 0.0002333	- 0.0010049
5 MiscManuf	-	- 0.0000058	- 0.0001065	- 0.0000035	- 0.0000132	- 0.0000050	- 0.0000158	- 0.0000096	- 0.0000011	- 0.0000042	- 0.0000071	- 0.0000138	- 0.0000013	- 0.0001689	- 0.0001891	- 0.0001360	- 0.0000733	- 0.0000499	- 0.0000533	- 0.0008990	- 0.0002143	- 0.0020043	- 0.0002103	- 0.0005010
6 WoodProds	-	- 0.0000021	- 0.0001025	- 0.0000020	- 0.0000021	- 0.0000146	- 0.0000405	- 0.0000052	- 0.0000018	- 0.0000023	- 0.0000027	- 0.0000029	- 0.0000001	- 0.0000446	- 0.0001292	- 0.0001199	- 0.0000587	- 0.0000101	- 0.0000119	- 0.0002002	- 0.0001825	- 0.0016740	- 0.0003463	- 0.0007460
7 PaperPrint	-	- 0.0000021	- 0.0000131	- 0.0000012	- 0.0000018	- 0.0000029	- 0.0000297	- 0.0000018	- 0.0000007	- 0.0000020	- 0.0000013	- 0.0000048	- 0.0000003	- 0.0000350	- 0.0002588	- 0.0006852	- 0.0001374	- 0.0000164	- 0.0000669	- 0.0011291	- 0.0010094	- 0.0032161	- 0.0012781	- 0.0004289
8 ChemCoalPrds	-	- 0.0001086	- 0.0000319	- 0.0000086	- 0.0000359	- 0.0000107	- 0.0000157	- 0.0000780	- 0.0000108	- 0.0000130	- 0.0000070	- 0.0000148	- 0.0000074	- 0.0002949	- 0.0003480	- 0.0003575	- 0.0002165	- 0.0004932	- 0.0000091	- 0.0007011	- 0.0009954	- 0.0017480	- 0.0001464	- 0.0046651
9 NonMetMinPrd	-	- 0.0000025	- 0.0000251	- 0.0000010	- 0.0000011	- 0.0000007	- 0.0000002	- 0.0000014	- 0.0000336	- 0.0000052	- 0.0000032	- 0.0000047	- 0.0000012	- 0.0005115	- 0.0000770	- 0.0000534	- 0.0000139	- 0.0000008	- 0.0000001	- 0.0000019	- 0.0002308	- 0.0001760	- 0.0000138	- 0.0000755
10 MetalPrds	-	- 0.0000424	- 0.0000587	- 0.0000073	- 0.0000125	- 0.0000107	- 0.0000021	- 0.0000050	- 0.0000056	- 0.0001656	- 0.0000340	- 0.0001254	- 0.0000026	- 0.0006451	- 0.0001826	- 0.0001578	- 0.0000649	- 0.0000529	- 0.0000326	- 0.0005633	- 0.0005908	- 0.0018347	- 0.0002179	- 0.0002980
11 TransEqp	-	- 0.0000079	- 0.0000019	- 0.0000003	- 0.0000010	- 0.0000008	- 0.0000003	- 0.0000002	- 0.0000006	- 0.0000007	- 0.0000643	- 0.0000052	- 0.0000001	- 0.0000475	- 0.0001155	- 0.0012226	- 0.0000164	- 0.0003025	- 0.0000220	- 0.0003719	- 0.0001268	- 0.0055855	- 0.0000740	- 0.0000237
12 OthMachEqp	-	- 0.0001794	- 0.0007758	- 0.0000306	- 0.0000280	- 0.0000253	- 0.0000449	- 0.0000986	- 0.0000305	- 0.0001457	- 0.0000410	- 0.0000638	- 0.0000387	- 0.0014839	- 0.0012247	- 0.0019397	- 0.0008518	- 0.0005901	- 0.0001443	- 0.0029540	- 0.0041755	- 0.0132208	- 0.0019090	- 0.0045730
13 EGW	-	- 0.0000260	- 0.0000340	- 0.0000023	- 0.0000025	- 0.0000029	- 0.0000025	- 0.0000039	- 0.0000042	- 0.0000160	- 0.0000032	- 0.0000085	- 0.0000824	- 0.0000673	- 0.0000838	- 0.0002488	- 0.0001156	- 0.0000771	- 0.0000251	- 0.0004237	- 0.0009834	- 0.0010743	- 0.0007115	- 0.0007790
14 Construction	-	- 0.0000649	- 0.0000089	- 0.0000012	- 0.0000007	- 0.0000003	- 0.0000008	- 0.0000073	- 0.0000003	- 0.0000021	- 0.0000006	- 0.0000026	- 0.0000110	- 0.0025803	- 0.0003128	- 0.0001713	- 0.0000776	- 0.0000854	- 0.0001030	- 0.0017378	- 0.0013433	- 0.0073922	- 0.0000157	- 0.0000839
15 WholesalTrad	-	- 0.0008768	- 0.0037916	- 0.0001494	- 0.0001367	- 0.0001238	- 0.0002196	- 0.0004817	- 0.0001490	- 0.0007122	- 0.0002002	- 0.0003117	- 0.0001894	- 0.0072528	- 0.0059855	- 0.0094801	- 0.0041634	- 0.0028841	- 0.0007053	- 0.0144377	- 0.0204076	- 0.0646165	- 0.0093304	- 0.0223506
16 RetailTrade	-	- 0.0000071	- 0.0000217	- 0.0000013	- 0.0000011	- 0.0000014	- 0.0000060	- 0.0000019	- 0.0000005	- 0.0000009	- 0.0000004	- 0.0000017	- 0.0000011	- 0.0000635	- 0.0002731	- 0.0005626	- 0.0001333	- 0.0002518	- 0.0000453	- 0.0007647	- 0.0008515	- 0.0009825	- 0.0001586	- 0.0006742
17 RecPersSrvc	-	- 0.0000151	- 0.0000834	- 0.0000023	- 0.0000018	- 0.0000019	- 0.0000119	- 0.0000079	- 0.0000021	- 0.0000050	- 0.0000050	- 0.0000069	- 0.0000018	- 0.0000633	- 0.0002697	- 0.0004912	- 0.0006130	- 0.0000695	- 0.0000403	- 0.0008628	- 0.0035732	- 0.0037009	- 0.0011303	- 0.0026827
18 Transport	-	- 0.0000676	- 0.0000868	- 0.0000080	- 0.0000046	- 0.0000065	- 0.0000150	- 0.0000097	- 0.0000060	- 0.0000153	- 0.0000048	- 0.0000129	- 0.0000012	- 0.0001329	- 0.0015615	- 0.0002648	- 0.0000882	- 0.0004779	- 0.0000381	- 0.0012911	- 0.0018115	- 0.0061395	- 0.0005156	- 0.0007189
19 PostalSrvcs	-	- 0.0000004	- 0.0000044	- 0.0000003	- 0.0000004	- 0.0000002	- 0.0000034	- 0.0000002	- 0.0000003	- 0.0000006	- 0.0000003	- 0.0000018	- 0.0000001	- 0.0000076	- 0.0000414	- 0.0001402	- 0.0000565	- 0.0000102	- 0.0000171	- 0.0002886	- 0.0003565	- 0.0008165	- 0.0001669	- 0.0005222
20 Telecomms	-	- 0.0032309	- 0.0139709	- 0.0005503	- 0.0005038	- 0.0004560	- 0.0008093	- 0.0017750	- 0.0005489	- 0.0026244	- 0.0007378	- 0.0011486	- 0.0006977	- 0.0267242	- 0.0220548	- 0.0349311	- 0.0153408	- 0.0106272	- 0.0025988	- 0.0531984	- 0.0751956	- 0.2380917	- 0.0343795	- 0.0823548
21 FinBusSrvces	-	- 0.0015366	- 0.0066444	- 0.0002617	- 0.0002396	- 0.0002169	- 0.0003849	- 0.0008442	- 0.0002610	- 0.0012481	- 0.0003509	- 0.0005463	- 0.0003318	- 0.0127097	- 0.0104890	- 0.0166129	- 0.0072959	- 0.0050542	- 0.0012360	- 0.0253006	- 0.0357623	- 0.1132339	- 0.0163505	- 0.0391671
22 PubAdmDef	-	- 0.0000053	- 0.0000070	- 0.0000003	- 0.0000003	- 0.0000006	- 0.0000040	- 0.0000018	- 0.0000002	- 0.0000010	- 0.0000012	- 0.0000007	- 0.0000003	- 0.0000403	- 0.0000269	- 0.0000786	- 0.0000125	- 0.0000690	- 0.0000037	- 0.0003763	- 0.0004720	- 0.0056914	- 0.0002767	- 0.0003541
23 Education	-	- 0.0000030	- 0.0000087	- 0.0000007	- 0.0000004	- 0.0000003	- 0.0000012	- 0.0000013	- 0.0000006	- 0.0000011	- 0.0000009	- 0.0000025	- 0.0000010	- 0.0000064	- 0.0000089	- 0.0000489	- 0.0000525	- 0.0000216	- 0.0000031	- 0.0000516	- 0.0008106	- 0.0008294	- 0.0007507	- 0.0002530
24 Community	-	- 0.0000000	- 0.0000033	- 0.0000004	- 0.0000000	- 0.0000001	- 0.0000011	- 0.0000013	- 0.0000000	- 0.0000000	- 0.0000005	- 0.0000001	- 0.0000000	- 0.0000007	- 0.0000037	- 0.0000084	- 0.0000093	- 0.0000057	- 0.0000009	- 0.0000905	- 0.0000231	- 0.0002988	- 0.0000436	- 0.0012748

Table C.24: Intermediate technical change through cloud computing in Adelaide, South Australia, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	- 0.0000009	- 0.0021846	- 0.0000152	- 0.0000030	- 0.0000027	- 0.0000002	- 0.0000046	- 0.0000000	- 0.0000002	- 0.0000001	- 0.0000005	- 0.0000000	- 0.0000122	- 0.0000564	- 0.0001560	- 0.0001378	- 0.0000055	- 0.0000005	- 0.0000032	- 0.0000898	- 0.0002213	- 0.0000073	- 0.0000393
2 Mining	-	- 0.0001985	- 0.0000603	- 0.0000010	- 0.0000017	- 0.0000022	- 0.0000005	- 0.0001482	- 0.0000279	- 0.0002048	- 0.0000009	- 0.0000039	- 0.0000109	- 0.0000800	- 0.0000188	- 0.0001235	- 0.0000296	- 0.0000055	- 0.0000139	- 0.0000873	- 0.0000851	- 0.0001465	- 0.0000485	- 0.0002687
3 FoodDrinkTob	-	- 0.0000009	- 0.0011089	- 0.0000009	- 0.0000049	- 0.0000001	- 0.0000003	- 0.0000059	- 0.0000001	- 0.0000002	- 0.0000003	- 0.0000005	- 0.0000000	- 0.0000071	- 0.0000799	- 0.0014822	- 0.0006191	- 0.0000056	- 0.0000095	- 0.0000597	- 0.0001410	- 0.0004258	- 0.0001511	- 0.0001902
4 TCFs	-	- 0.0000017	- 0.0000178	- 0.0000337	- 0.0000035	- 0.0000166	- 0.0000021	- 0.0000010	- 0.0000005	- 0.0000046	- 0.0000021	- 0.0000028	- 0.0000001	- 0.0003540	- 0.0000964	- 0.0001338	- 0.0000413	- 0.0000280	- 0.0000074	- 0.0000461	- 0.0001656	- 0.0005983	- 0.0001806	- 0.0008064
5 MiscManuf	-	- 0.0000046	- 0.0001737	- 0.0000028	- 0.0000104	- 0.0000039	- 0.0000125	- 0.0000076	- 0.0000008	- 0.0000033	- 0.0000056	- 0.0000109	- 0.0000007	- 0.0001978	- 0.0001466	- 0.0001346	- 0.0000511	- 0.0000673	- 0.0000719	- 0.0004499	- 0.0001346	- 0.0012428	- 0.0001628	- 0.0004021
6 WoodProds	-	- 0.0000016	- 0.0001672	- 0.0000016	- 0.0000016	- 0.0000115	- 0.0000320	- 0.0000041	- 0.0000014	- 0.0000018	- 0.0000021	- 0.0000023	- 0.0000001	- 0.0000522	- 0.0001002	- 0.0001187	- 0.0000410	- 0.0000136	- 0.0000160	- 0.0001002	- 0.0001147	- 0.0010380	- 0.0002680	- 0.0005987
7 PaperPrint	-	- 0.0000016	- 0.0000213	- 0.0000009	- 0.0000014	- 0.0000023	- 0.0000235	- 0.0000014	- 0.0000005	- 0.0000016	- 0.0000010	- 0.0000038	- 0.0000002	- 0.0000410	- 0.0002007	- 0.0006783	- 0.0000959	- 0.0000221	- 0.0000902	- 0.0005651	- 0.0006342	- 0.0019943	- 0.0009894	- 0.0003442
8 ChemCoalPrds	-	- 0.0000858	- 0.0000520	- 0.0000068	- 0.0000284	- 0.0000085	- 0.0000124	- 0.0000616	- 0.0000085	- 0.0000103	- 0.0000056	- 0.0000117	- 0.0000039	- 0.0003453	- 0.0002699	- 0.0003539	- 0.0001511	- 0.0006651	- 0.0000123	- 0.0003509	- 0.0006254	- 0.0010839	- 0.0001134	- 0.0037437
9 NonMetMinPrd	-	- 0.0000020	- 0.0000409	- 0.0000008	- 0.0000009	- 0.0000006	- 0.0000002	- 0.0000011	- 0.0000266	- 0.0000041	- 0.0000025	- 0.0000037	- 0.0000006	- 0.0005989	- 0.0000597	- 0.0000528	- 0.0000097	- 0.0000011	- 0.0000001	- 0.0000009	- 0.0001450	- 0.0001091	- 0.0000107	- 0.0000606
10 MetalPrds	-	- 0.0000335	- 0.0000958	- 0.0000058	- 0.0000099	- 0.0000085	- 0.0000017	- 0.0000040	- 0.0000044	- 0.0001309	- 0.0000269	- 0.0000991	- 0.0000014	- 0.0007553	- 0.0001416	- 0.0001562	- 0.0000453	- 0.0000713	- 0.0000440	- 0.0002819	- 0.0003712	- 0.0011377	- 0.0001686	- 0.0002392
11 TransEqp	-	- 0.0000062	- 0.0000031	- 0.0000002	- 0.0000008	- 0.0000007	- 0.0000003	- 0.0000002	- 0.0000005	- 0.0000006	- 0.0000508	- 0.0000041	- 0.0000000	- 0.0000556	- 0.0000896	- 0.0012103	- 0.0000114	- 0.0004079	- 0.0000297	- 0.0001861	- 0.0000796	- 0.0034635	- 0.0000573	- 0.0000190
12 OthMachEqp	-	- 0.0001418	- 0.0012656	- 0.0000242	- 0.0000221	- 0.0000200	- 0.0000355	- 0.0000779	- 0.0000241	- 0.0001152	- 0.0000324	- 0.0000504	- 0.0000203	- 0.0017376	- 0.0009496	- 0.0019201	- 0.0005945	- 0.0007958	- 0.0001946	- 0.0014784	- 0.0026234	- 0.0081981	- 0.0014778	- 0.0036697
13 EGW	-	- 0.0000206	- 0.0000554	- 0.0000019	- 0.0000020	- 0.0000023	- 0.0000020	- 0.0000031	- 0.0000033	- 0.0000127	- 0.0000025	- 0.0000067	- 0.0000432	- 0.0000788	- 0.0000650	- 0.0002463	- 0.0000807	- 0.0001039	- 0.0000339	- 0.0002120	- 0.0006179	- 0.0006662	- 0.0005508	- 0.0006251
14 Construction	-	- 0.0000513	- 0.0000146	- 0.0000010	- 0.0000005	- 0.0000003	- 0.0000006	- 0.0000058	- 0.0000003	- 0.0000016	- 0.0000004	- 0.0000021	- 0.0000058	- 0.0030215	- 0.0002426	- 0.0001696	- 0.0000542	- 0.0001151	- 0.0001389	- 0.0008697	- 0.0008440	- 0.0045838	- 0.0000122	- 0.0000673
15 WholesalTrad	-	- 0.0006930	- 0.0061858	- 0.0001181	- 0.0001081	- 0.0000978	- 0.0001736	- 0.0003807	- 0.0001177	- 0.0005630	- 0.0001583	- 0.0002464	- 0.0000994	- 0.0084927	- 0.0046413	- 0.0093844	- 0.0029055	- 0.0038892	- 0.0009511	- 0.0072256	- 0.0128220	- 0.0400680	- 0.0072228	- 0.0179358
16 RetailTrade	-	- 0.0000056	- 0.0000354	- 0.0000010	- 0.0000008	- 0.0000011	- 0.0000047	- 0.0000015	- 0.0000004	- 0.0000007	- 0.0000003	- 0.0000014	- 0.0000006	- 0.0000744	- 0.0002118	- 0.0005570	- 0.0000930	- 0.0003395	- 0.0000611	- 0.0003827	- 0.0005350	- 0.0006092	- 0.0001228	- 0.0005410
17 RecPersSrvc	-	- 0.0000119	- 0.0001360	- 0.0000018	- 0.0000014	- 0.0000015	- 0.0000094	- 0.0000062	- 0.0000017	- 0.0000040	- 0.0000040	- 0.0000055	- 0.0000010	- 0.0000741	- 0.0002091	- 0.0004863	- 0.0004278	- 0.0000937	- 0.0000543	- 0.0004318	- 0.0022451	- 0.0022949	- 0.0008750	- 0.0021528
18 Transport	-	- 0.0000534	- 0.0001416	- 0.0000063	- 0.0000037	- 0.0000051	- 0.0000118	- 0.0000077	- 0.0000048	- 0.0000121	- 0.0000038	- 0.0000102	- 0.0000007	- 0.0001556	- 0.0012108	- 0.0002622	- 0.0000615	- 0.0006444	- 0.0000514	- 0.0006462	- 0.0011381	- 0.0038071	- 0.0003991	- 0.0005769
19 PostalSrvcs	-	- 0.0000003	- 0.0000072	- 0.0000002	- 0.0000003	- 0.0000002	- 0.0000027	- 0.0000002	- 0.0000003	- 0.0000005	- 0.0000003	- 0.0000014	- 0.0000001	- 0.0000089	- 0.0000321	- 0.0001388	- 0.0000394	- 0.0000138	- 0.0000231	- 0.0001444	- 0.0002240	- 0.0005063	- 0.0001292	- 0.0004191
20 Telecomms	-	- 0.0025537	- 0.0227927	- 0.0004350	- 0.0003982	- 0.0003604	- 0.0006396	- 0.0014029	- 0.0004338	- 0.0020743	- 0.0005832	- 0.0009079	- 0.0003661	- 0.0312929	- 0.0171019	- 0.0345786	- 0.0107059	- 0.0143305	- 0.0035044	- 0.0266240	- 0.0472450	- 0.1476380	- 0.0266138	- 0.0660877
21 FinBusSrvces	-	- 0.0012145	- 0.0108400	- 0.0002069	- 0.0001894	- 0.0001714	- 0.0003042	- 0.0006672	- 0.0002063	- 0.0009865	- 0.0002774	- 0.0004318	- 0.0001741	- 0.0148826	- 0.0081335	- 0.0164452	- 0.0050916	- 0.0068155	- 0.0016667	- 0.0126621	- 0.0224692	- 0.0702151	- 0.0126573	- 0.0314306
22 PubAdmDef	-	- 0.0000042	- 0.0000115	- 0.0000002	- 0.0000002	- 0.0000004	- 0.0000032	- 0.0000014	- 0.0000002	- 0.0000008	- 0.0000009	- 0.0000006	- 0.0000001	- 0.0000472	- 0.0000209	- 0.0000778	- 0.0000088	- 0.0000930	- 0.0000049	- 0.0001883	- 0.0002965	- 0.0035292	- 0.0002142	- 0.0002842
23 Education	-	- 0.0000024	- 0.0000142	- 0.0000006	- 0.0000004	- 0.0000003	- 0.0000009	- 0.0000010	- 0.0000005	- 0.0000009	- 0.0000007	- 0.0000020	- 0.0000005	- 0.0000074	- 0.0000069	- 0.0000485	- 0.0000366	- 0.0000291	- 0.0000041	- 0.0000258	- 0.0005093	- 0.0005143	- 0.0005811	- 0.0002031
24 Community	-	- 0.0000000	- 0.0000055	- 0.0000003	- 0.0000000	- 0.0000001	- 0.0000009	- 0.0000010	- 0.0000000	- 0.0000000	- 0.0000004	- 0.0000001	- 0.0000000	- 0.0000009	- 0.0000028	- 0.0000083	- 0.0000065	- 0.0000077	- 0.0000012	- 0.0000453	- 0.0000145	- 0.0001853	- 0.0000337	- 0.0010230

Table C.25: Intermediate technical change through cloud computing in Rest of South Australia, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 Mining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 FoodDrinkTob	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 TCFs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 MiscManuf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 WoodProds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 PaperPrint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8 ChemCoalPrds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 NonMetMinPrd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10 MetalPrds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11 TransEqp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12 OthMachEqp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13 EGW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14 Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15 WholesalTrad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16 RetailTrade	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17 RecPersSrvc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18 Transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19 PostalSrvcs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 Telecomms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21 FinBusSrvces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22 PubAdmDef	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23 Education	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24 Community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C.26: Intermediate technical change through cloud computing in Perth, Western Australia, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-0.0000001	-0.0007065	-0.0000022	-0.0000004	-0.0000004	-0.0000000	-0.0000007	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000000	-0.0000011	-0.0000138	-0.0000507	-0.0000640	-0.0000014	-0.0000001	-0.0000016	-0.0000422	-0.0000313	-0.0000040	-0.0000224
2 Mining	-	-0.0000290	-0.0000195	-0.0000001	-0.0000003	-0.0000003	-0.0000001	-0.0000216	-0.0000041	-0.0000299	-0.0000001	-0.0000006	-0.0000048	-0.0000072	-0.0000046	-0.0000401	-0.0000138	-0.0000014	-0.0000035	-0.0000433	-0.0000399	-0.0000207	-0.0000262	-0.0001534
3 FoodDrinkTob	-	-0.0000001	-0.0003586	-0.0000001	-0.0000007	-0.0000000	-0.0000001	-0.0000009	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000000	-0.0000006	-0.0000196	-0.0004820	-0.0002877	-0.0000014	-0.0000024	-0.0000296	-0.0000662	-0.0000602	-0.0000818	-0.0001086
4 TCFs	-	-0.0000002	-0.0000058	-0.0000049	-0.0000005	-0.0000024	-0.0000003	-0.0000001	-0.0000001	-0.0000007	-0.0000003	-0.0000004	-0.0000001	-0.0000320	-0.0000236	-0.0000435	-0.0000192	-0.0000069	-0.0000018	-0.0000229	-0.0000778	-0.0000846	-0.0000978	-0.0004604
5 MiscManuf	-	-0.0000007	-0.0000562	-0.0000004	-0.0000015	-0.0000006	-0.0000018	-0.0000011	-0.0000001	-0.0000005	-0.0000008	-0.0000016	-0.0000003	-0.0000179	-0.0000359	-0.0000438	-0.0000238	-0.0000167	-0.0000178	-0.0002232	-0.0000632	-0.0001757	-0.0000881	-0.0002296
6 WoodProds	-	-0.0000002	-0.0000541	-0.0000002	-0.0000002	-0.0000017	-0.0000047	-0.0000006	-0.0000002	-0.0000003	-0.0000003	-0.0000003	-0.0000000	-0.0000047	-0.0000245	-0.0000386	-0.0000191	-0.0000034	-0.0000040	-0.0000497	-0.0000539	-0.0001467	-0.0001451	-0.0003418
7 PaperPrint	-	-0.0000002	-0.0000069	-0.0000001	-0.0000002	-0.0000003	-0.0000034	-0.0000002	-0.0000001	-0.0000002	-0.0000002	-0.0000006	-0.0000001	-0.0000037	-0.0000492	-0.0002206	-0.0000446	-0.0000055	-0.0000224	-0.0002803	-0.0002978	-0.0002819	-0.0005356	-0.0001965
8 ChemCoalPrds	-	-0.0000125	-0.0000168	-0.0000010	-0.0000041	-0.0000012	-0.0000018	-0.0000090	-0.0000012	-0.0000015	-0.0000008	-0.0000017	-0.0000017	-0.0000312	-0.0000661	-0.0001151	-0.0000702	-0.0001649	-0.0000031	-0.0001741	-0.0002937	-0.0001532	-0.0000614	-0.0021376
9 NonMetMinPrd	-	-0.0000003	-0.0000132	-0.0000001	-0.0000001	-0.0000001	-0.0000000	-0.0000002	-0.0000039	-0.0000006	-0.0000004	-0.0000005	-0.0000003	-0.0000541	-0.0000146	-0.0000172	-0.0000045	-0.0000003	-0.0000000	-0.0000005	-0.0000681	-0.0000154	-0.0000058	-0.0000346
10 MetalPrds	-	-0.0000049	-0.0000310	-0.0000008	-0.0000014	-0.0000012	-0.0000002	-0.0000006	-0.0000006	-0.0000191	-0.0000039	-0.0000145	-0.0000006	-0.0000682	-0.0000347	-0.0000508	-0.0000210	-0.0000177	-0.0000109	-0.0001399	-0.0001743	-0.0001608	-0.0000913	-0.0001366
11 TransEqp	-	-0.0000009	-0.0000010	-0.0000000	-0.0000001	-0.0000001	-0.0000000	-0.0000000	-0.0000001	-0.0000001	-0.0000074	-0.0000006	-0.0000000	-0.0000050	-0.0000219	-0.0003936	-0.0000053	-0.0001011	-0.0000074	-0.0000923	-0.0000374	-0.0004896	-0.0000310	-0.0000109
12 OthMachEqp	-	-0.0000207	-0.0004093	-0.0000035	-0.0000032	-0.0000029	-0.0000052	-0.0000114	-0.0000035	-0.0000168	-0.0000047	-0.0000074	-0.0000090	-0.0001569	-0.0002326	-0.0006244	-0.0002763	-0.0001973	-0.0000482	-0.0007334	-0.0012320	-0.0011589	-0.0007999	-0.0020954
13 EGW	-	-0.0000030	-0.0000179	-0.0000003	-0.0000003	-0.0000003	-0.0000003	-0.0000004	-0.0000005	-0.0000019	-0.0000004	-0.0000010	-0.0000192	-0.0000071	-0.0000159	-0.0000801	-0.0000375	-0.0000258	-0.0000084	-0.0001052	-0.0002902	-0.0000942	-0.0002981	-0.0003569
14 Construction	-	-0.0000075	-0.0000047	-0.0000001	-0.0000001	-0.0000000	-0.0000001	-0.0000008	-0.0000000	-0.0000002	-0.0000001	-0.0000003	-0.0000026	-0.0002729	-0.0000594	-0.0000551	-0.0000252	-0.0000285	-0.0000344	-0.0004315	-0.0003964	-0.0006480	-0.0000066	-0.0000384
15 WholesalTrad	-	-0.0001012	-0.0020005	-0.0000172	-0.0000158	-0.0000143	-0.0000254	-0.0000556	-0.0000172	-0.0000822	-0.0000231	-0.0000360	-0.0000440	-0.0007671	-0.0011370	-0.0030519	-0.0013503	-0.0009642	-0.0002358	-0.0035845	-0.0060215	-0.0056642	-0.0039097	-0.0102411
16 RetailTrade	-	-0.0000008	-0.0000115	-0.0000001	-0.0000001	-0.0000002	-0.0000007	-0.0000002	-0.0000001	-0.0000001	-0.0000000	-0.0000002	-0.0000002	-0.0000067	-0.0000519	-0.0001811	-0.0000432	-0.0000842	-0.0000151	-0.0001899	-0.0002512	-0.0000861	-0.0000665	-0.0003089
17 RecPersSrvc	-	-0.0000017	-0.0000440	-0.0000003	-0.0000002	-0.0000002	-0.0000014	-0.0000009	-0.0000002	-0.0000006	-0.0000006	-0.0000008	-0.0000004	-0.0000067	-0.0000512	-0.0001581	-0.0001988	-0.0000232	-0.0000135	-0.0002142	-0.0010543	-0.0003244	-0.0004736	-0.0012292
18 Transport	-	-0.0000078	-0.0000458	-0.0000009	-0.0000005	-0.0000007	-0.0000017	-0.0000011	-0.0000007	-0.0000018	-0.0000006	-0.0000015	-0.0000003	-0.0000141	-0.0002966	-0.0000853	-0.0000286	-0.0001598	-0.0000127	-0.0003205	-0.0005345	-0.0005382	-0.0002160	-0.0003294
19 PostalSrvcs	-	-0.0000000	-0.0000023	-0.0000000	-0.0000000	-0.0000000	-0.0000004	-0.0000000	-0.0000000	-0.0000001	-0.0000000	-0.0000002	-0.0000000	-0.0000008	-0.0000079	-0.0000451	-0.0000183	-0.0000034	-0.0000057	-0.0000716	-0.0001052	-0.0000716	-0.0000699	-0.0002393
20 Telecomms	-	-0.0003729	-0.0073712	-0.0000635	-0.0000582	-0.0000526	-0.0000934	-0.0002049	-0.0000634	-0.0003029	-0.0000852	-0.0001326	-0.0001622	-0.0028264	-0.0041896	-0.0112453	-0.0049755	-0.0035529	-0.0008688	-0.0132076	-0.0221873	-0.0208706	-0.0144061	-0.0377352
21 FinBusSrvces	-	-0.0001774	-0.0035056	-0.0000302	-0.0000277	-0.0000250	-0.0000444	-0.0000974	-0.0000301	-0.0001441	-0.0000405	-0.0000631	-0.0000771	-0.0013442	-0.0019925	-0.0053481	-0.0023663	-0.0016897	-0.0004132	-0.0062814	-0.0105520	-0.0099259	-0.0068514	-0.0179465
22 PubAdmDef	-	-0.0000006	-0.0000037	-0.0000000	-0.0000000	-0.0000001	-0.0000005	-0.0000002	-0.0000000	-0.0000001	-0.0000001	-0.0000001	-0.0000001	-0.0000043	-0.0000051	-0.0000253	-0.0000041	-0.0000231	-0.0000012	-0.0000934	-0.0001393	-0.0004989	-0.0001159	-0.0001623
23 Education	-	-0.0000004	-0.0000046	-0.0000001	-0.0000001	-0.0000000	-0.0000001	-0.0000001	-0.0000001	-0.0000001	-0.0000001	-0.0000003	-0.0000002	-0.0000007	-0.0000017	-0.0000158	-0.0000170	-0.0000072	-0.0000010	-0.0000128	-0.0002392	-0.0000727	-0.0003146	-0.0001159
24 Community	-	-0.0000000	-0.0000018	-0.0000000	-0.0000000	-0.0000000	-0.0000001	-0.0000001	-0.0000000	-0.0000000	-0.0000001	-0.0000000	-0.0000000	-0.0000001	-0.0000007	-0.0000027	-0.0000030	-0.0000019	-0.0000003	-0.0000225	-0.0000068	-0.0000262	-0.0000183	-0.0005841

Table C.27: Intermediate technical change through cloud computing in Rest of Western Australia, when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	- 0.0000001	- 0.0001229	- 0.0000012	- 0.0000002	- 0.0000002	- 0.0000000	- 0.0000004	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000007	- 0.0000018	- 0.0000181	- 0.0000135	- 0.0000008	- 0.0000001	- 0.0000000	- 0.0000078	- 0.0000020	- 0.0000001	- 0.0000057
2 Mining	-	- 0.0000154	- 0.0000034	- 0.0000001	- 0.0000001	- 0.0000002	- 0.0000000	- 0.0000115	- 0.0000022	- 0.0000159	- 0.0000001	- 0.0000003	- 0.0000019	- 0.0000047	- 0.0000006	- 0.0000143	- 0.0000029	- 0.0000008	- 0.0000020	- 0.0000010	- 0.0000074	- 0.0000014	- 0.0000009	- 0.0000392
3 FoodDrinkTob	-	- 0.0000001	- 0.0000624	- 0.0000001	- 0.0000004	- 0.0000000	- 0.0000000	- 0.0000005	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000004	- 0.0000026	- 0.0001720	- 0.0000608	- 0.0000008	- 0.0000014	- 0.0000007	- 0.0000122	- 0.0000039	- 0.0000028	- 0.0000277
4 TCFs	-	- 0.0000001	- 0.0000010	- 0.0000026	- 0.0000003	- 0.0000013	- 0.0000002	- 0.0000001	- 0.0000000	- 0.0000004	- 0.0000002	- 0.0000002	- 0.0000000	- 0.0000207	- 0.0000031	- 0.0000155	- 0.0000041	- 0.0000041	- 0.0000011	- 0.0000005	- 0.0000143	- 0.0000055	- 0.0000033	- 0.0001175
5 MiscManuf	-	- 0.0000004	- 0.0000098	- 0.0000002	- 0.0000008	- 0.0000003	- 0.0000010	- 0.0000006	- 0.0000001	- 0.0000003	- 0.0000004	- 0.0000008	- 0.0000001	- 0.0000116	- 0.0000047	- 0.0000156	- 0.0000050	- 0.0000098	- 0.0000105	- 0.0000050	- 0.0000116	- 0.0000115	- 0.0000030	- 0.0000586
6 WoodProds	-	- 0.0000001	- 0.0000094	- 0.0000001	- 0.0000001	- 0.0000009	- 0.0000025	- 0.0000003	- 0.0000001	- 0.0000001	- 0.0000002	- 0.0000002	- 0.0000000	- 0.0000030	- 0.0000032	- 0.0000138	- 0.0000040	- 0.0000020	- 0.0000023	- 0.0000011	- 0.0000099	- 0.0000096	- 0.0000049	- 0.0000872
7 PaperPrint	-	- 0.0000001	- 0.0000012	- 0.0000001	- 0.0000001	- 0.0000002	- 0.0000018	- 0.0000001	- 0.0000000	- 0.0000001	- 0.0000001	- 0.0000003	- 0.0000000	- 0.0000024	- 0.0000064	- 0.0000787	- 0.0000094	- 0.0000032	- 0.0000131	- 0.0000062	- 0.0000548	- 0.0000184	- 0.0000181	- 0.0000502
8 ChemCoalPrds	-	- 0.0000067	- 0.0000029	- 0.0000005	- 0.0000022	- 0.0000007	- 0.0000010	- 0.0000048	- 0.0000007	- 0.0000008	- 0.0000004	- 0.0000009	- 0.0000007	- 0.0000202	- 0.0000086	- 0.0000411	- 0.0000148	- 0.0000968	- 0.0000018	- 0.0000039	- 0.0000540	- 0.0000100	- 0.0000021	- 0.0005455
9 NonMetMinPrd	-	- 0.0000002	- 0.0000023	- 0.0000001	- 0.0000001	- 0.0000000	- 0.0000000	- 0.0000001	- 0.0000021	- 0.0000003	- 0.0000002	- 0.0000003	- 0.0000001	- 0.0000350	- 0.0000019	- 0.0000061	- 0.0000010	- 0.0000002	- 0.0000000	- 0.0000000	- 0.0000125	- 0.0000010	- 0.0000002	- 0.0000088
10 MetalPrds	-	- 0.0000026	- 0.0000054	- 0.0000004	- 0.0000008	- 0.0000007	- 0.0000001	- 0.0000003	- 0.0000003	- 0.0000102	- 0.0000021	- 0.0000077	- 0.0000002	- 0.0000441	- 0.0000045	- 0.0000181	- 0.0000044	- 0.0000104	- 0.0000064	- 0.0000031	- 0.0000321	- 0.0000105	- 0.0000031	- 0.0000349
11 TransEqp	-	- 0.0000005	- 0.0000002	- 0.0000000	- 0.0000001	- 0.0000001	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000039	- 0.0000003	- 0.0000000	- 0.0000033	- 0.0000029	- 0.0001404	- 0.0000011	- 0.0000594	- 0.0000043	- 0.0000020	- 0.0000069	- 0.0000320	- 0.0000010	- 0.0000028
12 OthMachEqp	-	- 0.0000110	- 0.0000712	- 0.0000019	- 0.0000017	- 0.0000016	- 0.0000028	- 0.0000060	- 0.0000019	- 0.0000089	- 0.0000025	- 0.0000039	- 0.0000035	- 0.0001015	- 0.0000304	- 0.0002228	- 0.0000584	- 0.0001159	- 0.0000283	- 0.0000163	- 0.0002267	- 0.0000757	- 0.0000270	- 0.0005347
13 EGW	-	- 0.0000016	- 0.0000031	- 0.0000001	- 0.0000002	- 0.0000002	- 0.0000002	- 0.0000002	- 0.0000003	- 0.0000010	- 0.0000002	- 0.0000005	- 0.0000074	- 0.0000046	- 0.0000021	- 0.0000286	- 0.0000079	- 0.0000151	- 0.0000049	- 0.0000023	- 0.0000534	- 0.0000061	- 0.0000101	- 0.0000911
14 Construction	-	- 0.0000040	- 0.0000008	- 0.0000001	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000004	- 0.0000000	- 0.0000001	- 0.0000000	- 0.0000002	- 0.0000010	- 0.0001765	- 0.0000078	- 0.0000197	- 0.0000053	- 0.0000168	- 0.0000202	- 0.0000096	- 0.0000729	- 0.0000423	- 0.0000002	- 0.0000098
15 WholesalTrad	-	- 0.0000538	- 0.0003479	- 0.0000092	- 0.0000084	- 0.0000076	- 0.0000135	- 0.0000295	- 0.0000091	- 0.0000437	- 0.0000123	- 0.0000191	- 0.0000171	- 0.0004962	- 0.0001485	- 0.0010888	- 0.0002854	- 0.0005663	- 0.0001385	- 0.0000796	- 0.0011081	- 0.0003698	- 0.0001320	- 0.0026135
16 RetailTrade	-	- 0.0000004	- 0.0000020	- 0.0000001	- 0.0000001	- 0.0000001	- 0.0000004	- 0.0000001	- 0.0000000	- 0.0000001	- 0.0000000	- 0.0000001	- 0.0000001	- 0.0000043	- 0.0000068	- 0.0000646	- 0.0000091	- 0.0000494	- 0.0000089	- 0.0000042	- 0.0000462	- 0.0000056	- 0.0000022	- 0.0000788
17 RecPersSrvc	-	- 0.0000009	- 0.0000076	- 0.0000001	- 0.0000001	- 0.0000001	- 0.0000007	- 0.0000005	- 0.0000001	- 0.0000003	- 0.0000003	- 0.0000004	- 0.0000002	- 0.0000043	- 0.0000067	- 0.0000564	- 0.0000420	- 0.0000136	- 0.0000079	- 0.0000048	- 0.0001940	- 0.0000212	- 0.0000160	- 0.0003137
18 Transport	-	- 0.0000041	- 0.0000080	- 0.0000005	- 0.0000003	- 0.0000004	- 0.0000009	- 0.0000006	- 0.0000004	- 0.0000009	- 0.0000003	- 0.0000008	- 0.0000001	- 0.0000091	- 0.0000387	- 0.0000304	- 0.0000060	- 0.0000938	- 0.0000075	- 0.0000071	- 0.0000984	- 0.0000351	- 0.0000073	- 0.0000841
19 PostalSrvcs	-	- 0.0000000	- 0.0000004	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000002	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000001	- 0.0000000	- 0.0000005	- 0.0000010	- 0.0000161	- 0.0000039	- 0.0000020	- 0.0000034	- 0.0000016	- 0.0000194	- 0.0000047	- 0.0000024	- 0.0000611
20 Telecomms	-	- 0.0001981	- 0.0012818	- 0.0000337	- 0.0000309	- 0.0000280	- 0.0000496	- 0.0001088	- 0.0000337	- 0.0001609	- 0.0000452	- 0.0000704	- 0.0000629	- 0.0018283	- 0.0005471	- 0.0040120	- 0.0010514	- 0.0020865	- 0.0005102	- 0.0002931	- 0.0040828	- 0.0013627	- 0.0004865	- 0.0096301
21 FinBusSrvces	-	- 0.0000942	- 0.0006096	- 0.0000161	- 0.0000147	- 0.0000133	- 0.0000236	- 0.0000518	- 0.0000160	- 0.0000765	- 0.0000215	- 0.0000335	- 0.0000299	- 0.0008695	- 0.0002602	- 0.0019081	- 0.0005001	- 0.0009923	- 0.0002427	- 0.0001394	- 0.0019418	- 0.0006481	- 0.0002314	- 0.0045800
22 PubAdmDef	-	- 0.0000003	- 0.0000006	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000002	- 0.0000001	- 0.0000000	- 0.0000001	- 0.0000001	- 0.0000000	- 0.0000000	- 0.0000028	- 0.0000007	- 0.0000090	- 0.0000009	- 0.0000135	- 0.0000007	- 0.0000021	- 0.0000256	- 0.0000326	- 0.0000039	- 0.0000414
23 Education	-	- 0.0000002	- 0.0000008	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000001	- 0.0000001	- 0.0000000	- 0.0000001	- 0.0000001	- 0.0000002	- 0.0000001	- 0.0000004	- 0.0000002	- 0.0000056	- 0.0000036	- 0.0000042	- 0.0000006	- 0.0000003	- 0.0000440	- 0.0000047	- 0.0000106	- 0.0000296
24 Community	-	- 0.0000000	- 0.0000003	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000001	- 0.0000001	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000000	- 0.0000001	- 0.0000010	- 0.0000006	- 0.0000011	- 0.0000002	- 0.0000005	- 0.0000013	- 0.0000017	- 0.0000006	- 0.0001491

Table C.28: Intermediate technical change through cloud computing in Tasmania when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	- 0.0000008	- 0.0020967	- 0.0000133	- 0.0000026	- 0.0000024	- 0.0000002	- 0.0000040	- 0.0000000	- 0.0000002	- 0.0000001	- 0.0000004	- 0.0000000	- 0.0000112	- 0.0000430	- 0.0001460	- 0.0000534	- 0.0000030	- 0.0000003	- 0.0000012	- 0.0000758	- 0.0001769	- 0.0000087	- 0.0000377
2 Mining	-	- 0.0001731	- 0.0000578	- 0.0000009	- 0.0000015	- 0.0000019	- 0.0000004	- 0.0001293	- 0.0000244	- 0.0001786	- 0.0000008	- 0.0000034	- 0.0000212	- 0.0000733	- 0.0000143	- 0.0001155	- 0.0000115	- 0.0000030	- 0.0000077	- 0.0000336	- 0.0000718	- 0.0001171	- 0.0000573	- 0.0002581
3 FoodDrinkTob	-	- 0.0000007	- 0.0010643	- 0.0000007	- 0.0000042	- 0.0000001	- 0.0000003	- 0.0000052	- 0.0000001	- 0.0000001	- 0.0000002	- 0.0000004	- 0.0000001	- 0.0000065	- 0.0000609	- 0.0013870	- 0.0002401	- 0.0000031	- 0.0000053	- 0.0000230	- 0.0001190	- 0.0003404	- 0.0001785	- 0.0001827
4 TCFs	-	- 0.0000015	- 0.0000171	- 0.0000294	- 0.0000030	- 0.0000145	- 0.0000019	- 0.0000009	- 0.0000005	- 0.0000040	- 0.0000018	- 0.0000024	- 0.0000003	- 0.0003243	- 0.0000734	- 0.0001252	- 0.0000160	- 0.0000155	- 0.0000041	- 0.0000178	- 0.0001398	- 0.0004783	- 0.0002133	- 0.0007747
5 MiscManuf	-	- 0.0000040	- 0.0001667	- 0.0000024	- 0.0000091	- 0.0000034	- 0.0000109	- 0.0000066	- 0.0000007	- 0.0000029	- 0.0000049	- 0.0000095	- 0.0000013	- 0.0001812	- 0.0001117	- 0.0001260	- 0.0000198	- 0.0000373	- 0.0000398	- 0.0001733	- 0.0001137	- 0.0009937	- 0.0001923	- 0.0003863
6 WoodProds	-	- 0.0000014	- 0.0001605	- 0.0000014	- 0.0000014	- 0.0000101	- 0.0000279	- 0.0000036	- 0.0000012	- 0.0000016	- 0.0000019	- 0.0000020	- 0.0000001	- 0.0000478	- 0.0000763	- 0.0001111	- 0.0000159	- 0.0000075	- 0.0000089	- 0.0000386	- 0.0000968	- 0.0008300	- 0.0003166	- 0.0005751
7 PaperPrint	-	- 0.0000014	- 0.0000205	- 0.0000008	- 0.0000012	- 0.0000020	- 0.0000205	- 0.0000012	- 0.0000005	- 0.0000014	- 0.0000009	- 0.0000033	- 0.0000003	- 0.0000375	- 0.0001529	- 0.0006347	- 0.0000372	- 0.0000122	- 0.0000499	- 0.0002176	- 0.0005354	- 0.0015945	- 0.0011688	- 0.0003306
8 ChemCoalPrds	-	- 0.0000749	- 0.0000499	- 0.0000059	- 0.0000247	- 0.0000074	- 0.0000108	- 0.0000537	- 0.0000074	- 0.0000089	- 0.0000048	- 0.0000102	- 0.0000075	- 0.0003163	- 0.0002055	- 0.0003312	- 0.0000586	- 0.0003681	- 0.0000068	- 0.0001351	- 0.0005280	- 0.0008667	- 0.0001339	- 0.0035965
9 NonMetMinPrd	-	- 0.0000017	- 0.0000393	- 0.0000007	- 0.0000008	- 0.0000005	- 0.0000001	- 0.0000010	- 0.0000232	- 0.0000036	- 0.0000022	- 0.0000032	- 0.0000012	- 0.0005486	- 0.0000455	- 0.0000494	- 0.0000038	- 0.0000006	- 0.0000001	- 0.0000004	- 0.0001224	- 0.0000873	- 0.0000126	- 0.0000582
10 MetalPrds	-	- 0.0000292	- 0.0000920	- 0.0000050	- 0.0000086	- 0.0000074	- 0.0000015	- 0.0000035	- 0.0000039	- 0.0001141	- 0.0000235	- 0.0000864	- 0.0000027	- 0.0006919	- 0.0001079	- 0.0001461	- 0.0000176	- 0.0000395	- 0.0000243	- 0.0001086	- 0.0003134	- 0.0009096	- 0.0001992	- 0.0002298
11 TransEqp	-	- 0.0000054	- 0.0000029	- 0.0000002	- 0.0000007	- 0.0000006	- 0.0000002	- 0.0000001	- 0.0000004	- 0.0000005	- 0.0000443	- 0.0000036	- 0.0000001	- 0.0000510	- 0.0000682	- 0.0011325	- 0.0000044	- 0.0002257	- 0.0000165	- 0.0000717	- 0.0000672	- 0.0027693	- 0.0000677	- 0.0000183
12 OthMachEqp	-	- 0.0001237	- 0.0012147	- 0.0000211	- 0.0000193	- 0.0000175	- 0.0000310	- 0.0000679	- 0.0000210	- 0.0001005	- 0.0000282	- 0.0000440	- 0.0000395	- 0.0015918	- 0.0007234	- 0.0017968	- 0.0002305	- 0.0004404	- 0.0001077	- 0.0005693	- 0.0022148	- 0.0065548	- 0.0017458	- 0.0035255
13 EGW	-	- 0.0000179	- 0.0000532	- 0.0000016	- 0.0000017	- 0.0000020	- 0.0000017	- 0.0000027	- 0.0000029	- 0.0000111	- 0.0000022	- 0.0000059	- 0.0000840	- 0.0000722	- 0.0000495	- 0.0002305	- 0.0000313	- 0.0000575	- 0.0000187	- 0.0000817	- 0.0005216	- 0.0005326	- 0.0006506	- 0.0006006
14 Construction	-	- 0.0000447	- 0.0000140	- 0.0000008	- 0.0000005	- 0.0000002	- 0.0000005	- 0.0000050	- 0.0000002	- 0.0000014	- 0.0000004	- 0.0000018	- 0.0000112	- 0.0027678	- 0.0001848	- 0.0001587	- 0.0000210	- 0.0000637	- 0.0000768	- 0.0003349	- 0.0007125	- 0.0036650	- 0.0000144	- 0.0000647
15 WholesalTrad	-	- 0.0006044	- 0.0059369	- 0.0001030	- 0.0000943	- 0.0000853	- 0.0001514	- 0.0003321	- 0.0001027	- 0.0004910	- 0.0001380	- 0.0002149	- 0.0001930	- 0.0077797	- 0.0035354	- 0.0087816	- 0.0011267	- 0.0021524	- 0.0005264	- 0.0027826	- 0.0108246	- 0.0320366	- 0.0085326	- 0.0172306
16 RetailTrade	-	- 0.0000049	- 0.0000340	- 0.0000009	- 0.0000007	- 0.0000010	- 0.0000041	- 0.0000013	- 0.0000003	- 0.0000006	- 0.0000003	- 0.0000012	- 0.0000011	- 0.0000681	- 0.0001613	- 0.0005212	- 0.0000361	- 0.0001879	- 0.0000338	- 0.0001474	- 0.0004516	- 0.0004871	- 0.0001451	- 0.0005198
17 RecPersSrvc	-	- 0.0000104	- 0.0001305	- 0.0000016	- 0.0000013	- 0.0000013	- 0.0000082	- 0.0000054	- 0.0000015	- 0.0000034	- 0.0000035	- 0.0000048	- 0.0000019	- 0.0000679	- 0.0001593	- 0.0004550	- 0.0001659	- 0.0000518	- 0.0000301	- 0.0001663	- 0.0018953	- 0.0018349	- 0.0010336	- 0.0020682
18 Transport	-	- 0.0000466	- 0.0001359	- 0.0000055	- 0.0000032	- 0.0000044	- 0.0000103	- 0.0000067	- 0.0000041	- 0.0000106	- 0.0000033	- 0.0000089	- 0.0000013	- 0.0001425	- 0.0009223	- 0.0002453	- 0.0000239	- 0.0003566	- 0.0000284	- 0.0002488	- 0.0009608	- 0.0030439	- 0.0004715	- 0.0005542
19 PostalSrvcs	-	- 0.0000003	- 0.0000069	- 0.0000002	- 0.0000003	- 0.0000001	- 0.0000024	- 0.0000002	- 0.0000002	- 0.0000004	- 0.0000002	- 0.0000012	- 0.0000001	- 0.0000081	- 0.0000245	- 0.0001299	- 0.0000153	- 0.0000076	- 0.0000128	- 0.0000556	- 0.0001891	- 0.0004048	- 0.0001526	- 0.0004026
20 Telecomms	-	- 0.0022272	- 0.0218755	- 0.0003794	- 0.0003473	- 0.0003144	- 0.0005579	- 0.0012236	- 0.0003784	- 0.0018091	- 0.0005086	- 0.0007918	- 0.0007112	- 0.0286657	- 0.0130268	- 0.0323576	- 0.0041516	- 0.0079311	- 0.0019395	- 0.0102531	- 0.0398851	- 0.1180447	- 0.0314398	- 0.0634894
21 FinBusSrvces	-	- 0.0010592	- 0.0104038	- 0.0001804	- 0.0001652	- 0.0001495	- 0.0002653	- 0.0005819	- 0.0001799	- 0.0008604	- 0.0002419	- 0.0003766	- 0.0003383	- 0.0136331	- 0.0061954	- 0.0153889	- 0.0019744	- 0.0037719	- 0.0009224	- 0.0048762	- 0.0189690	- 0.0561408	- 0.0149524	- 0.0301949
22 PubAdmDef	-	- 0.0000037	- 0.0000110	- 0.0000002	- 0.0000002	- 0.0000004	- 0.0000028	- 0.0000013	- 0.0000002	- 0.0000007	- 0.0000008	- 0.0000005	- 0.0000003	- 0.0000432	- 0.0000159	- 0.0000728	- 0.0000034	- 0.0000515	- 0.0000027	- 0.0000725	- 0.0002503	- 0.0028218	- 0.0002530	- 0.0002730
23 Education	-	- 0.0000021	- 0.0000137	- 0.0000005	- 0.0000003	- 0.0000002	- 0.0000008	- 0.0000009	- 0.0000004	- 0.0000008	- 0.0000006	- 0.0000017	- 0.0000010	- 0.0000068	- 0.0000052	- 0.0000453	- 0.0000142	- 0.0000161	- 0.0000023	- 0.0000099	- 0.0004300	- 0.0004112	- 0.0006865	- 0.0001951
24 Community	-	- 0.0000000	- 0.0000052	- 0.0000003	- 0.0000000	- 0.0000000	- 0.0000008	- 0.0000009	- 0.0000000	- 0.0000000	- 0.0000004	- 0.0000001	- 0.0000000	- 0.0000008	- 0.0000022	- 0.0000078	- 0.0000025	- 0.0000042	- 0.0000007	- 0.0000175	- 0.0000123	- 0.0001481	- 0.0000398	- 0.0009827

Table C.29: Intermediate technical change through cloud computing in Northern Territory when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-	- 0.0007204	-	-	-	-	-	-	-	-	-	-	-	- 0.0000140	- 0.0000481	- 0.0000485	- 0.0000022	- 0.0000002	- 0.0000030	- 0.0000475	- 0.0001975	- 0.0000066	- 0.0000170
2 Mining	-	-	- 0.0000199	-	-	-	-	-	-	-	-	-	-	-	- 0.0000047	- 0.0000380	- 0.0000104	- 0.0000022	- 0.0000055	- 0.0000840	- 0.0000450	- 0.0001307	- 0.0000436	- 0.0001162
3 FoodDrinkTob	-	-	- 0.0003657	-	-	-	-	-	-	-	-	-	-	-	- 0.0000198	- 0.0004566	- 0.0002178	- 0.0000022	- 0.0000038	- 0.0000574	- 0.0000746	- 0.0003799	- 0.0001360	- 0.0000823
4 TCFs	-	-	- 0.0000059	-	-	-	-	-	-	-	-	-	-	-	- 0.0000239	- 0.0000412	- 0.0000145	- 0.0000111	- 0.0000029	- 0.0000443	- 0.0000876	- 0.0005338	- 0.0001626	- 0.0003487
5 MiscManuf	-	-	- 0.0000573	-	-	-	-	-	-	-	-	-	-	-	- 0.0000363	- 0.0000415	- 0.0000180	- 0.0000267	- 0.0000285	- 0.0004325	- 0.0000713	- 0.0011090	- 0.0001466	- 0.0001739
6 WoodProds	-	-	- 0.0000552	-	-	-	-	-	-	-	-	-	-	-	- 0.0000248	- 0.0000366	- 0.0000144	- 0.0000054	- 0.0000063	- 0.0000963	- 0.0000607	- 0.0009262	- 0.0002413	- 0.0002589
7 PaperPrint	-	-	- 0.0000070	-	-	-	-	-	-	-	-	-	-	-	- 0.0000497	- 0.0002089	- 0.0000337	- 0.0000088	- 0.0000358	- 0.0005431	- 0.0003356	- 0.0017795	- 0.0008906	- 0.0001488
8 ChemCoalPrds	-	-	- 0.0000171	-	-	-	-	-	-	-	-	-	-	-	- 0.0000668	- 0.0001090	- 0.0000532	- 0.0002638	- 0.0000049	- 0.0003373	- 0.0003310	- 0.0009672	- 0.0001020	- 0.0016190
9 NonMetMinPrd	-	-	- 0.0000135	-	-	-	-	-	-	-	-	-	-	-	- 0.0000148	- 0.0000163	- 0.0000034	- 0.0000004	- 0.0000001	- 0.0000009	- 0.0000768	- 0.0000974	- 0.0000096	- 0.0000262
10 MetalPrds	-	-	- 0.0000316	-	-	-	-	-	-	-	-	-	-	-	- 0.0000351	- 0.0000481	- 0.0000159	- 0.0000283	- 0.0000174	- 0.0002710	- 0.0001965	- 0.0010151	- 0.0001518	- 0.0001034
11 TransEqp	-	-	- 0.0000010	-	-	-	-	-	-	-	-	-	-	-	- 0.0000222	- 0.0003728	- 0.0000040	- 0.0001618	- 0.0000118	- 0.0001789	- 0.0000422	- 0.0030905	- 0.0000516	- 0.0000082
12 OthMachEqp	-	-	- 0.0004173	-	-	-	-	-	-	-	-	-	-	-	- 0.0002352	- 0.0005915	- 0.0002091	- 0.0003156	- 0.0000772	- 0.0014210	- 0.0013884	- 0.0073151	- 0.0013302	- 0.0015870
13 EGW	-	-	- 0.0000183	-	-	-	-	-	-	-	-	-	-	-	- 0.0000161	- 0.0000759	- 0.0000284	- 0.0000412	- 0.0000134	- 0.0002038	- 0.0003270	- 0.0005944	- 0.0004957	- 0.0002703
14 Construction	-	-	- 0.0000048	-	-	-	-	-	-	-	-	-	-	-	- 0.0000601	- 0.0000522	- 0.0000191	- 0.0000456	- 0.0000551	- 0.0008360	- 0.0004467	- 0.0040901	- 0.0000110	- 0.0000291
15 WholesalTrad	-	-	- 0.0020398	-	-	-	-	-	-	-	-	-	-	-	- 0.0011495	- 0.0028910	- 0.0010222	- 0.0015424	- 0.0003772	- 0.0069451	- 0.0067857	- 0.0357525	- 0.0065014	- 0.0077565
16 RetailTrade	-	-	- 0.0000117	-	-	-	-	-	-	-	-	-	-	-	- 0.0000524	- 0.0001716	- 0.0000327	- 0.0001346	- 0.0000242	- 0.0003679	- 0.0002831	- 0.0005436	- 0.0001105	- 0.0002340
17 RecPersSrvc	-	-	- 0.0000448	-	-	-	-	-	-	-	-	-	-	-	- 0.0000518	- 0.0001498	- 0.0001505	- 0.0000371	- 0.0000215	- 0.0004150	- 0.0011881	- 0.0020477	- 0.0007876	- 0.0009310
18 Transport	-	-	- 0.0000467	-	-	-	-	-	-	-	-	-	-	-	- 0.0002999	- 0.0000808	- 0.0000217	- 0.0002556	- 0.0000204	- 0.0006211	- 0.0006023	- 0.0033970	- 0.0003593	- 0.0002495
19 PostalSrvcs	-	-	- 0.0000024	-	-	-	-	-	-	-	-	-	-	-	- 0.0000080	- 0.0000428	- 0.0000139	- 0.0000055	- 0.0000091	- 0.0001388	- 0.0001185	- 0.0004518	- 0.0001163	- 0.0001812
20 Telecomms	-	-	- 0.0075159	-	-	-	-	-	-	-	-	-	-	-	- 0.0042356	- 0.0106523	- 0.0037665	- 0.0056834	- 0.0013898	- 0.0255906	- 0.0250033	- 0.1317367	- 0.0239556	- 0.0285802
21 FinBusSrvces	-	-	- 0.0035745	-	-	-	-	-	-	-	-	-	-	-	- 0.0020144	- 0.0050661	- 0.0017913	- 0.0027030	- 0.0006610	- 0.0121706	- 0.0118913	- 0.0626526	- 0.0113930	- 0.0135925
22 PubAdmDef	-	-	- 0.0000038	-	-	-	-	-	-	-	-	-	-	-	- 0.0000052	- 0.0000240	- 0.0000031	- 0.0000369	- 0.0000020	- 0.0001810	- 0.0001569	- 0.0031491	- 0.0001928	- 0.0001229
23 Education	-	-	- 0.0000047	-	-	-	-	-	-	-	-	-	-	-	- 0.0000017	- 0.0000149	- 0.0000129	- 0.0000115	- 0.0000016	- 0.0000248	- 0.0002695	- 0.0004589	- 0.0005231	- 0.0000878
24 Community	-	-	- 0.0000018	-	-	-	-	-	-	-	-	-	-	-	- 0.0000007	- 0.0000026	- 0.0000023	- 0.0000030	- 0.0000005	- 0.0000436	- 0.0000077	- 0.0001653	- 0.0000304	- 0.0004424

Table C.30: Intermediate technical change through cloud computing in Australian Capital Territory when services require high access speeds (%)

Commodity	1 AgriForFish	2 Mining	3 FoodDrinkTob	4 TCFs	5 MiscManuf	6 WoodProds	7 PaperPrint	8 ChemCoalPrds	9 NonMetMinPrd	10 MetalPrds	11 TransEqp	12 OthMachEqp	13 EGW	14 Construction	15 WholesalTrad	16 RetailTrade	17 RecPersSrvc	18 Transport	19 PostalSrvcs	20 Telecomms	21 FinBusSrvces	22 PubAdmDef	23 Education	24 Community
1 AgriForFish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 Mining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 FoodDrinkTob	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 TCFs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 MiscManuf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 WoodProds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 PaperPrint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8 ChemCoalPrds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 NonMetMinPrd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10 MetalPrds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11 TransEqp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12 OthMachEqp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13 EGW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14 Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15 WholesalTrad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16 RetailTrade	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17 RecPersSrvc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18 Transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19 PostalSrvcs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 Telecomms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21 FinBusSrvces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22 PubAdmDef	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23 Education	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24 Community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Electronic Commerce

Tables C.31 and C.32 show the percentage change values we have estimated in equation (17) for the labour-augmenting technical change variable over all occupations by industry and region of use due to electronic commerce made more widely available through the NBN.

Table C.31: Labour-augmenting technical change through electronic commerce when services require modest access speeds (%)

Industry	SydneyNSW	RoNSW	MelbourneVic	RoVic	BrisbaneQld	RoQld	AdelaideSA	RoSA	PerthWA	RoWA	Tas	NT	ACT
1 AgriForFish	-	-	-	-	-	-	-	-	-	-	-	-	-
2 Mining	-	-	-	-	-	-	-	-	-	-	-	-	-
3 FoodDrinkTob	-0.0597117	-0.0276001	-0.1351712	-0.0301158	-0.0852151	-0.0495423	-0.0105813	-0.0163897	-0.0046038	-0.0667285	-0.0003099	-	-0.0006636
4 TCFs	-0.0006324	-0.0004541	-0.0016360	-0.0005486	-0.0006760	-0.0003654	-0.0002573	-0.0013806	-0.0000563	-0.0002583	-0.0011516	-0.0002523	-0.0000110
5 MiscManuf	-0.0005789	-0.0004157	-0.0014978	-0.0005023	-0.0006189	-0.0003345	-0.0002355	-0.0012639	-0.0000515	-0.0002365	-0.0010543	-0.0002310	-0.0000101
6 WoodProds	-0.0005240	-0.0003763	-0.0013557	-0.0004546	-0.0005602	-0.0003028	-0.0002132	-0.0011440	-0.0000466	-0.0002140	-0.0009543	-0.0002091	-0.0000091
7 PaperPrint	-0.0009299	-0.0006678	-0.0024058	-0.0008067	-0.0009941	-0.0005373	-0.0003783	-0.0020301	-0.0000827	-0.0003798	-0.0016935	-0.0003710	-0.0000162
8 ChemCoalPrds	-0.0020395	-0.0014646	-0.0052766	-0.0017694	-0.0021804	-0.0011784	-0.0008297	-0.0044527	-0.0001815	-0.0008331	-0.0037143	-0.0008138	-0.0000355
9 NonMetMinPrd	-0.0006307	-0.0004529	-0.0016317	-0.0005472	-0.0006742	-0.0003644	-0.0002566	-0.0013769	-0.0000561	-0.0002576	-0.0011485	-0.0002516	-0.0000110
10 MetalPrds	-0.0030155	-0.0021655	-0.0078019	-0.0026162	-0.0032238	-0.0017424	-0.0012268	-0.0065836	-0.0002684	-0.0012317	-0.0054919	-0.0012032	-0.0000524
11 TransEqp	-0.0008478	-0.0006088	-0.0021934	-0.0007355	-0.0009064	-0.0004899	-0.0003449	-0.0018509	-0.0000754	-0.0003463	-0.0015440	-0.0003383	-0.0000147
12 OthMachEqp	-0.0013198	-0.0009478	-0.0034147	-0.0011451	-0.0014110	-0.0007626	-0.0005369	-0.0028815	-0.0001175	-0.0005391	-0.0024036	-0.0005266	-0.0000230
13 EGW	-0.0054379	-0.0014246	-0.0120398	-0.0073395	-0.0015547	-0.0095094	-0.0011071	-0.0038128	-	-0.0091622	-0.0063670	-	-
14 Construction	-0.0743598	-0.0621921	-0.1288671	-0.0528037	-0.0264510	-0.0565160	-0.0686106	-0.1844673	-0.0158480	-0.0558431	-0.3241531	-0.0191331	-0.0001703
15 WholesalTrad	-0.0151179	-0.0107969	-0.0243492	-0.0042184	-0.0169372	-0.0127139	-0.0042718	-0.0091331	-0.0008129	-0.0103887	-0.0007527	-	-0.0000516
16 RetailTrade	-0.0629011	-0.0269504	-0.0737842	-0.0312207	-0.0313800	-0.0344983	-0.0067595	-0.0337106	-0.0028443	-0.0543780	-0.0148164	-	-0.0002627
17 RecPersSrvc	-0.0363023	-0.0214032	-0.0681102	-0.0084052	-0.0458070	-0.0403941	-0.0047895	-0.0021763	-	-0.0047819	-	-	-0.0006652
18 Transport	-0.0604960	-0.0249870	-0.0754856	-0.0555030	-0.0194160	-0.0644869	-0.0126796	-0.0595552	-0.0060780	-0.1017898	-0.0237167	-	-0.0001101
19 PostalSrvcs	-0.0031528	-0.0013022	-0.0039339	-0.0028925	-0.0010119	-0.0033607	-0.0006608	-0.0031037	-0.0003168	-0.0053048	-0.0012360	-	-0.0000057
20 Telecomms	-0.0059564	-0.0030437	-0.0156519	-0.0049146	-0.0287122	-0.0068875	-0.0050241	-0.0060672	-	-0.0114111	-	-	-0.0001352
21 FinBusSrvces	-0.0333477	-0.0180559	-0.0748017	-0.0268214	-0.0625994	-0.0492694	-0.0072968	-0.0171558	-0.0016214	-0.0348973	-0.0087320	-	-0.0007698
22 PubAdmDef	-0.1547249	-0.0122739	-0.1229852	-0.0084147	-0.0493442	-0.1144687	-0.0151592	-0.0366762	-0.0011392	-0.0020138	-0.0172817	-	-0.0005116
23 Education	-0.0582057	-0.0206173	-0.0845758	-0.0302612	-0.0803220	-0.0265331	-0.0056043	-	-0.0015947	-0.0122360	-	-	-0.0052629
24 Community	-0.1468334	-0.0350478	-0.2102931	-0.0238701	-0.1225281	-0.0417963	-0.0151531	-0.0356748	-0.0008079	-0.0462274	-0.0036663	-	-0.0005458

Table C.32: Labour-augmenting technical change through electronic commerce when services require high access speeds (%)

Industry	SydneyNSW	RoNSW	MelbourneVic	RoVic	BrisbaneQld	RoQld	AdelaideSA	RoSA	PerthWA	RoWA	Tas	NT	ACT
1 AgriForFish	-	-	-	-	-	-	-	-	-	-	-	-	-
2 Mining	-	-	-	-	-	-	-	-	-	-	-	-	-
3 FoodDrinkTob	-1.8856964	-1.3435837	-2.8229197	-1.7395471	-1.2537152	-1.6693017	-2.4189733	-0.9753983	-1.5507425	-1.3753759	-1.7804795	-0.7740766	-0.4205314
4 TCFs	-0.0164363	-0.0153758	-0.0186364	-0.0176076	-0.0102682	-0.0231456	-0.0168058	-0.0117742	-0.0120209	-0.0099605	-0.0135670	-0.0069824	-0.0103639
5 MiscManuf	-0.0150472	-0.0140763	-0.0170613	-0.0161194	-0.0094004	-0.0211894	-0.0153854	-0.0107791	-0.0110049	-0.0091187	-0.0124204	-0.0063923	-0.0094880
6 WoodProds	-0.0136201	-0.0127414	-0.0154433	-0.0145907	-0.0085089	-0.0191799	-0.0139263	-0.0097568	-0.0099612	-0.0082539	-0.0112424	-0.0057860	-0.0085882
7 PaperPrint	-0.0241696	-0.0226102	-0.0274048	-0.0258919	-0.0150994	-0.0340356	-0.0247128	-0.0173140	-0.0176767	-0.0146469	-0.0199502	-0.0102676	-0.0152402
8 ChemCoalPrds	-0.0530114	-0.0495911	-0.0601072	-0.0567889	-0.0331176	-0.0746505	-0.0542029	-0.0379749	-0.0387704	-0.0321252	-0.0437570	-0.0225200	-0.0334264
9 NonMetMinPrd	-0.0163923	-0.0153346	-0.0185865	-0.0175604	-0.0102407	-0.0230836	-0.0167607	-0.0117427	-0.0119887	-0.0099338	-0.0135306	-0.0069637	-0.0103362
10 MetalPrds	-0.0783809	-0.0733237	-0.0888725	-0.0839662	-0.0489666	-0.1103758	-0.0801426	-0.0561485	-0.0573247	-0.0474993	-0.0646976	-0.0332973	-0.0494232
11 TransEqp	-0.0220362	-0.0206144	-0.0249859	-0.0236065	-0.0137666	-0.0310314	-0.0225315	-0.0157857	-0.0161164	-0.0133541	-0.0181893	-0.0093613	-0.0138950
12 OthMachEqp	-0.0343052	-0.0320918	-0.0388971	-0.0367497	-0.0214313	-0.0483085	-0.0350762	-0.0245747	-0.0250894	-0.0207891	-0.0283164	-0.0145733	-0.0216312
13 EGW	-0.1442386	-0.0627025	-0.1240045	-0.0751369	-0.0657809	-0.0882110	-0.0679323	-0.0568729	-0.0871828	-0.1085235	-0.0367912	-0.1226714	-0.0167075
14 Construction	-1.7808552	-1.9725659	-1.7812757	-2.1656098	-0.6971685	-2.5855195	-1.9837125	-1.6766351	-0.9477056	-1.1833934	-2.3626611	-0.9604067	-0.0988155
15 WholesalTrad	-0.4710783	-0.5125336	-0.4804974	-0.4335475	-0.2776068	-0.8180690	-0.5505339	-0.4385136	-0.3255204	-0.2935064	-0.4405723	-0.2487280	-0.2621549
16 RetailTrade	-1.3293943	-1.2871375	-1.3263601	-1.4213257	-0.6691840	-1.8917235	-1.3204964	-1.6224221	-1.0984243	-1.2919704	-1.2565773	-0.7514431	-0.3221789
17 RecPersSrvc	-2.1217732	-1.5599342	-1.2554947	-1.0826771	-1.0709581	-2.9411352	-1.7547870	-1.1653890	-1.5863474	-1.2735228	-0.6821443	-0.6842314	-0.7709793
18 Transport	-1.0777960	-1.5685869	-1.2711453	-1.9655827	-0.6527792	-1.7762482	-1.4048006	-2.5949813	-1.0154169	-1.7176173	-0.9866610	-0.6903803	-0.2461137
19 PostalSrvcs	-0.0561695	-0.0817472	-0.0662460	-0.1024367	-0.0340197	-0.0925695	-0.0732114	-0.1352379	-0.0529186	-0.0895139	-0.0514200	-0.0359793	-0.0128263
20 Telecomms	-0.5608656	-0.2154471	-0.4744258	-0.2764883	-0.4488326	-1.0532632	-0.4589290	-0.2693805	-0.7163484	-0.4597862	-0.1241528	-0.5048387	-0.1104428
21 FinBusSrvces	-1.6314823	-1.1740235	-1.7642246	-1.2958267	-0.9582359	-2.8007195	-1.8076615	-1.1549401	-1.4851763	-0.9926541	-1.0768596	-0.9688660	-0.3377866
22 PubAdmDef	-3.4870847	-1.5663424	-2.2478932	-1.4996318	-1.9096468	-4.1237510	-2.9279391	-2.8554735	-2.0875359	-1.3863241	-2.6536946	-2.6159806	-0.5673717
23 Education	-2.1221391	-1.1672749	-1.8635587	-0.9492803	-1.1113126	-2.0747053	-1.4722769	-0.6769306	-1.3263808	-0.8956349	-1.2609572	-1.2691137	-0.5063219
24 Community	-4.7196767	-3.4544598	-4.1990748	-2.9810572	-2.1767283	-5.2962118	-3.9078552	-2.6520783	-3.3413311	-2.9424851	-2.7547861	-1.9826155	-0.5112812

Online Higher Education

Table C.33 shows the percentage change values we have estimated in equation (19) for capital-augmenting technical change in the Education industry when services require modest and high access speeds.

Table C.33: Percentage change values for capital-augmenting technical change in the Education industry

Region	acap (Education) in the modest access-speed scenario (%)	acap (Education) in the high access-speed scenario (%)
Greater Sydney	-0.0996075%	-3.8485999%
Rest of NSW	-0.2523706%	-7.5142868%
Greater Melbourne	-0.2851798%	-7.0073210%
Rest of Vic.	-0.5038629%	-11.2431761%
Greater Brisbane	-0.0949333%	-3.4743522%
Rest of Qld	-0.1111639%	-4.1542260%
Greater Adelaide	-0.0533393%	-6.8414433%
Rest of SA	-0.5115403%	-8.2297152%
Greater Perth	-0.0265783%	-6.1818277%
Rest of WA	-0.2947080%	-5.6164715%
Tasmania	-0.7619018%	-7.8454107%
Northern Territory	-0.2498450%	-8.1866348%
Australian Capital Territory	-0.0003657%	-0.0159851%

Telehealth Practice – Aged care

The percentage change values we have estimated in equation (21) for all-input augmenting technical change in the Community industry with the NBN and telehealth interventions into existing aged care programs, when services require modest and high access speeds, are shown in Table C.34.

Table C.34: Percentage change values for all-input augmenting technical change in the Community services industry with telehealth for aged care and the NBN

Region	atot (Community) in the modest access-speed scenario (%)	atot (Community) in the high access-speed scenario (%)
Greater Sydney	-0.051653%	-2.281584%
Rest of NSW	-0.208361%	-6.885273%
Greater Melbourne	-0.133105%	-2.505366%
Rest of Vic.	-0.231441%	-6.245998%
Greater Brisbane	-0.062874%	-2.216292%
Rest of Qld	-0.182814%	-7.294812%
Greater Adelaide	-0.024647%	-3.823350%
Rest of SA	-0.305629%	-6.245836%
Greater Perth	-0.019500%	-4.636973%
Rest of WA	-0.213844%	-4.314541%
Tasmania	-0.524746%	-6.421928%
Northern Territory	-0.054401%	-2.066758%
Australian Capital Territory	-0.000119%	-0.002852%

Telehealth Practice - provider-to-provider tele-consulting

The percentage change values we have estimated in equation (22) for all-input augmenting technical change in the Community industry with the NBN and provider-to-provider tele-consulting, when services require modest and high access speeds, are shown in Table C.35.

Table C.35: Percentage change values for all-input augmenting technical change in the Community industry with provider-to-provider tele-consulting and the NBN

Region	atot (Community) in the modest access-speed scenario (%)	atot (Community) in the high access-speed scenario (%)
Greater Sydney	-0.005673%	-0.188923%
Rest of NSW	-0.011618%	-0.356871%
Greater Melbourne	-0.008732%	-0.199585%
Rest of Vic.	-0.013628%	-0.311808%
Greater Brisbane	-0.003069%	-0.109958%
Rest of Qld	-0.001161%	-0.100014%
Greater Adelaide	-0.001870%	-0.256478%
Rest of SA	-0.020179%	-0.325072%
Greater Perth	-0.001257%	-0.291239%
Rest of WA	-0.010408%	-0.201886%
Tasmania	-0.034217%	-0.352540%
Northern Territory	-0.001418%	-0.167811%
Australian Capital Territory	-0.000010%	-0.000278%

Telehealth Practice – Secure, private communications with clinicians

The percentage change values we have estimated in equation (23) for all-input augmenting technical change in the Community industry with the NBN and secure, private communications with clinicians, when services require modest and high access speeds, are shown in Table C.36.

Table C.36: Percentage change values for all-input augmenting technical change in the Community industry with secure, private communications with clinicians and the NBN

Region	atot (Community) in the modest access-speed scenario (%)	atot (Community) in the high access-speed scenario (%)
Greater Sydney	-0.003646%	-0.140890%
Rest of NSW	-0.009624%	-0.286562%
Greater Melbourne	-0.006823%	-0.167643%
Rest of Vic.	-0.011920%	-0.265981%
Greater Brisbane	-0.003904%	-0.142880%
Rest of Qld	-0.010213%	-0.381676%
Greater Adelaide	-0.001550%	-0.198749%
Rest of SA	-0.014894%	-0.239616%
Greater Perth	-0.001270%	-0.295474%
Rest of WA	-0.014343%	-0.273341%
Tasmania	-0.028984%	-0.298450%
Northern Territory	-0.008213%	-0.269104%
Australian Capital Territory	-0.000013%	-0.000032%

Telehealth Practice – Microclinics

The percentage change values we have estimated in equation (24) for all-input augmenting technical change in the Community industry with the NBN and microclinics, when services require modest and high access speeds, are shown in Table C.37.

Table C.37: Percentage change values for all-input augmenting technical change in the Community industry with microclinics and the NBN

Region	atot (Community) in the modest access-speed scenario (%)	atot (Community) in the high access-speed scenario (%)
Greater Sydney	-	-
Rest of NSW	-1.2201040%	-0.0003233%
Greater Melbourne	-	-
Rest of Vic.	-1.3216732%	-
Greater Brisbane	-0.0257252%	-
Rest of Qld	-2.6683463%	-0.3023637%
Greater Adelaide	-	-
Rest of SA	-6.1527699%	-
Greater Perth	-	-
Rest of WA	-4.1310802%	-0.2260322%
Tasmania	-2.7834561%	-0.4167911%
Northern Territory	-7.7010498%	-1.8964332%
Australian Capital Territory	-	-

Transport

The percentage change values we have estimated in equation (25) for the subsistence taste shift variable for transport services is shown in Table C.38.

Table C.38: Percentage change values for subsistence taste shift variable for transport services with provider-to-provider tele-consulting and the NBN

Region	ahou_s (Transport) in the modest access-speed scenario (%)	ahou_s (Transport) in the high access-speed scenario (%)
Greater Sydney	-0.00818%	-0.31136%
Rest of NSW	-0.04780%	-1.03821%
Greater Melbourne	-0.01684%	-0.39383%
Rest of Vic.	-0.05625%	-1.09045%
Greater Brisbane	-0.01004%	-0.31452%
Rest of Qld	-0.07158%	-2.10619%
Greater Adelaide	-0.00418%	-0.48128%
Rest of SA	-0.07993%	-1.42876%
Greater Perth	-0.00365%	-0.66626%
Rest of WA	-0.08595%	-1.55823%
Tasmania	-0.15828%	-1.43418%
Northern Territory	-0.08347%	-2.07839%
Australian Capital Territory	-0.00003%	-0.00124%

Telework – Labour productivity

Tables C.39 and C.40 show the percentage change values we have estimated in equation (30) for the labour-augmenting technical change variable over all occupations by industry and region of use with people telework more with the NBN.

Table C.39: Labour-augmenting technical change through telework when services require modest access speeds (%)

Industry	SydneyNSW	RoNSW	MelbourneVic	RoVic	BrisbaneQld	RoQld	AdelaideSA	RoSA	PerthWA	RoWA	Tas	NT	ACT
1 AgriForFish	- 0.0059891	-0.0140654	- 0.0109196	-0.0177120	- 0.0072719	- 0.0074543	- 0.0026659	- 0.0218583	-0.0022057	-0.0182620	-0.0423970	-0.0106299	- 0.0000165
2 Mining	- 0.0034029	-0.0079916	- 0.0062042	-0.0100635	- 0.0041317	- 0.0042354	- 0.0015147	- 0.0124194	-0.0012532	-0.0103761	-0.0240890	-0.0060397	- 0.0000094
3 FoodDrinkTob	- 0.0052872	-0.0124170	- 0.0096399	-0.0156363	- 0.0064197	- 0.0065807	- 0.0023535	- 0.0192966	-0.0019472	-0.0161219	-0.0374284	-0.0093842	- 0.0000145
4 TCFs	- 0.0045369	-0.0106548	- 0.0082718	-0.0134172	- 0.0055086	- 0.0056468	- 0.0020195	- 0.0165581	-0.0016709	-0.0138339	-0.0321166	-0.0080524	- 0.0000125
5 MiscManuf	- 0.0037491	-0.0088048	- 0.0068355	-0.0110875	- 0.0045522	- 0.0046663	- 0.0016688	- 0.0136831	-0.0013808	-0.0114319	-0.0265401	-0.0066542	- 0.0000103
6 WoodProds	- 0.0046603	-0.0109446	- 0.0084968	-0.0137821	- 0.0056585	- 0.0058004	- 0.0020744	- 0.0170085	-0.0017163	-0.0142102	-0.0329902	-0.0082714	- 0.0000128
7 PaperPrint	- 0.0044691	-0.0104956	- 0.0081482	-0.0132167	- 0.0054263	- 0.0055624	- 0.0019893	- 0.0163107	-0.0016459	-0.0136272	-0.0316367	-0.0079321	- 0.0000123
8 ChemCoalPrds	- 0.0042588	-0.0100017	- 0.0077647	-0.0125947	- 0.0051710	- 0.0053006	- 0.0018957	- 0.0155431	-0.0015685	-0.0129858	-0.0301478	-0.0075588	- 0.0000117
9 NonMetMinPrd	- 0.0050418	-0.0118407	- 0.0091925	-0.0149105	- 0.0061217	- 0.0062753	- 0.0022442	- 0.0184010	-0.0018569	-0.0153736	-0.0356912	-0.0089486	- 0.0000139
10 MetalPrds	- 0.0043947	-0.0103209	- 0.0080126	-0.0129967	- 0.0053360	- 0.0054698	- 0.0019562	- 0.0160392	-0.0016185	-0.0134003	-0.0311100	-0.0078000	- 0.0000121
11 TransEqp	- 0.0031393	-0.0073726	- 0.0057237	-0.0092840	- 0.0038117	- 0.0039073	- 0.0013974	- 0.0114574	-0.0011562	-0.0095723	-0.0222231	-0.0055719	- 0.0000086
12 OthMachEqp	- 0.0044444	-0.0104377	- 0.0081032	-0.0131438	- 0.0053964	- 0.0055317	- 0.0019783	- 0.0162207	-0.0016368	-0.0135519	-0.0314621	-0.0078883	- 0.0000122
13 EGW	- 0.0034988	-0.0082170	- 0.0063792	-0.0103473	- 0.0042483	- 0.0043548	- 0.0015574	- 0.0127696	-0.0012886	-0.0106687	-0.0247683	-0.0062100	- 0.0000096
14 Construction	- 0.0058445	-0.0137257	- 0.0106558	-0.0172842	- 0.0070963	- 0.0072743	- 0.0026015	- 0.0213304	-0.0021525	-0.0178210	-0.0413730	-0.0103732	- 0.0000161
15 WholesalTrad	- 0.0041808	-0.0098186	- 0.0076226	-0.0123641	- 0.0050763	- 0.0052036	- 0.0018610	- 0.0152585	-0.0015397	-0.0127481	-0.0295958	-0.0074204	- 0.0000115
16 RetailTrade	- 0.0057666	-0.0135428	- 0.0105139	-0.0170539	- 0.0070018	- 0.0071774	- 0.0025668	- 0.0210462	-0.0021238	-0.0175836	-0.0408219	-0.0102350	- 0.0000159
17 RecPersSrvc	- 0.0046069	-0.0108194	- 0.0083996	-0.0136244	- 0.0055937	- 0.0057340	- 0.0020507	- 0.0168138	-0.0016967	-0.0140475	-0.0326126	-0.0081768	- 0.0000127
18 Transport	- 0.0037301	-0.0087601	- 0.0068009	-0.0110313	- 0.0045291	- 0.0046426	- 0.0016604	- 0.0136136	-0.0013738	-0.0113739	-0.0264054	-0.0066205	- 0.0000103
19 PostalSrvcs	- 0.0053999	-0.0126817	- 0.0098453	-0.0159695	- 0.0065565	- 0.0067210	- 0.0024036	- 0.0197079	-0.0019887	-0.0164655	-0.0382261	-0.0095842	- 0.0000149
20 Telecomms	- 0.0028255	-0.0066356	- 0.0051515	-0.0083559	- 0.0034307	- 0.0035167	- 0.0012577	- 0.0103120	-0.0010406	-0.0086154	-0.0200015	-0.0050149	- 0.0000078
21 FinBusSrvces	- 0.0049769	-0.0116883	- 0.0090741	-0.0147185	- 0.0060429	- 0.0061945	- 0.0022153	- 0.0181641	-0.0018329	-0.0151756	-0.0352316	-0.0088334	- 0.0000137
22 PubAdmDef	- 0.0041461	-0.0097370	- 0.0075593	-0.0122614	- 0.0050341	- 0.0051604	- 0.0018455	- 0.0151317	-0.0015270	-0.0126422	-0.0293500	-0.0073587	- 0.0000114
23 Education	- 0.0049426	-0.0116077	- 0.0090116	-0.0146171	- 0.0060013	- 0.0061518	- 0.0022001	- 0.0180390	-0.0018203	-0.0150711	-0.0349889	-0.0087726	- 0.0000136
24 Community	- 0.0050266	-0.0118050	- 0.0091647	-0.0148656	- 0.0061033	- 0.0062564	- 0.0022375	- 0.0183455	-0.0018513	-0.0153272	-0.0355835	-0.0089216	- 0.0000138

Table C.40: Labour-augmenting technical change through telework when services require high access speeds (%)

Industry	SydneyNSW	RoNSW	MelbourneVic	RoVic	BrisbaneQld	RoQld	AdelaideSA	RoSA	PerthWA	RoWA	Tas	NT	ACT
1 AgriForFish	-0.1928588	-0.3765516	-0.2222425	-0.3565859	-0.2579329	-0.3084062	-0.2713046	-0.3263580	-0.3669426	-0.3333841	-0.3902957	-0.3231728	-0.0007203
2 Mining	-0.1095778	-0.2139476	-0.1262729	-0.2026036	-0.1465513	-0.1752290	-0.1541488	-0.1854288	-0.2084880	-0.1894208	-0.2217566	-0.1836190	-0.0004092
3 FoodDrinkTob	-0.1702570	-0.3324222	-0.1961972	-0.3147964	-0.2277049	-0.2722630	-0.2395095	-0.2881110	-0.3239394	-0.2943136	-0.3445556	-0.2852990	-0.0006359
4 TCFs	-0.1460945	-0.2852456	-0.1683533	-0.2701212	-0.1953895	-0.2336240	-0.2055189	-0.2472229	-0.2779666	-0.2525453	-0.2956570	-0.2448100	-0.0005456
5 MiscManuf	-0.1207276	-0.2357174	-0.1391216	-0.2232191	-0.1614634	-0.1930591	-0.1698339	-0.2042968	-0.2297024	-0.2086950	-0.2443211	-0.2023028	-0.0004509
6 WoodProds	-0.1500682	-0.2930042	-0.1729325	-0.2774684	-0.2007040	-0.2399785	-0.2111089	-0.2539473	-0.2855272	-0.2594145	-0.3036988	-0.2514688	-0.0005605
7 PaperPrint	-0.1439115	-0.2809832	-0.1658376	-0.2660848	-0.1924699	-0.2301331	-0.2024478	-0.2435287	-0.2738130	-0.2487716	-0.2912391	-0.2411519	-0.0005375
8 ChemCoalPrds	-0.1371388	-0.2677597	-0.1580330	-0.2535624	-0.1834119	-0.2193026	-0.1929203	-0.2320679	-0.2609270	-0.2370640	-0.2775329	-0.2298029	-0.0005122
9 NonMetMinPrd	-0.1623547	-0.3169932	-0.1870909	-0.3001854	-0.2171362	-0.2596262	-0.2283929	-0.2747386	-0.3089041	-0.2806534	-0.3285634	-0.2720572	-0.0006064
10 MetalPrds	-0.1415157	-0.2763056	-0.1630769	-0.2616552	-0.1892657	-0.2263020	-0.1990776	-0.2394747	-0.2692548	-0.2446302	-0.2863907	-0.2371374	-0.0005285
11 TransEqp	-0.1010900	-0.1973754	-0.1164919	-0.1869101	-0.1351996	-0.1616560	-0.1422086	-0.1710657	-0.1923388	-0.1747485	-0.2045796	-0.1693961	-0.0003775
12 OthMachEqp	-0.1431171	-0.2794323	-0.1649223	-0.2646162	-0.1914075	-0.2288628	-0.2013304	-0.2421846	-0.2723017	-0.2473985	-0.2896316	-0.2398209	-0.0005345
13 EGW	-0.1126679	-0.2199811	-0.1298339	-0.2083171	-0.1506842	-0.1801706	-0.1584959	-0.1906580	-0.2143675	-0.1947627	-0.2280104	-0.1887972	-0.0004208
14 Construction	-0.1882008	-0.3674570	-0.2168749	-0.3479736	-0.2517033	-0.3009575	-0.2647520	-0.3184758	-0.3580802	-0.3253321	-0.3808692	-0.3153674	-0.0007029
15 WholesalTrad	-0.1346278	-0.2628572	-0.1551396	-0.2489199	-0.1800538	-0.2152873	-0.1893881	-0.2278189	-0.2561496	-0.2327235	-0.2724515	-0.2255954	-0.0005028
16 RetailTrade	-0.1856936	-0.3625617	-0.2139857	-0.3433378	-0.2483501	-0.2969481	-0.2612250	-0.3142330	-0.3533098	-0.3209980	-0.3757952	-0.3111661	-0.0006935
17 RecPersSrvc	-0.1483509	-0.2896511	-0.1709535	-0.2742931	-0.1984072	-0.2372323	-0.2086930	-0.2510412	-0.2822597	-0.2564458	-0.3002233	-0.2485910	-0.0005541
18 Transport	-0.1201151	-0.2345216	-0.1384157	-0.2220867	-0.1606442	-0.1920796	-0.1689723	-0.2032603	-0.2285370	-0.2076362	-0.2430816	-0.2012765	-0.0004486
19 PostalSrvcs	-0.1738859	-0.3395075	-0.2003790	-0.3215060	-0.2325582	-0.2780661	-0.2446145	-0.2942519	-0.3308439	-0.3005867	-0.3518995	-0.2913800	-0.0006494
20 Telecomms	-0.0909846	-0.1776449	-0.1048469	-0.1682258	-0.1216845	-0.1454961	-0.1279928	-0.1539652	-0.1731117	-0.1572799	-0.1841289	-0.1524625	-0.0003398
21 FinBusSrvces	-0.1602643	-0.3129116	-0.1846819	-0.2963203	-0.2143404	-0.2562833	-0.2254522	-0.2712012	-0.3049267	-0.2770398	-0.3243329	-0.2685542	-0.0005986
22 PubAdmDef	-0.1335095	-0.2606738	-0.1538509	-0.2468522	-0.1785581	-0.2134990	-0.1878149	-0.2259265	-0.2540218	-0.2307904	-0.2701883	-0.2237214	-0.0004986
23 Education	-0.1591603	-0.3107562	-0.1834098	-0.2942792	-0.2128640	-0.2545180	-0.2238992	-0.2693331	-0.3028263	-0.2751314	-0.3220988	-0.2667044	-0.0005944
24 Community	-0.1618652	-0.3160374	-0.1865268	-0.2992803	-0.2164815	-0.2588434	-0.2277043	-0.2739103	-0.3079727	-0.2798072	-0.3275727	-0.2712369	-0.0006045

Telework – Aggregate employment

The percentage change values we have estimated in equation (33) for aggregate employment with people telework more with the NBN are shown in Table C.40.

Table C.41: Percentage change values of aggregate employment through telework

Variable name	Growth in the modest access-speed scenario (%)	Growth in the high access-speed scenario (%)
NatMacro (AggEmploy)	0.022530%	0.619131%

Entertainment

The percentage change values we have estimated in equation (34) for the subsistence taste shift variable for composite (imported and domestic) Recreation and Personal Services are shown in Table C.42. For regions where the NBN has a significant impact on service delivery, our estimates are slightly lower when services require high access-speeds outside major metropolitan areas. As discussed in chapter 5.3, this is due to the service access-speed requirements exceeding the capabilities of the NBN fixed wireless network in the high access-speed scenario.

Table C.42: Percentage change values of the subsistence taste shift variable estimated for Recreation and Personal Services with the NBN

Region	ahou_s (RecPersSrvc) in the modest access-speed scenario (%)	ahou_s (RecPersSrvc) in the high access-speed scenario (%)
Greater Sydney	1.108033%	1.108027%
Rest of NSW	2.125766%	2.088306%
Greater Melbourne	1.478234%	1.475703%
Rest of Vic.	2.182344%	2.014204%
Greater Brisbane	1.054629%	1.051772%
Rest of Qld	2.624716%	2.578827%
Greater Adelaide	1.802162%	1.801309%
Rest of SA	1.755733%	1.678538%
Greater Perth	2.417979%	2.415940%
Rest of WA	1.803350%	1.755762%
Tasmania	2.199831%	2.088251%
Northern Territory	1.760608%	1.742974%
Australian Capital Territory	0.004071%	0.004071%

Appendix D Carbon and Energy Footprint Estimates of the NBN

Appendix D.1 Greenhouse gas emissions data

The Department of the Environment and Energy tracks emissions of greenhouse gases including carbon dioxide, methane, nitrous dioxide and synthetic gases. Together, they are expressed as carbon dioxide equivalent (CO_2-e) by taking into consideration the respective gas global warming potential. The National Inventory by Economic Sector report is based on the national greenhouse gas inventory prepared in accordance with Australia's Kyoto Protocol reporting obligations. The Department maps Kyoto Protocol inventory sector data across to the equivalent ANZSIC sector. The National Inventory by Economic Sector database from the Department of the Environment and Energy (a) disaggregates national emissions data down to two industry classification levels as shown in Table D.1.

Table D.1: National inventory by economic sector for the fiscal year 2011

Sector	GHG (1,000 Tonnes)
Div. A Agriculture, Forestry and Fishing	**85,106.41**
Div. B Mining	**61,315.22**
• 06 Coal Mining	*32,710.10*
• 07 Oil and Gas Extraction	*17,302.16*
• 08-10 Metal Ore and Non-Metallic Mineral Mining and Quarrying	*11,302.96*
Div. C Manufacturing	**71,589.31**
• 11-12 Food, Beverages and Tobacco Product Manufacturing	*4,805.66*
• 13 Textile, Leather, Clothing and Footwear Manufacturing	*492.56*
• 14-16 Wood and Paper Manufacturing and Printing Services	*1,981.60*
• 17 Petroleum and Coal Product Manufacturing	*6,300.18*
• 18-19 Basic Chemical and Chemical, Polymer and Rubber Product Manufacturing	*13,699.83*
• 20 Non-Metallic Mineral Product Manufacturing	*11,558.19*
• 21-22 Metal Product Manufacturing	*31,627.57*
• 24 Machinery and Equipment Manufacturing	*950.99*
• 25 Furniture and Other Manufacturing	*172.74*
Div. D Electricity, Gas and Water Supply	**204,363.07**
• 26-27 Electricity and Gas Supply	*202,071.20*
• 28 Water Supply, Sewerage and Drainage	*2,291.88*
Div. E Construction	**9,517.20**
Div. F-H, J-Q Commercial Services	**25,584.32**
Div. F,G Wholesale and Retail Trade	**3,554.39**
Div. H,P,Q Accommodation, Food Services, Education and Health Services	**13,411.35**
Div. J Information Media and Telecommunications	**3,913.76**
Div. K,L Finance, Insurance, Rental, Hiring and Real Estate	**583.1**

Sector	GHG (1,000 Tonnes)
Div. M Professional, Scientific and Technical Services	**2,543.56**
Div. N,O Administration, Public Administration and Services	**1,578.15**
Div. I Transport, Postal and Warehousing	**26,189.93**
• 46 Road Transport	*9,231.12*
• 47 Railway Transport	*3,732.31*
• 48 Domestic Water Transport	*3,182.84*
• 49 Domestic Air and Space Transport	*7,355.74*
• 50-53 Other Transport, Services and Storage	*2,687.91*
Residential	**55,154.70**
• Residential (non transport)	*11,703.29*
• Residential (transport)	*43,451.42*
Total of all Economic (ANZSIC) Sectors	**538,820.17**

Source: Department of the Environment and Energy, National Inventory by Economic Sector

We have mapped the ANZSIC sector emissions data from Table D.1 across to industry groups in the economic model database as follows:

$$\mathrm{E}_{\mathrm{Industry}} = \mathrm{E}_{\mathrm{ANZSIC}} \times \mathrm{S}_{\mathrm{Industry}} \tag{D.1}$$

where

$\mathrm{E}_{\mathrm{Industry}}$ is estimated GHG emissions of the industry in the economic model (TERM) database;

$\mathrm{E}_{\mathrm{ANZSIC}}$ is GHG emissions of ANZSIC sector from the second column in Table D.2; and

$\mathrm{S}_{\mathrm{Industry}}$ is factor used to allocate GHG emissions of ANZSIC sectors to the mapped industry in the economic model databse in the fifth column in Table D.2.

The GHG emissions split factor $\mathrm{S}_{\mathrm{Industry}}$ is derived from industry output. If one industry is mapped to an ANZSIC sector, the factor is the numerical value one. If more than one industry is mapped to an ANZSIC sector, the factor is derived through industry output divided by the sum of industry output of industries mapped to the ANZSIC sector. For example, Div. C (14-16) Wood and Paper Manufacturing and Printing Services is mapped to both wood and wood products, and paper and printing. The split factors are 0.36 (20,906/(20,906+37,213)) for wood and wood products, and 0.64 (37,213/(20,906+37,213)) for paper and printing shown in the fifth column in Table D.2.

Table D.2: Base year (2010/2011) direct GHG emissions allocated to TERM industry groups

ANZSIC sector	GHG (1,000 Tonnes CO_2-e) (2)	Allocated TERM industry group (3)	TERM industry output from the base year data for 2010/2011 (million $AU)	GHG emission split factor (5)=(3a)/((3a)+(3b)); (3b)/((3a)+(3b));	Allocated GHG (1,000 Tonnes CO_2-e) (6)=(2)×(5)
Div. A Agriculture, Forestry and Fishing	85,106.41	Agriculture, forestry & fishing	81,836	1	85,106.41
Div. B Mining	61,315.22	Mining	179,350	1	61,315.22
Div. C (11-12) Food, Beverages and Tobacco Product Manufacturing	4,805.66	Food, beverages & tobacco	120,233	1	4,805.66
Div. C (13) Textile, Leather, Clothing and Footwear Manufacturing	492.56	Textiles, clothing & footwear	25,132	1	492.56
Div. C (14-16) Wood and Paper Manufacturing and Printing Services		Wood & wood products (3a)	20,906	0.36	712.81
	1,981.60	Paper and printing (3b)	37,213	0.64	1,268.79
Div. C (17) Petroleum and Coal Product Manufacturing	6,300.18	Chemicals & coal products	81,345	1	6,300.18
Div. C (18-19) Basic	13,699.83	Miscellaneous manufacturing (3a)	22,998	0.22	3,019.52

ANZSIC sector	GHG (1,000 Tonnes CO_2-e) (2)	Allocated TERM industry group (3)	TERM industry output from the base year data for 2010/2011 (million $AU)	GHG emission split factor (5)=(3a)/((3a)+(3b)); (3b)/((3a)+(3b));	Allocated GHG (1,000 Tonnes CO_2-e) (6)=(2)×(5)
Chemical and Chemical, Polymer and Rubber Product Manufacturing		Chemicals & coal products (3b)	81,345	0.78	10,680.31
Div. C (20) Non-Metallic Mineral Product Manufacturing	11,558.19	Non-metallic mineral products	25,426	1	11,558.19
Div. C (21-22) Metal Product Manufacturing	31,627.57	Metal products	121,416	1	31,627.57
Div. C (24) Machinery and Equipment Manufacturing	950.99	Transport equipment (3a)	32,709	0.38	364.47
		Other machinery & equipment (3b)	52,638	0.62	586.52
Div. C (25) Furniture and Other Manufacturing	172.74	Miscellaneous manufacturing	22,998	1	172.74
Div. D Electricity, Gas and Water Supply	204,363.07	Electricity, gas & water	82,430		204,363.07
Div. E Construction	9,517.20	Construction	418,889		9,517.20
Div. F,G Wholesale and Retail Trade	3,554.39	Wholesale trade (3a)	194,173	0.49	1,751.91
		Retail trade (3b)	199,778	0.51	1,802.48
Not available		Recreation & personal services	221,672	1	0.0

ANZSIC sector	GHG (1,000 Tonnes CO_2-e) (2)	Allocated TERM industry group (3)	TERM industry output from the base year data for 2010/2011 (million $AU)	GHG emission split factor (5)=(3a)/((3a)+(3b)); (3b)/((3a)+(3b));	Allocated GHG (1,000 Tonnes CO_2-e) (6)=(2)×(5)
Div. I (46) Road Transport	9,231.12	Transport & storage	178,221	1	9,231.12
Div. I (47) Railway Transport	3,732.31	Transport & storage	178,221	1	3,732.31
Div. I (48) Domestic Water Transport	3,182.84	Transport & storage	178,221	1	3,182.84
Div. I (49) Domestic Air and Space Transport	7,355.74	Transport & storage	178,221	1	7,355.74
Div. I (50-53) Other Transport, Services and Storage	2,687.91	Postal services	9,346	1	2,687.91
Div. J Information Media and Telecommunications	3,913.76	Telecommunication services	76,353	1	3,913.76
Div. K,L Finance, Insurance, Rental, Hiring and Real Estate	583.10	Finance & business services	878,701	1	583.10
Div. M Professional, Scientific and Technical Services	2,543.56	Finance & business services	878,701	1	2,543.56
Div. N,O	1,578.15	Finance & business services (3a)	878,701	0.86	1,364.53

ANZSIC sector	GHG (1,000 Tonnes CO_2-e) (2)	Allocated TERM industry group (3)	TERM industry output from the base year data for 2010/2011 (million $AU)	GHG emission split factor (5)=(3a)/((3a)+(3b)); (3b)/((3a)+(3b));	Allocated GHG (1,000 Tonnes CO_2-e) (6)=(2)×(5)
Administration, Public Administration and Services		Public admin. & defence (3b)	137,562	0.14	213.62
Div. H,P,Q Accommodation, Food Services, Education and Health Services	13,411.35	Education (3a)	109,378	0.44	5,873.88
		Health, welfare & community services (3b)	140,356	0.56	7,537.47

Greenhouse gas emissions data for the ANZSIC sectors Arts and Recreation Services (Div. R) and Other Services (Div. S) were unavailable because it cannot be separately identified within Australia's national greenhouse inventory. This is due to Australia's Energy Statistics and source data for fuel consumption not being available at the level of detail required to identify the emissions for Div. R and Div. S. We have assumed that the emissions of Div. R and Div. S are included in the emissions data for all other economic sectors.

The emissions matrix in the database of the MMRF-Green CGE model (Adams et al., 2002) shows that the entertainment sector emitted less than 0.36% of total emissions of which less than 0.31% related to the use of fuels and approximately 0.05% to the use of gas. We have assumed that emissions of the TERM industry group Recreation and Personal Services in the fiscal year 2011 are approximately 2,000,000 (0.36%×538,820,170) tonnes CO_2-e. For consistency purposes, we have subtracted the estimated emissions for Recreation and Personal Services equi-proportionate from the emissions allocated to the TERM industry groups.

The GHG emissions for each economic model industry group estimated in equation (D.1) are shown in Table 8.1.

Appendix D.2 Estimated growth in greenhouse gas emissions

In Tables D.3 to D.17, we have derived the growth in greenhouse gas emissions for each service group separately with the NBN in the long term. We have calculated the growth of GHG emissions shown in the fourth columns using our industry results from Tables 7.6 and 7.4 and estimated percentage changes in Real Private Household Consumption from Tables 7.7 and 7.5 shown in the third columns. The percentage changes in the activity level of all economic sectors in the third columns were multiplied with the base year emissions in the second columns. Tables D.3 to D.10 shows our estimates for the service groups with the NBN in the long term when services require modest access speeds.

Table D.3: Carbon impact of the NBN on economic sectors in the long term for telehealth practice when services require *modest* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.07%	55.2	84,856.2
2 Mining	61,095.1	0.10%	62.2	61,157.3
3 FoodDrinkTob	4,788.4	0.04%	1.9	4,790.4
4 TCFs	490.8	0.05%	0.3	491.1
5 MiscManuf	3,180.8	0.01%	0.3	3,181.1
6 WoodProds	710.2	0.05%	0.3	710.6
7 PaperPrint	1,264.2	0.05%	0.7	1,264.9
8 ChemCoalPrds	16,919.5	0.02%	4.1	16,923.7
9 NonMetMinPrd	11,516.7	0.04%	4.8	11,521.6
10 MetalPrds	31,514.0	0.06%	19.0	31,533.1
11 TransEqp	363.2	0.06%	0.2	363.4

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
12 OthMachEqp	584.4	0.02%	0.1	584.5
13 EGW	203,629.6	0.06%	118.3	203,747.8
14 Construction	9,483.0	0.05%	4.4	9,487.4
15 WholesalTrad	1,745.6	0.04%	0.7	1,746.3
16 RetailTrade	1,796.0	0.04%	0.8	1,796.8
17 RecPersSrvc	1,934.0	0.07%	1.3	1,935.3
18 Transport	23,417.7	0.05%	12.0	23,429.6
19 PostalSrvcs	2,678.3	0.03%	0.9	2,679.1
20 Telecomms	3,899.7	0.05%	2.1	3,901.8
21 FinBusSrvces	4,475.1	0.06%	2.8	4,477.9
22 PubAdmDef	212.9	0.09%	0.2	213.0
23 Education	5,852.8	0.08%	4.8	5,857.6
24 Community	7,510.4	0.24%	17.8	7,528.2
Residential	54,956.7	0.10%	54.3	55,011.0
Total	**538,820.2**	**0.07%**	**369.5**	**539,189.6**

Table D.4: Carbon impact of the NBN on economic sectors in the long term for online higher education when services require *modest* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.0005%	0.4	84,801.4
2 Mining	61,095.1	-0.0007%	- 0.4	61,094.7
3 FoodDrinkTob	4,788.4	0.0005%	0.0	4,788.4
4 TCFs	490.8	-0.0007%	- 0.0	490.8
5 MiscManuf	3,180.8	-0.0002%	- 0.0	3,180.8
6 WoodProds	710.2	0.0001%	0.0	710.2
7 PaperPrint	1,264.2	-0.0022%	- 0.0	1,264.2
8 ChemCoalPrds	16,919.5	0.00003%	0.0	16,919.6
9 NonMetMinPrd	11,516.7	-0.0023%	- 0.3	11,516.4
10 MetalPrds	31,514.0	-0.0010%	- 0.3	31,513.7
11 TransEqp	363.2	0.0006%	0.0	363.2
12 OthMachEqp	584.4	-0.0002%	- 0.0	584.4
13 EGW	203,629.6	0.0007%	1.5	203,631.0
14 Construction	9,483.0	-0.0035%	- 0.3	9,482.7
15 WholesalTrad	1,745.6	-0.00003%	- 0.0	1,745.6
16 RetailTrade	1,796.0	0.0003%	0.0	1,796.0
17 RecPersSrvc	1,934.0	0.0013%	0.0	1,934.0
18 Transport	23,417.7	0.0002%	0.0	23,417.7
19 PostalSrvcs	2,678.3	0.0007%	0.0	2,678.3
20 Telecomms	3,899.7	0.0009%	0.0	3,899.7

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
21 FinBusSrvces	4,475.1	0.0006%	0.0	4,475.1
22 PubAdmDef	212.9	0.0018%	0.0	212.9
23 Education	5,852.8	0.0068%	0.4	5,853.2
24 Community	7,510.4	0.0018%	0.1	7,510.6
Residential	54,956.7	0.0020%	1.1	54,957.8
Total	**538,820.2**	**0.0004%**	**2.3**	**538,822.5**

Table D.5: Carbon impact of the NBN on economic sectors in the long term for telework when services require *modest* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.02%	16.8	84,817.7
2 Mining	61,095.1	0.03%	17.7	61,112.9
3 FoodDrinkTob	4,788.4	0.02%	0.9	4,789.3
4 TCFs	490.8	0.03%	0.1	490.9
5 MiscManuf	3,180.8	0.03%	0.9	3,181.7
6 WoodProds	710.2	0.03%	0.2	710.5
7 PaperPrint	1,264.2	0.03%	0.4	1,264.6
8 ChemCoalPrds	16,919.5	0.03%	4.3	16,923.8
9 NonMetMinPrd	11,516.7	0.03%	3.6	11,520.3
10 MetalPrds	31,514.0	0.03%	8.9	31,522.9
11 TransEqp	363.2	0.03%	0.1	363.3
12 OthMachEqp	584.4	0.03%	0.2	584.6
13 EGW	203,629.6	0.03%	59.9	203,689.4
14 Construction	9,483.0	0.03%	2.9	9,486.0
15 WholesalTrad	1,745.6	0.03%	0.5	1,746.1
16 RetailTrade	1,796.0	0.03%	0.5	1,796.5
17 RecPersSrvc	1,934.0	0.03%	0.6	1,934.5
18 Transport	23,417.7	0.03%	6.8	23,424.5
19 PostalSrvcs	2,678.3	0.03%	0.8	2,679.1
20 Telecomms	3,899.7	0.03%	1.2	3,900.9
21 FinBusSrvces	4,475.1	0.03%	1.5	4,476.6
22 PubAdmDef	212.9	0.03%	0.1	212.9
23 Education	5,852.8	0.03%	1.8	5,854.6
24 Community	7,510.4	0.03%	2.2	7,512.6
Residential	54,956.7	0.03%	16.4	54,973.1
Total	**538,820.2**	**0.03%**	**149.2**	**538,969.4**

Table D.6: Carbon impact of the NBN on economic sectors in the long term for transport when services require *modest* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.0002%	0.2	84,801.1
2 Mining	61,095.1	-0.0011%	- 0.7	61,094.5
3 FoodDrinkTob	4,788.4	0.0004%	0.0	4,788.4
4 TCFs	490.8	-0.0002%	- 0.0	490.8
5 MiscManuf	3,180.8	-0.0001%	- 0.0	3,180.8
6 WoodProds	710.2	0.0006%	0.0	710.3
7 PaperPrint	1,264.2	0.0006%	0.0	1,264.2
8 ChemCoalPrds	16,919.5	-0.0003%	- 0.1	16,919.5
9 NonMetMinPrd	11,516.7	-0.0001%	- 0.0	11,516.7
10 MetalPrds	31,514.0	-0.0009%	- 0.3	31,513.8
11 TransEqp	363.2	-0.0010%	- 0.0	363.2
12 OthMachEqp	584.4	-0.0001%	- 0.0	584.4
13 EGW	203,629.6	0.0004%	0.9	203,630.5
14 Construction	9,483.0	-0.0002%	- 0.0	9,483.0
15 WholesalTrad	1,745.6	0.0001%	0.0	1,745.6
16 RetailTrade	1,796.0	0.0005%	0.0	1,796.0
17 RecPersSrvc	1,934.0	0.0009%	0.0	1,934.0
18 Transport	23,417.7	-0.0048%	- 1.1	23,416.5
19 PostalSrvcs	2,678.3	0.0002%	0.0	2,678.3
20 Telecomms	3,899.7	0.0003%	0.0	3,899.7
21 FinBusSrvces	4,475.1	0.0004%	0.0	4,475.1
22 PubAdmDef	212.9	0.0001%	0.0	212.9
23 Education	5,852.8	0.0005%	0.0	5,852.8
24 Community	7,510.4	0.0006%	0.0	7,510.5
Residential	54,956.7	0.0002%	0.1	54,956.8
Total	**538,820.2**	**-0.0002%**	**- 0.8**	**538,819.3**

Table D.7: Carbon impact of the NBN on economic sectors in the long term for online entertainment when services require *modest* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	-0.04%	- 35.8	84,765.1
2 Mining	61,095.1	-0.05%	- 31.4	61,063.8
3 FoodDrinkTob	4,788.4	-0.05%	- 2.2	4,786.2
4 TCFs	490.8	-0.08%	- 0.4	490.4
5 MiscManuf	3,180.8	-0.05%	- 1.5	3,179.3
6 WoodProds	710.2	-0.06%	- 0.4	709.8
7 PaperPrint	1,264.2	-0.06%	- 0.8	1,263.5

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
8 ChemCoalPrds	16,919.5	-0.07%	- 11.6	16,907.9
9 NonMetMinPrd	11,516.7	-0.03%	- 3.6	11,513.1
10 MetalPrds	31,514.0	-0.04%	- 12.5	31,501.5
11 TransEqp	363.2	-0.11%	- 0.4	362.8
12 OthMachEqp	584.4	-0.06%	- 0.3	584.1
13 EGW	203,629.6	-0.08%	- 159.8	203,469.8
14 Construction	9,483.0	-0.01%	- 1.0	9,482.0
15 WholesalTrad	1,745.6	-0.06%	- 1.0	1,744.6
16 RetailTrade	1,796.0	-0.09%	- 1.6	1,794.5
17 RecPersSrvc	1,934.0	0.77%	14.9	1,948.9
18 Transport	23,417.7	-0.06%	- 13.7	23,403.9
19 PostalSrvcs	2,678.3	0.05%	1.4	2,679.6
20 Telecomms	3,899.7	-0.04%	- 1.7	3,898.0
21 FinBusSrvces	4,475.1	-0.07%	- 3.2	4,471.9
22 PubAdmDef	212.9	-0.01%	- 0.0	212.8
23 Education	5,852.8	-0.07%	- 4.2	5,848.6
24 Community	7,510.4	-0.07%	- 5.1	7,505.3
Residential	54,956.7	0.00%	1.0	54,957.8
Total	**538,820.2**	**-0.05%**	**- 275.0**	**538,545.2**

Table D.8: Carbon impact of the NBN on economic sectors in the long term for electronic commerce when services require *modest* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.02%	12.9	84,813.9
2 Mining	61,095.1	0.02%	14.6	61,109.7
3 FoodDrinkTob	4,788.4	0.03%	1.6	4,790.0
4 TCFs	490.8	0.03%	0.1	490.9
5 MiscManuf	3,180.8	0.04%	1.3	3,182.1
6 WoodProds	710.2	0.05%	0.3	710.6
7 PaperPrint	1,264.2	0.04%	0.5	1,264.8
8 ChemCoalPrds	16,919.5	0.04%	6.3	16,925.8
9 NonMetMinPrd	11,516.7	0.04%	4.9	11,521.6
10 MetalPrds	31,514.0	0.03%	8.4	31,522.4
11 TransEqp	363.2	0.04%	0.2	363.3
12 OthMachEqp	584.4	0.04%	0.2	584.7
13 EGW	203,629.6	0.04%	79.4	203,708.9
14 Construction	9,483.0	0.05%	4.3	9,487.3
15 WholesalTrad	1,745.6	0.04%	0.7	1,746.3
16 RetailTrade	1,796.0	0.04%	0.7	1,796.7

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
17 RecPersSrvc	1,934.0	0.04%	0.8	1,934.8
18 Transport	23,417.7	0.05%	11.3	23,428.9
19 PostalSrvcs	2,678.3	0.04%	1.2	2,679.5
20 Telecomms	3,899.7	0.04%	1.7	3,901.4
21 FinBusSrvces	4,475.1	0.05%	2.3	4,477.4
22 PubAdmDef	212.9	0.04%	0.1	212.9
23 Education	5,852.8	0.05%	2.8	5,855.6
24 Community	7,510.4	0.05%	3.9	7,514.3
Residential	54,956.7	0.04%	23.5	54,980.3
Total	**538,820.2**	**0.03%**	**183.9**	**539,004.1**

Table D.9: Carbon impact of the NBN on economic sectors in the long term for cloud computing when services require *modest* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	-0.001%	- 0.5	84,800.5
2 Mining	61,095.1	0.006%	3.8	61,098.9
3 FoodDrinkTob	4,788.4	0.005%	0.2	4,788.7
4 TCFs	490.8	-0.002%	- 0.0	490.8
5 MiscManuf	3,180.8	0.002%	0.1	3,180.9
6 WoodProds	710.2	0.008%	0.1	710.3
7 PaperPrint	1,264.2	0.003%	0.0	1,264.3
8 ChemCoalPrds	16,919.5	0.005%	0.9	16,920.5
9 NonMetMinPrd	11,516.7	-0.001%	- 0.1	11,516.6
10 MetalPrds	31,514.0	-0.001%	- 0.3	31,513.7
11 TransEqp	363.2	0.005%	0.0	363.2
12 OthMachEqp	584.4	0.004%	0.0	584.4
13 EGW	203,629.6	0.005%	10.2	203,639.7
14 Construction	9,483.0	0.001%	0.1	9,483.2
15 WholesalTrad	1,745.6	0.004%	0.1	1,745.7
16 RetailTrade	1,796.0	0.006%	0.1	1,796.1
17 RecPersSrvc	1,934.0	0.008%	0.2	1,934.1
18 Transport	23,417.7	0.006%	1.5	23,419.2
19 PostalSrvcs	2,678.3	-0.001%	- 0.0	2,678.2
20 Telecomms	3,899.7	-0.030%	- 1.2	3,898.5
21 FinBusSrvces	4,475.1	-0.008%	- 0.3	4,474.7
22 PubAdmDef	212.9	0.016%	0.0	212.9
23 Education	5,852.8	0.010%	0.6	5,853.4
24 Community	7,510.4	0.015%	1.1	7,511.5
Residential	54,956.7	0.017%	9.6	54,966.3

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
Total	**538,820.2**	**0.005%**	**26.2**	**538,846.4**

Table D.10: Carbon impact of the NBN on economic sectors in the long term for debt-servicing repayments when services require *modest* and *high* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.29%	242.5	85,043.4
2 Mining	61,095.1	1.30%	795.1	61,890.2
3 FoodDrinkTob	4,788.4	0.37%	17.5	4,805.9
4 TCFs	490.8	0.47%	2.3	493.1
5 MiscManuf	3,180.8	0.50%	16.0	3,196.7
6 WoodProds	710.2	-0.01%	- 0.0	710.2
7 PaperPrint	1,264.2	-0.09%	- 1.1	1,263.1
8 ChemCoalPrds	16,919.5	0.46%	78.4	16,997.9
9 NonMetMinPrd	11,516.7	0.14%	16.4	11,533.1
10 MetalPrds	31,514.0	1.07%	336.5	31,850.5
11 TransEqp	363.2	0.97%	3.5	366.7
12 OthMachEqp	584.4	0.52%	3.0	587.4
13 EGW	203,629.6	-0.01%	- 30.1	203,599.4
14 Construction	9,483.0	-0.01%	- 0.6	9,482.4
15 WholesalTrad	1,745.6	0.15%	2.6	1,748.3
16 RetailTrade	1,796.0	-0.02%	- 0.4	1,795.6
17 RecPersSrvc	1,934.0	-0.24%	- 4.7	1,929.2
18 Transport	23,417.7	0.50%	116.3	23,533.9
19 PostalSrvcs	2,678.3	-0.03%	- 0.9	2,677.3
20 Telecomms	3,899.7	-0.14%	- 5.3	3,894.4
21 FinBusSrvces	4,475.1	-0.15%	- 6.7	4,468.4
22 PubAdmDef	212.9	-0.46%	- 1.0	211.9
23 Education	5,852.8	-0.30%	- 17.4	5,835.4
24 Community	7,510.4	-0.48%	- 36.0	7,474.4
Residential	54,956.7	-0.53%	- 291.0	54,665.7
Total	**538,820.2**	**0.23%**	**1,234.7**	**540,054.8**

Our estimates of the carbon impact of the NBN on economic sectors in the long term for debt-servicing repayments are independent of the access-speed requirements. Tables D.11 to D.17 shows our estimates for the service groups with the NBN in the long term when services require high access speeds.

Table D.11: Carbon impact of the NBN on economic sectors in the long term for telehealth practice when services require *high* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.24%	206.0	85,006.9
2 Mining	61,095.1	0.37%	227.3	61,322.4
3 FoodDrinkTob	4,788.4	0.20%	9.8	4,798.2
4 TCFs	490.8	0.25%	1.2	492.0
5 MiscManuf	3,180.8	0.16%	5.2	3,186.0
6 WoodProds	710.2	0.30%	2.1	712.4
7 PaperPrint	1,264.2	0.33%	4.2	1,268.4
8 ChemCoalPrds	16,919.5	0.20%	33.6	16,953.2
9 NonMetMinPrd	11,516.7	0.25%	29.1	11,545.8
10 MetalPrds	31,514.0	0.25%	78.5	31,592.5
11 TransEqp	363.2	0.40%	1.4	364.6
12 OthMachEqp	584.4	0.21%	1.2	585.6
13 EGW	203,629.6	0.32%	651.5	204,281.1
14 Construction	9,483.0	0.24%	22.4	9,505.5
15 WholesalTrad	1,745.6	0.23%	4.1	1,749.7
16 RetailTrade	1,796.0	0.25%	4.5	1,800.5
17 RecPersSrvc	1,934.0	0.36%	7.0	1,941.0
18 Transport	23,417.7	0.29%	67.9	23,485.6
19 PostalSrvcs	2,678.3	0.20%	5.3	2,683.5
20 Telecomms	3,899.7	0.30%	11.6	3,911.3
21 FinBusSrvces	4,475.1	0.35%	15.6	4,490.7
22 PubAdmDef	212.9	0.50%	1.1	213.9
23 Education	5,852.8	0.45%	26.2	5,879.0
24 Community	7,510.4	1.33%	99.7	7,610.1
Residential	54,956.7	0.62%	341.2	55,297.9
Total	**538,820.2**	**0.34%**	**1,857.7**	**540,677.8**

Table D.12: Carbon impact of the NBN on economic sectors in the long term for online higher education when services require *high* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.01%	9.5	84,810.4
2 Mining	61,095.1	-0.01%	- 8.1	61,087.1
3 FoodDrinkTob	4,788.4	0.01%	0.6	4,789.0
4 TCFs	490.8	-0.03%	- 0.1	490.7
5 MiscManuf	3,180.8	-0.01%	- 0.2	3,180.6
6 WoodProds	710.2	0.00%	0.0	710.3
7 PaperPrint	1,264.2	-0.07%	- 0.8	1,263.4

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
8 ChemCoalPrds	16,919.5	0.00%	0.3	16,919.8
9 NonMetMinPrd	11,516.7	-0.07%	- 7.8	11,508.9
10 MetalPrds	31,514.0	-0.03%	- 9.1	31,505.0
11 TransEqp	363.2	0.02%	0.1	363.2
12 OthMachEqp	584.4	-0.01%	- 0.0	584.4
13 EGW	203,629.6	0.02%	48.4	203,678.0
14 Construction	9,483.0	-0.10%	- 9.8	9,473.2
15 WholesalTrad	1,745.6	0.00%	- 0.0	1,745.6
16 RetailTrade	1,796.0	0.01%	0.2	1,796.2
17 RecPersSrvc	1,934.0	0.04%	0.8	1,934.7
18 Transport	23,417.7	0.00%	1.0	23,418.6
19 PostalSrvcs	2,678.3	0.02%	0.6	2,678.9
20 Telecomms	3,899.7	0.03%	1.0	3,900.7
21 FinBusSrvces	4,475.1	0.02%	0.8	4,475.9
22 PubAdmDef	212.9	0.05%	0.1	213.0
23 Education	5,852.8	0.20%	12.0	5,864.8
24 Community	7,510.4	0.05%	4.1	7,514.5
Residential	54,956.7	0.06%	32.8	54,989.5
Total	**538,820.2**	**0.01%**	**76.1**	**538,896.3**

Table D.13: Carbon impact of the NBN on economic sectors in the long term for telework when services require *high* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.51%	435.6	85,236.5
2 Mining	61,095.1	0.85%	520.3	61,615.5
3 FoodDrinkTob	4,788.4	0.52%	24.7	4,813.1
4 TCFs	490.8	0.77%	3.8	494.6
5 MiscManuf	3,180.8	0.81%	25.7	3,206.5
6 WoodProds	710.2	0.90%	6.4	716.7
7 PaperPrint	1,264.2	0.84%	10.7	1,274.9
8 ChemCoalPrds	16,919.5	0.71%	119.6	17,039.1
9 NonMetMinPrd	11,516.7	0.87%	100.5	11,617.2
10 MetalPrds	31,514.0	0.79%	250.1	31,764.1
11 TransEqp	363.2	0.96%	3.5	366.6
12 OthMachEqp	584.4	0.87%	5.1	589.5
13 EGW	203,629.6	0.82%	1,675.1	205,304.6
14 Construction	9,483.0	0.86%	82.0	9,565.0
15 WholesalTrad	1,745.6	0.75%	13.0	1,758.6
16 RetailTrade	1,796.0	0.70%	12.6	1,808.6

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
17 RecPersSrvc	1,934.0	0.82%	15.8	1,949.8
18 Transport	23,417.7	0.80%	187.2	23,604.9
19 PostalSrvcs	2,678.3	0.83%	22.2	2,700.5
20 Telecomms	3,899.7	0.82%	31.9	3,931.6
21 FinBusSrvces	4,475.1	0.94%	42.3	4,517.4
22 PubAdmDef	212.9	0.83%	1.8	214.6
23 Education	5,852.8	0.83%	48.7	5,901.5
24 Community	7,510.4	0.83%	62.0	7,572.4
Residential	54,956.7	0.83%	454.7	55,411.5
Total	**538,820.2**	**0.77%**	**4,155.1**	**542,975.3**

Table D.14: Carbon impact of the NBN on economic sectors in the long term for transport when services require *high* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.006%	4.9	84,805.9
2 Mining	61,095.1	-0.028%	- 17.3	61,077.8
3 FoodDrinkTob	4,788.4	0.011%	0.5	4,789.0
4 TCFs	490.8	-0.003%	- 0.0	490.8
5 MiscManuf	3,180.8	-0.003%	- 0.1	3,180.7
6 WoodProds	710.2	0.014%	0.1	710.3
7 PaperPrint	1,264.2	0.015%	0.2	1,264.4
8 ChemCoalPrds	16,919.5	-0.009%	- 1.5	16,918.1
9 NonMetMinPrd	11,516.7	-0.003%	- 0.3	11,516.4
10 MetalPrds	31,514.0	-0.022%	- 7.1	31,507.0
11 TransEqp	363.2	-0.024%	- 0.1	363.1
12 OthMachEqp	584.4	-0.003%	- 0.0	584.4
13 EGW	203,629.6	0.010%	20.7	203,650.3
14 Construction	9,483.0	-0.004%	- 0.4	9,482.6
15 WholesalTrad	1,745.6	0.002%	0.0	1,745.7
16 RetailTrade	1,796.0	0.012%	0.2	1,796.2
17 RecPersSrvc	1,934.0	0.021%	0.4	1,934.4
18 Transport	23,417.7	-0.117%	- 27.4	23,390.3
19 PostalSrvcs	2,678.3	0.006%	0.2	2,678.4
20 Telecomms	3,899.7	0.007%	0.3	3,900.0
21 FinBusSrvces	4,475.1	0.010%	0.4	4,475.5
22 PubAdmDef	212.9	0.003%	0.0	212.9
23 Education	5,852.8	0.012%	0.7	5,853.5
24 Community	7,510.4	0.014%	1.0	7,511.5
Residential	54,956.7	0.004%	2.3	54,959.1

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)$\times$(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
Total	**538,820.2**	**-0.004%**	**- 22.0**	**538,798.1**

Table D.15: Carbon impact of the NBN on economic sectors in the long term for online entertainment when services require *high* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)$\times$(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	-0.041%	- 35.1	84,765.8
2 Mining	61,095.1	-0.051%	- 30.9	61,064.3
3 FoodDrinkTob	4,788.4	-0.045%	- 2.2	4,786.3
4 TCFs	490.8	-0.075%	- 0.4	490.4
5 MiscManuf	3,180.8	-0.046%	- 1.5	3,179.3
6 WoodProds	710.2	-0.062%	- 0.4	709.8
7 PaperPrint	1,264.2	-0.060%	- 0.8	1,263.5
8 ChemCoalPrds	16,919.5	-0.068%	- 11.5	16,908.1
9 NonMetMinPrd	11,516.7	-0.030%	- 3.5	11,513.2
10 MetalPrds	31,514.0	-0.039%	- 12.3	31,501.7
11 TransEqp	363.2	-0.110%	- 0.4	362.8
12 OthMachEqp	584.4	-0.054%	- 0.3	584.1
13 EGW	203,629.6	-0.077%	- 157.1	203,472.4
14 Construction	9,483.0	-0.011%	- 1.0	9,482.0
15 WholesalTrad	1,745.6	-0.058%	- 1.0	1,744.6
16 RetailTrade	1,796.0	-0.085%	- 1.5	1,794.5
17 RecPersSrvc	1,934.0	0.760%	14.7	1,948.7
18 Transport	23,417.7	-0.058%	- 13.5	23,404.1
19 PostalSrvcs	2,678.3	0.050%	1.3	2,679.6
20 Telecomms	3,899.7	-0.043%	- 1.7	3,898.0
21 FinBusSrvces	4,475.1	-0.071%	- 3.2	4,471.9
22 PubAdmDef	212.9	-0.005%	- 0.0	212.8
23 Education	5,852.8	-0.071%	- 4.1	5,848.7
24 Community	7,510.4	-0.067%	- 5.0	7,505.4
Residential	54,956.7	0.002%	1.0	54,957.8
Total	**538,820.2**	**-0.050%**	**- 270.4**	**538,549.8**

Table D.16: Carbon impact of the NBN on economic sectors in the long term for electronic commerce when services require *high* access speeds

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)$\times$(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.58%	492.9	85,293.8

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
2 Mining	61,095.1	1.25%	766.0	61,861.2
3 FoodDrinkTob	4,788.4	1.01%	48.4	4,836.8
4 TCFs	490.8	0.87%	4.3	495.1
5 MiscManuf	3,180.8	1.14%	36.4	3,217.2
6 WoodProds	710.2	1.38%	9.8	720.0
7 PaperPrint	1,264.2	1.33%	16.9	1,281.1
8 ChemCoalPrds	16,919.5	1.16%	195.7	17,115.3
9 NonMetMinPrd	11,516.7	1.34%	153.8	11,670.5
10 MetalPrds	31,514.0	0.89%	279.4	31,793.5
11 TransEqp	363.2	1.25%	4.6	367.7
12 OthMachEqp	584.4	1.25%	7.3	591.7
13 EGW	203,629.6	1.30%	2,652.7	206,282.2
14 Construction	9,483.0	1.46%	138.2	9,621.2
15 WholesalTrad	1,745.6	1.21%	21.1	1,766.7
16 RetailTrade	1,796.0	1.21%	21.8	1,817.8
17 RecPersSrvc	1,934.0	1.51%	29.3	1,963.2
18 Transport	23,417.7	1.49%	348.9	23,766.6
19 PostalSrvcs	2,678.3	1.43%	38.2	2,716.4
20 Telecomms	3,899.7	1.41%	55.1	3,954.8
21 FinBusSrvces	4,475.1	1.71%	76.4	4,551.4
22 PubAdmDef	212.9	1.48%	3.2	216.0
23 Education	5,852.8	1.61%	94.0	5,946.7
24 Community	7,510.4	1.82%	137.0	7,647.4
Residential	54,956.7	1.47%	805.8	55,762.5
Total	**538,820.2**	**1.18%**	**6,436.9**	**545,257.1**

Table D.17: Carbon impact of the NBN on economic sectors in the long term for cloud computing when services require *high* access speeds

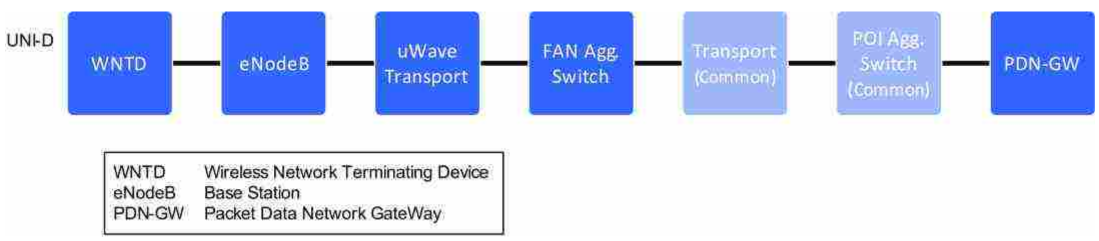
Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
1 AgriForFish	84,800.9	0.0001%	0.1	84,801.0
2 Mining	61,095.1	0.0008%	0.5	61,095.6
3 FoodDrinkTob	4,788.4	0.0028%	0.1	4,788.5
4 TCFs	490.8	-0.0007%	- 0.0	490.8
5 MiscManuf	3,180.8	0.0015%	0.0	3,180.8
6 WoodProds	710.2	0.0041%	0.0	710.3
7 PaperPrint	1,264.2	0.0014%	0.0	1,264.3
8 ChemCoalPrds	16,919.5	0.0028%	0.5	16,920.0
9 NonMetMinPrd	11,516.7	-0.0005%	- 0.1	11,516.7
10 MetalPrds	31,514.0	-0.0005%	- 0.2	31,513.9

Industry	Base year (2010/2011) direct GHG (1,000 Tonnes CO2-e); (2)	Economic Sector Activity Level Growth (%); (3)	GHG Growth (1,000 Tonnes CO_2-e); (4)=(2)×(3)	Total GHG (1,000 Tonnes CO_2-e); (5)=(2)+(4)
11 TransEqp	363.2	0.0029%	0.0	363.2
12 OthMachEqp	584.4	0.0019%	0.0	584.4
13 EGW	203,629.6	0.0019%	3.8	203,633.4
14 Construction	9,483.0	0.0002%	0.0	9,483.1
15 WholesalTrad	1,745.6	0.0018%	0.0	1,745.7
16 RetailTrade	1,796.0	0.0031%	0.1	1,796.1
17 RecPersSrvc	1,934.0	0.0040%	0.1	1,934.1
18 Transport	23,417.7	0.0027%	0.6	23,418.3
19 PostalSrvcs	2,678.3	-0.0005%	- 0.0	2,678.2
20 Telecomms	3,899.7	-0.0139%	- 0.5	3,899.2
21 FinBusSrvces	4,475.1	-0.0037%	- 0.2	4,474.9
22 PubAdmDef	212.9	0.0074%	0.0	212.9
23 Education	5,852.8	0.0048%	0.3	5,853.1
24 Community	7,510.4	0.0073%	0.5	7,511.0
Residential	54,956.7	0.0084%	4.6	54,961.4
Total	**538,820.2**	**0.0019%**	**10.5**	**538,830.6**

Appendix D.3 NBN fixed wireless access network power consumption

The power consumption of customer premises equipment (CPE) of the NBN fixed wireless service is approximately 25 Watts.[26] To estimate the per-premises power consumption of the NBN fixed wireless service, we have followed the network design rules published by NBN Company (2014f). Figure D.1 shows the key network elements and their interconnection.

Figure D.1: Indicative interconnection block diagram of the NBN fixed wireless access network



Source: NBN Company (2014f), Figure 19, p. 25

Table D.18 lists the design parameters of the key network elements that we have used for the network dimensioning.

[26] Email response from NBN Company to an inquiry on 27 November 2014.

Table D.18: NBN fixed wireless network parameters

Network design parameter	Value	Unit	Source
eNodeB per WSAM	8	# of eNodeB	NBN Company (2014f)
WSAM per WSA (FAN)	24	# of WSAM	NBN Company (2014f)
End user per PDN-GW	25,000	# of end user	NBN Company (2014f)
End user per SGSN-MME	100,000	# of end user	Ericsson website

In accordance with NBN deployment scenario 2 in NBN Company (2014d), we have assumed that 581,000 end-user premises and 2,700 base stations are in the fixed wireless footprint. Table D.19 shows our estimate of the dimensioning of the network equipment of the NBN fixed wireless service excluding CPE.

Table D.19: NBN fixed wireless dimensioning

Network equipment	Network equipment (# rounded up)	Description	Dimensioning
FAN Aggregation Switch	15	No. of eNodeB / eNodeB per WSAM / WSAM per WSA	2,700 / 8 / 24
Packed Data Network Gateway (PDN-GW)	24	End-user premises / end user per PDN-GW	581,000 / 25,000
Ericsson SGSN-MME	6	End-user premises / end user per SGSN-MME	581,000 / 100,000

Based on the network dimensioning shown in Table D.19, we have derived the network power consumption as shown in Table D.20.

Table D.20: NBN fixed wireless power consumption

Network equipment	Network equipment (#); (2)	Power consumption (W); (3)	Total power consumption (W); (4)=(2)×(3)
eNodeB	2,700	1,500 (Baliga et al., 2011)	4,050,000
FAN Aggregation Switch	15	40 (Assumption)	600
Packed Data Network Gateway (PDN-GW)	24	40 (Ericsson)	960
Ericsson SGSN-MME	6	50 (Ericsson)	300

For the power consumption of FAN Aggregation Switches, we have assumed that it will be similar to the power consumption of the PDN-GW. The total power consumption of the network equipment excluding CPE is about 4 MW or 35,500 megawatt hours per annum, assuming electricity is consumed by fixed wireless access network equipment continuously throughout the year. The power consumption per-premises excluding CPE is less than 7 (4,052,000/581,000) Watts.

Appendix D.4 NBN satellite access network power consumption

NBN's network of Satellite Ground Stations will feature 24 satellite dishes across 10 sites (NBN Company, 2014e). For the average ground station power consumption, we have assumed 20 kW based on the power consumption of Optus' ground station in Auckland, the smallest of Optus' five ground stations.[27] Assuming electricity is consumed by Satellite ground stations continuously throughout the year, the power consumption of 10 sites is equal to 1,752 megawatt hours per annum. Assuming 408,000 premises in the Satellite footprint in accordance with NBN deployment scenario 2 in NBN Company (2014d), power consumption excluding CPE is about 0.5 Watts per premises.

The power consumption of customer premises equipment (CPE) of the NBN satellite service is up to 75 Watts with a 4 Watts block upconverter (BUC), or up to 113 Watts with a 10 Watts BUC.[28] We have assumed the power consumption shown in Table D.21.

Table D.21: NBN satellite power consumption

Parameter	Value	Unit
Power consumption of VSAT CPE (average)	94	Watts
Power consumption of VSAT CPE in stand-by mode	47	Watts
Time of the day VSAT CPE is in stand-by mode	22	Hours
Hours in a day	24	Hours
Average power consumption of VSAT CPE	50.92	Watts

We have assumed the average of 94 Watts power consumption of the VSAT CPE when active, and half, or 47 Watts, when in stand-by mode. Given the constraints on data usage stated by the fair use policy (NBN Company, b), we have assumed that end-users are actively using NBN satellite service for two hours per day. This results in average power consumption weighted by hours in a day of about 51 Watts.

Appendix D.5 Aggregation network domain

The purpose of the aggregation domain is to aggregate media between the retail service providers and the NBN access networks and to distribute the traffic between aggregation domain network elements (switches) (NBN Company, 2014f). The ethernet aggregation switches are exclusively deployed in Points of Interconnect sites (POIs) (NBN Company, 2014f). They combine many thousands of end-user services together for transport over the NBN and handover to retail service providers (NBN Company, 2010b). The type of architecture and number of switches deployed depend on the size of the customer serving area and POI site (NBN Company, 2014f). Two types of switches are typically used in larger POIs, whereas the same functions are performed by only one type of switch used in smaller POIs (NBN Company, 2014f).

The 121 POIs that the ACCC had proposed comprise 80 metropolitan locations and 41 regional locations (Ferris, 2012). In metropolitan locations, we have assumed two-tier architecture with two

[27] Site statistics available on the website under the following link (last accessed on 28 November 2014): http://www.optus.com.au/aboutoptus/About+Optus/Satellite/Satellite+Network/Earth+Stations+&+Teleports

[28] Email response from NBN Company to an inquiry on 27 November 2014.

pairs of switches, and a one-tier architecture with a pair of switches deployed in regional locations. For the power consumption of a typical ethernet aggregation switch, we have assumed that it will be similar to the power consumption of FAN Aggregation Switches and PDN-GWs, i.e. 40 Watts. Our estimate of the power consumption of 320 ($80 \text{ POIs} \times 4$) switches in metropolitan locations and 82 ($41 \text{ POIs} \times 2$) in regional locations is 16,080 ($402 \times 40 \text{ Watts}$) Watts or about 141 megawatt hours per annum.