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PERSONAL INCOME TAX REFORM TO SECURE THE SOUTH AFRICAN REVENUE BASE USING A MICRO-SIMULATION TAX MODEL

by

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Submitted in partial fulfilment of the requirements for the degree

PhD in Economics

in the

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES

at the

UNIVERSITY OF PRETORIA

November 2013

Acknowledgements

It would not have been possible to write this thesis without the help and support of my family and people around me, to only some of whom it is possible to give particular mention here. A special token of appreciation to my family for understanding why I could not have spent more time with them when I was writing my thesis.

I would like to specially thank my thesis supervisor, Prof N.J. Schoeman, for his continuous support, motivation, patience, time, comments and various adjustments to this thesis. His guidance and the sharing of his extensive knowledge throughout my studies and career are sincerely appreciated. Working with Prof Schoeman gave me invaluable insight, and I cannot imagine having a better advisor and mentor. I would also like to thank my thesis co-supervisor, Prof S. Caner, for his invaluable inputs and comments.

My husband, Terence Jordaan, earns my gratitude for his moral support, understanding and especially for recovering my corrupt data half way through my research. I must also mention that my two little dogs Rocco and Heidi were always by my side offering companionship while I wrote this thesis.

To my parents, Anne-Marie and Mike van Heerden, thank you for your continuous and motivational support throughout my life. Thank you for giving me the opportunity and financial support to study further. Also for making time to assist with language aspects and proofreading of my thesis throughout the writing process.

My appreciation and thanks go to Mike McCoy who language edited my thesis.

Last but not least, I thank my Heavenly Father for giving me the health, strength and perseverance throughout the study period.

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Abstract

The purpose of the study is to analyse tax reform measures to secure the tax revenue base, in particular the personal income tax structure of South Africa. The main objectives are: firstly, to identify personal income tax reform interventions so as to align the personal income tax structure in South Africa with international best practices. Secondly, the impact of tax reforms on revenue collection, given optimal economic growth levels, is determined. Thirdly, to determine the best tax reform scenario which could minimise the individual tax burden and maximise its efficiency. Lastly, the impact of the suggested tax reforms on fairness as a principle of a good tax system is evaluated.

A static micro-simulation model is developed from survey data and used to simulate the proposed tax reforms. Different tax reforms were selected from a study of international tax reform trends and an analysis of the South African personal income tax structure. The literature provides clear margins for the structuring of tax bands and threshold margins.

Tax elasticities are estimated in order to explain the methodology for determining the impact of tax reforms. These elasticities include the elasticities for determining the progressiveness of the PIT structure, determining the deadweight loss (tax efficiency) and

also to determine the optimal levels of taxes and economic growth and revenue maximisation. The different tax reform scenarios take the economy closer to or further away from optimum growth and optimum revenue.

The results show that as far as marginal rates are concerned, a lowering in rates to levels on par with South Africa's peers offers potential for improved levels of efficiency with the tax burden equal to or even below the optimal tax ratio from an economic growth point of view. Although such a ratio is below the optimal revenue ratio the results suggest that the loss in revenue could be minimised over time through a resultant increase in productivity and economic growth.

By adjusting the non-taxable thresholds and taxable income bands according to the algorithm defined in the best practice scenario, more taxpayers will be included into the tax net but with a net decrease in tax liability. As a result the tax/GDP level also declines to a level below the optimal growth level but tax efficiency increases. The resultant loss in revenue will have to be recouped through increases in other than individual income taxes but improved levels of tax morality because of the lower margins for each tax band and increased productivity might also contribute to increased revenue performance. The tax structure is also more progressive which contributes towards the "fairness" of the tax regime.

Regarding tax expenditure reforms, the analysis shows that medical tax credits offer a more equitable form of relief than medical deductions which substantiate this kind of reform as already implemented by government and which is to be fully phased in over the next couple of years. Tax liability is slightly lower in the case of medical credits compared to medical deductions but the difference is only marginal as far as net revenue and optimal growth and efficiency is concerned. However, a medical credit which increases disposable income at the lower end of the scale and discriminates against higher income groups also improves progressiveness of the tax regime and therefore the fairness thereof accordingly.

Finally, the demographic impact of the suggested reforms also shows some important trends. Better education improves skills levels which seems to be positively correlated to taxable income levels. As far as age is concerned, the analysis shows that a substantial number of taxpayers in the categories below the age of 24 and above 65 fall within the lower taxable income groups. Those are also the most vulnerable groups from a subsistence point of view. Thus, tax reform that specifically improves their levels of disposable income should be prioritised in order to address equity and fairness as objectives for a “good” tax structure.

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TAX REFORM TO SECURE THE SOUTH AFRICAN REVENUE BASE USING A MICRO-SIMULATION TAX MODEL

CHAPTER 1
GENERAL INTRODUCTION

1.1 BACKGROUND

The financial crisis that started in 2007 has again emphasised the importance of sustainable fiscal policy as a precondition for economic stability. However, not only has the need for this sustainability become clear, but also the vulnerability of the fiscal balance – given the financial problems of countries such as Greece, Spain, and Portugal (not known for their fiscal prudence over the past few decades). These events all point to the importance of safety margins within which fiscal policy can be safely applied. Unfortunately, the desperate application of fiscal policy as a bailout measure in many countries far exceeded these margins, with the result that the world economy has been in turmoil ever since and will probably remain so for the foreseeable future.

South Africa has largely escaped the dire consequences of such intervention, due to relatively disciplined fiscal and monetary policies since transformation began in 1994. However, as will be shown in this study, the borrowing requirement increased substantially, and the ratio of debt to gross domestic product (GDP) is expected to remain relatively high over the next decade. Given such a scenario of fiscal challenges, it is of great importance that the revenue base from which the funding is to be sourced is secured and expanded in order to lower the borrowing requirement of the South African Government.

This study contributes to the literature on fiscal prudence, setting as its objective the role that tax reform plays in securing the revenue base and thus in ensuring fiscal sustainability. Of particular interest is personal income tax (PIT) – the major contributor to the revenue base – compared to corporate taxes and indirect taxes such as value-added tax (VAT). The focus is, therefore, on the PIT structure and on how it affects individual tax revenue. Current tax practices and possible reform measures based on international experience are being analysed and tested using a micro-simulation (MS) tax model to determine what can be done to optimise individual taxes so that they not only optimise revenue, but also minimise the negative burden of taxation on the performance of the economy. Given the unavailability of existing tax models that can be used for such an analysis, a model had to be constructed, as will be outlined in Chapters 4 and 5.

Governments continually have to face the challenge of finding ways to broaden their tax bases. As a result, tax reform has become a continuous process of intervention, and the literature shows that many lessons can be learned from the experience of other countries. In this study an attempt has been made to scan a broad range of relevant reforms, and identify a few that could fruitfully be implemented in South Africa.

The data shows that the ratio of South African PIT to total tax revenue increased from 40 to 43 per cent between 1994 and 1999, after which it decreased to around 34 per cent in 2011. This decrease was mainly due to lower marginal tax rates (the top marginal tax rate first decreased from 45 to 42 per cent and thereafter to the current 40 per cent), but the contribution from corporate taxes also substantially affected the share of individual taxes. The fact is that PIT is still extremely important, not only as a contributor to the revenue base, but also as a tool to improve the skewness of income distribution through its progressive structure. According to official data, 10.3 million taxpayers were accounted for by the South African Revenue Services (SARS) in the 2011 fiscal year. Of this total, only 4.5 million were assessed tax filers (Tax Statistics, 2012:33).

Tax reform should adhere to the characteristics of a tax system: efficiency, simplicity, and fairness. To test the efficiency of different identified tax reform measures, a number of scenarios are tested, with each scenario analysing changes in the PIT revenue base. Efficiency is quantified by opportunity cost and losses to the economy from excess burden (deadweight loss). The progressivity of PIT is influenced by many factors: for example, an increase in marginal tax rates, lowering of the non-taxable threshold, tax evasion and avoidance, and tax credit.

Tax reform scenarios include the adjustment of income bands and tax-free thresholds, as well as changes to marginal tax rates – reform measures that were proposed by various commissions or identified as best practices from the literature. Changes in the composition of medical deductions – a major source of tax expenditure – are simulated with current changes in relevant tax laws in this country. Thereafter, the findings are converted into tax policy recommendations.

In the next section, the problem statement, research questions, significance of the study, and conceptualisation of terms are provided. The research methodology, limitations to the study, and assumptions are also outlined, followed by an exposition of the sequencing of chapters and the research ethics approval.

1.2 PROBLEM STATEMENT

The primary obstacle when attempting to sustain a healthy fiscal balance appears to be an insufficient tax revenue base together with escalating government expenditure. This combination leads to a continuous growth in public debt, which in itself poses increased financial risk should debt service payments default in any way. From a public finance sustainability point of view, it is therefore important to scrutinise the revenue base and possible tax reform procedures to improve revenue flows and to negate the negative impact of tax leakages from the economy. Given the fact that PIT remains the largest contributor to the South African revenue base, this study focuses on this particular source of revenue. Various issues impact on PIT flows, such as the progressiveness of tax structures, thresholds, deductions, and taxable income levels. This study contributes to the relevant literature on taxation by analysing current individual tax practices and trends; and possible tax reform measures are suggested to compensate for the fiscal imbalances that have characterised the South African fiscal scenario over the last few years.

The outcome is crucial, given the level of unemployment in the country and the need for higher economic growth. Furthermore, tax reform has received substantial attention in the international literature as well as in South Africa, as will be outlined in the reports from the Franzsen, Margo, and Katz Commissions. However, the question is not only whether South Africa's tax policies are fully aligned with international trends, but – even more important – whether PIT is being optimised in both level and efficiency. This study aims to provide answers to these questions, realising that, given the challenges to the fiscus in this country, sustainable fiscal policy can only be possible through a continuous process of tax reform. Tax reforms should not only address the broadening of the tax base, but also reduce the excessive tax burden, thereby improving tax efficiency.

In this study, the impact of taxes on the economy, and possible alternative remedies, are analysed using an MS tax model. The model is capable of simulating the effects on disposable income of various policy interventions. The analysis is based on the experience of international tax reforms that were aimed at broadening the tax revenue base, lowering marginal tax rates, and minimising the concomitant deadweight loss. It is a generally accepted fact that sound fiscal sustainability contributes towards improved levels of economic growth (and also, therefore, job creation), which in turn sustains the revenue base.

1.3 RESEARCH QUESTIONS

This dissertation, through the application of primary and secondary sources and research methods, provides answers to the following research questions:

1.3.1 <u>Theoretical questions answered by this study:</u>

- What determines the optimal level of government revenue via individual taxes?
- What is the connection between taxes and economic growth?
- How can the individual tax burden be minimised and its efficiency optimised?

1.3.2 <u>Policy questions answered by this study:</u>

- Which relevant tax reform interventions for individual taxes should be considered in order to align tax reform in South Africa with international trends?
- How would such tax reforms contribute towards securing the South African PIT revenue base, given the increased levels of globalisation and international competition?

1.4 SIGNIFICANCE OF THE STUDY

To maximise revenue growth and to ensure 'fairness' with an appropriate level of progressiveness of individual taxes, policy makers have to implement the required tax reform policies based on international best practice.

The aim of this thesis is to identify possible areas of tax reform, and then to use an MS tax model to measure the impact of such reforms on individual tax liability and their efficiency, in terms of both the burden on the economy and their impact on the distribution of the tax burden. The point is that policymakers have to carefully weigh the trade-offs between lower tax rates and increased tax efficiency (lower deadweight loss).

1.5 CONCEPTUALISATION

Conceptualisation in the context of this study refers to both the clarification and the analysis of key terms in the study, and the way in which one's research integrates into the body of existing theory and research. Key terms used in the study are as follows:

Micro-simulation (MS) model: A model that simulates the behaviour of individuals using econometric techniques.

Micro-simulation tax model: An MS model that simulates policy changes in taxes and calculates before and after effects.

Static: The behaviour of individuals remains constant. The immediate effect of a policy change can be observed.

Dynamic: The behaviour of individuals changes over time.

Taxable income: The amount remaining after deducting allowances, but before tax is subtracted.

Disposable income: The amount after deducting allowances and taxes.

Up-rating: To improve on a value – for example, to take into account the increase in income over a period of four years.

Ages/re-weight: To account for economic changes since the data was released. The weights in the survey are re-weighted.

The following recognised abbreviations are used in the study (Table 1):

Table 1: Abbreviations used in this document

Abbreviation	Meaning
ABS	Australian Bureau of Statistics
ADF	Augmented Dickey-Fuller
AICPA	American Institute of Certified Public Accountants
ARDL	Autoregressive Distributed Lag
CASASP	Centre for the Analysis of South African Social Policy
CES	Constant elasticity of substitution
CGE	Computable general equilibrium
CIT	Corporate income tax
CoPS	Centre of Policy Studies
CPD	Netherlands Bureau for Economic Policy Analysis
CPI	Consumer price index
ECM	Error correction model
FES	Family expenditure survey
GDP	Gross domestic product
GLM	General linear modelling
GST	General sales tax
HES	Household expenditure survey
HITSM	Household income and tax simulation model
IDS	Income distribution survey
IES	Income and expenditure survey
IFS	Institute for Fiscal Studies
IMF	International Monetary Fund
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
LFS	Labour force survey
MATH	Micro-analysis of transfers to households
MITTS	Melbourne Institute tax and transfer simulator
MS	Micro-simulation
NATSEM	National Centre for Social and Economic Modelling
NP	Ng-Perron
OECD	Organisation for Economic Co-operation and Development
OHS	October household survey
OLS	Ordinary least square
PIT	Personal income tax
PSUs	Primary sampling units
RANUNI	Uniform random number generator
RPI	Retail price index
SADNAP	Social Affairs Department of the Netherlands Ageing and Pensions

SAM	Social Accounting Matrix
SARB	South African Reserve Bank
SARS	South African Revenue Services
SAS	Statistical Analysis Software
SERPS	State earnings-related pension scheme
SIHC	Survey of income and housing cost
SITE	Standard Income Tax on Employees
SPSD/M	Social Policy Simulation Database and Model
Stats SA	Statistics South Africa
STINMOD	Static incomes model
TAXBEN	Tax and benefit
TRIM	Transfer income model
UK	United Kingdom
UPGEM	University of Pretoria general equilibrium model
US	United States of America
USAID	United States Agency for International Development
VAT	Value-added tax
WEEDS	Weekly earnings of employees distribution survey

1.6 RESEARCH METHODOLOGY

The research strategy followed is to:

- Define the tax revenue base, tax reform, and tax elasticities;
- Identify generic trends in tax practices world-wide;
- Identify the trends in South Africa's fiscal stance since 1994;
- Compare South African scenarios to those of some other countries;
- Acquire time series data from the South African Reserve Bank (SARB) and the Income and Expenditure Survey (IES) 2005/2006 from Statistics South Africa (Stats SA);
- Construct an MS tax model;
- Simulate policy scenarios with the MS tax model;
- Analyse policy scenarios; and
- Make conclusions and recommendations on tax reform.

1.7 LIMITATIONS TO THIS STUDY AND ASSUMPTIONS

The study uses data on individual income as reflected in the IES of Stats SA, as well as data obtained from SARS. Only individual income is considered, therefore, as part of direct taxes that also include the important component of company taxes. However, surveyed accounting data for companies is not readily available in this country, which means that company data could not be included in the MS model.

Furthermore, the methodology used is primarily limited to static MS tax models, with limited allowance for dynamics such as population ageing and other demographic and environmental changes. The causes of escalating government expenditure are recognised, but the thesis is limited to only the PIT revenue base.

The analysis is also based on the following assumptions:

- The survey data accurately represents the total population.
- The official data sources used are sufficient to draw inferences about the South African gross income, tax payable, taxable income, and the number of taxpayers.

1.8 SEQUENCE OF CHAPTERS

Chapter 2

In this chapter, tax revenue structures are considered with an emphasis on international best practice. Thereafter the concept ‘tax reform’ is explained, with a discussion of approaches, properties, disadvantages, and lessons learned through an overview of relevant literature (e.g. tax reform practices in New Zealand, Canada, and Australia). In particular, various combinations of tax mixes, marginal rates, and tax incentives are discussed, with an outline of some common trends.

Chapter 3

In this chapter the tax revenue base of South Africa is defined, and an empirical analysis is done of the tax base, tax mix, and tax/GDP ratios. The relatively high marginal rates on individuals and high tax expenditures are outlined, together with their impact on the revenue base and the concomitant volatility in revenue flows. The chapter also includes references to the three most important commissions that have been appointed over the past few decades to investigate the stance of fiscal policy in South Africa. It concludes with a selection of possible tax reforms that could improve the tax structure in this country.

Chapter 4

This chapter focuses on the methodology for quantifying tax reform intervention. The main approach is the use of elasticities in an attempt to estimate improvements in revenue, growth, tax efficiency (deadweight loss), and tax fairness. Different types of elasticities are discussed, measuring the response of tax revenue to changes in the tax base, the business cycle, and marginal tax rates. This chapter also outlines the most relevant theories on tax optimisation and the estimation of tax efficiency by quantifying the deadweight loss concept.

Chapter 5

This chapter contains an overview of the literature from the discipline of MS models. The differences and limitations of MS and computable general equilibrium (CGE) models are discussed as well as the linking or layering of these models. The chapter also discusses the methodology behind the construction of the MS tax model that is used as a tool to estimate the effect of some identified tax reform suggestions. The MS model uses individual and household data from the IES of Stats SA. After substantial imputation, the data is calibrated to tax data published by SARS. An explanation is given for the data requirements and limitations and how these were dealt with. Re-weighting and up-rating techniques from the previous literature overview are applied to the data.

Chapter 6

In this chapter the selection of relevant PIT reforms that are based on international experience and have been discussed in the previous chapter, are analysed, and the impact of its implementation is demonstrated using the MS model. The model analyses individual tax liability by taxable income group, and the results indicate the gains and losses to the revenue base with changes in the tax codes on individuals.

The tax reform scenarios analyse tax policy changes and its impact on revenue, efficiency, progressivity and optimal economic growth levels. The first scenario considers different marginal tax rates that are aligned to international trends. Another scenario outlines the impact of policy adjustments to the taxable income bands and the non-taxable threshold level, to account for the impact of fiscal drag. The last scenario focuses on tax expenditures. The impact of medical tax credits on revenue, and optimal growth levels is compared to that of medical deductions and the analysis also outlines some demographical changes accompanied by such a tax reform.

Chapter 7

This chapter summarises the main findings of this study, and concludes with some policy recommendations.

1.9 RESEARCH ETHICS

The researcher has attempted to conduct the research objectively, honestly, and with integrity. The sources of the secondary data have been acknowledged, but since the data was collected from published macro- and micro-economic data bases, ethical problems, such as confidentiality of individual participants or permission to use the data, have not been a problem.

CHAPTER 2

LITERATURE REVIEW ON PERSONAL INCOME TAX REFORM

2.1 INTRODUCTION

This chapter starts with an overview of the definitional issues related to individual income tax, followed by the relevant theoretical and empirical literature on tax reform as a fiscal policy tool. The objective is to provide some guidelines on trends in the mainstream thinking about individual income tax structures, and to identify practices or structures that could be investigated as possible options for the expansion of the South African revenue base while also improving the efficiency of such taxes.

2.2 CONCEPTUAL ISSUES RELATED TO INDIVIDUAL INCOME TAX

This section provides an overview of some definitional issues, and thereafter explains the impact of proportional tax structures on the revenue base. Calculating personal tax revenue starts with gross income. According to the Haig-Simons definition, personal income is the "... money value of the net increase in an individual's power to consume during a period. This includes all sources of potential increases in consumption, regardless of whether the actual consumption takes place, and regardless of the form in which the consumption occurs... any decreases in an individual's potential to consume should be subtracted in determining income..." (Rosen, 2005:361).

The reality is that the actual individual tax system of a country does not exactly reflect the Haig-Simons definition; but it offers a structure that can be followed to define the tax revenue base. One difference is that income is given in nominal terms, and this does not account for adjustment for inflation. Capital gains tax is only added to gross income when assets are realised, and not on an annual basis. Gross income might also include income from small businesses, where business income is divided among the owners and added to their own gross income. Individuals receive most of their gross income in the form of salaries, wages, pension, interest, and dividends (Slemrod & Bakija, 2008:32).

Individual taxable income consists of gross income less contributions to pension funds, medical aid, and other deductions. These deductions are leakages from the PIT revenue base (tax expenditures). Tax expenditures are provisions determined by the tax law that result in a loss in revenue for the government, but provides relief to taxpayers. Different forms of tax expenditures include allowances (deducted from gross income), exclusions (not included in taxable income), rebates and tax credits (deducted from tax liability), and lower marginal rates. Recently, such tax expenditures have become controversial due to the fiscal deterioration in many countries, with increasing debt and a worsening fiscal scenario in general. As a result, many countries are looking into the possibility of reducing these tax expenditures to secure their revenue bases (Organisation for Economic Co-operation and Development [OECD], 2010:12).

From a policy perspective it is important to differentiate between deductions and tax credits. The former include subtractions from taxable income, while tax credits are credits from tax liability. The reason is that deductions and exclusions favour high income taxpayers more than do tax credits, since this high income group would save the deduction value times the marginal tax rate on their reduced income. However, tax expenditures are important as they assist in the redistribution of income; and therefore careful analysis should be done to decide which income groups are to be favoured (Joint Committee on Taxation, 2006:4).

The tax rate schedule is then applied to taxable income. In some countries tax law differentiates between married and unmarried individuals (marriage tax penalty), age groups (different rebates), and income groups (a non-taxable threshold is applied to low income earners). Adjustments to the taxable income bands, non-taxable threshold, and marginal tax rates are different forms of tax relief for a more equitable tax system. These adjustments are important to offset inflation (bracket creep) (Rosen, 2005:360 & 365).

2.2.1 Main insights and conclusion

Gross income consists mainly of wages and salaries. Taxable income is obtained after subtracting allowances and deductions from gross income. Tax expenditures cause the tax revenue base to shrink, but redistribute income over the income groups and provide relief to the poor. Tax liability is the product of taxable income and the tax rate. Rebates and tax credits are deducted from tax liability. Adjustments to taxable income bands and the non-taxable threshold for inflation are important to compensate for bracket creep. The next section defines tax reform and the type of tax reforms introduced by a selection of countries.

2.3 PERSONAL INCOME TAX REFORM

Tax reform is a regular necessity in a country (Colander, 2010:247). The level of tax reform, however, depends on a country's government expenditure allocations, the efficiency of its tax administration, and the tax system. The main reasons for tax reform are to reduce deadweight losses, to improve the equity of the tax system, to raise sufficient revenue for key government expenditures, and to reduce the compliance burden (Saez, 2001:205). The justification for tax reform is to be part of a tax structural adjustment process (since tax reform can reduce distortions in the form of inefficiencies and inequities in the allocation of resources). A second reason is that, with the aim of stabilising the economy, a reduction in public expenditures may be needed to generate revenue in a non-distorting and equitable manner. It essentially combines all the properties of a good balanced tax reform, and focuses on the optimal level, structure, and distribution of taxes. A well-balanced tax reform must include four particular properties: equity, efficiency, convenience, and certainty (Smith, 1776; Musgrave & Peacock, 1967:10).

A poorly-designed or malfunctioning tax system can lead to problems that can only be addressed through proper tax reform measures. Typical problems might be: insufficient revenue collected; economic distortions that reduce economic welfare and growth; an unequal tax burden where low income earners often bear a significant portion of the overall tax burden; and tax administrative problems causing tax evasion and corrupt practices (Bird, 2003:12). Tax reform lessons can be learned by looking at reforms from the past and at other countries' tax reform experiences. In this regard, some coefficients and ratios are noticeable: tax elasticities, tax/GDP ratios, marginal rates, and threshold levels. In addition, health and pension reforms in developed and developing countries have to be closely monitored.

Any change in the tax system involves several tax reform elements. It should also be noted that tax changes can be sensitive; and so they have to be designed carefully, as will be outlined later on. In the following sections, different aspects of tax reform are discussed under the following headings: 1) Definition of tax reform; 2) Different reasons for tax reform; 3) Approaches to tax reform; 4) Properties of a good tax system; 5) Disadvantages of tax reform; and 6) Tax reform lessons.

2.3.1 Defining tax reform

Tax reforms are usually aimed at achieving international competitiveness and minimising the distorting effects of taxation on economic behaviour, while preserving the fundamental progressiveness of the overall tax structure. Black, Calitz & Steenekamp (2006:147) defines tax reform as the process of changing the way in which taxes are collected or managed by the government. According to Peter, Buttrick & Duncan (2010:451), the tax systems of countries evolve over time and change continuously. Tax reforms in upper-middle income and high income countries consist mainly of inflationary adjustments in the taxable income bands to avoid bracket creep. In lower income countries, PIT is not as dominant as in the former groups of countries, and tax reform in PIT consists mainly of structural changes in the combination of taxes and adjustment of thresholds and marginal rates.

Successful tax reform consists of robustness and relevancy. Relevancy involves planning and implementing what really matters. Building capacity in tax policy ensures robustness. Implementing a broader tax base with lower marginal tax rates will, in the long run, increase the tax revenue base of individuals and businesses (Bird, 2003:27). The objective of tax reform is to remove any disincentives that the current system creates for saving and investing, and to encourage productivity in the labour market.

As stated by Foster (2011:3) the "...golden rule of tax reform is that tax reformers should not try to claim more gold...". When designing a tax structure, tax evasion should be a central concern in tax design. Most commonly, tax reform is applied by bringing about changes in a tax system while retaining the basic outline. By changing the structure of the current tax system, successful tax reform ensures neutrality by keeping the current level of tax revenue unchanged within the new tax structure (Foster, 2011:4).

According to Vančurová (2006:1), policy changes should aim to amend the tax mix ratio by increasing one type of tax revenue at the expense of another. Goode (1984:38) states that in "...the majority of developing countries, the most promising route to budget improvement is not through the introduction of a wholly new system but through the incorporation of some new elements...".

Slemrod *et al.* (2008: xi) remark that Albert Einstein once said that "…the hardest thing in the world to understand is the income tax. But understand it we must, because it is part of how government affects the lives of Americans. Unfortunately, though, when tax reform enters the political arena, the subtleties of the key issues are usually lost in the midst of self-serving arguments and misleading simplifications…". Musgrave (1987:59) states that reforming the income tax of individuals starts by increasing the level of the tax threshold, by creating horizontal equity (all individuals are similar with the same economic circumstances), and by reducing the number of tax brackets with lower marginal tax rates. "... Setting up an efficient and fair tax system is, however, far from simple, particularly for developing countries that want to become integrated in the international economy. The ideal tax system in these countries should raise essential revenue without excessive government borrowing and should do so without discouraging economic activity and without deviating too much from tax systems in other countries..." (Tanzi & Zee, 2001:1).

2.3.2 **Different reasons for tax reform**

As stated earlier, tax reform is the reforming of the structure of the tax system, which includes the types of taxes, the structure of the rates and allowances, and the social and economic impact of the different types of taxes. There could be many reasons for tax reform. A typical objective with income tax reform could be that it becomes more progressive (revenue grows in proportion to an increase in income) to ensure a more progressive distribution of the tax burden. This is normally important in countries where income is skewly distributed, and income tax is used as a tool to correct such skewness in income (Alm & Wallace, 2004:5). Another objective might be to simplify the tax system in order to make it easier to administer – for example, by imposing a flat rate PIT.

Other reasons include socio-economic objectives such as re-designing health care and pension schemes. These are known as tax expenditures, which could account for a considerable loss in revenue. However, such tax expenditures serve as important incentives to encourage saving schemes that would release pressure on the fiscus, and in the longer term contribute towards fiscal sustainability. For example, health system reforms could consist of the conversion of tax expenditures from a contributory scheme, to a credit system, thus also benefitting low income earners. The reason is that higher income earners (tax filers) benefit more from the traditional incentive schemes by subtracting medical contributions from their taxable income. This is not possible in the case of lower income earners, since they normally do not file income returns (Furman, 2008:630). Furthermore, deductions could be capped as a share of taxable income, or the tax rate at which deductions can be claimed could be capped, thereby reducing the disparity in the value of deductions between high and low tax bracket taxpayers. In addition, base broadening reforms can be implemented to achieve distributional or revenue objectives (Poterba, 2010:134).

2.3.3 Different approaches to tax reform

Four different approaches to tax reform can be found in the literature. First, there is a micro-economic approach, which focuses on the balancing of efficiency and equity, and on maintaining an optimal level of taxation (Lledo, Schneider & Moore, 2004:10).

Second, there is a macro-economic approach, which focuses on the impact of aggregate taxes on aggregate economic growth as well as on the distribution of income by using macro-econometric or CGE models. The objective here is that the tax system ensures a stable revenue flow to finance public expenditures. Foster (2011:3) states that, for tax reform to improve economic performance, a broader tax base with lower marginal rates proves to be more successful.

Third, there is the administrative approach, which aims at a simpler and more cost-effective tax system. The tax system should thus be simpler to administer, although the main objective is also to narrow the tax gap (Bird, 2003:4). With the administrative approach, a scheduled income tax is used where different sources of income are taxed at different rates and allowances are limited. This type of income tax is more popular in developing countries such as Africa and Latin America. The main goal of a scheduled tax is to simplify tax administration by withholding tax at the source and eliminating the necessity of individual returns, thereby creating a simpler cost-effective tax system with lower levels of tax evasion (Alm *et al.*, 2004:5).

Fourth, the political approach explains the behaviour of individuals in the political decision process regarding the amount of government revenue, the structure of government expenditure, and the extent of marginal tax rates. Tax reform requires approval from a variety of political domains, with taxation linked to expenditures. Reforms should address equity, while tax policy and administration should be transparent and accountable (Van Velthoven & Van Winden, 1991:64).

2.3.4 Properties of a good tax system that form the basis of tax reform

Smith (1776) proposes four canons as the basis of a tax system, and recommends that a well-balanced tax reform must include all four properties.

The first property is *equity*, where the tax schedule promotes a fair distribution of income. 'Horizontal equity' implies that all individuals within the same income category pay the same amount of tax, while 'vertical equity' refers to the progression in tax structures by which individuals who earn a higher income are taxed at higher rates. It should be noted that the tax burden can be shifted through tax reform – an effect that has to be considered when analysing the tax burden.

Second, taxes are *efficient* only if designed so that their distorting effects on the choices made by taxpayers are minimised.

Third, taxes should be *convenient*, and so be easily administered and collected.

Last, tax rules should be *certain*, not leaving taxpayers uncertain about their tax obligations. For example, it should be clear when to pay tax and what amount is due. Musgrave *et al.* (1967:12) also provide an outline of basic principles of taxation, which mostly correspond with Smith's canons. They also believe that these principles serve as guidelines for tax reform practice and admit that tax reforms are fairly easy to formulate, but difficult to apply in practice.

However, according to a report from the American Institute of Certified Public Accountants (AICPA) (2001:1), six more principles should be added to the four canons of Smith and be considered alongside them for tax reform. The first of these additional principles is that *collecting costs* have to be minimised. Second, the tax system should be kept *simple* for taxpayers to understand their tax liabilities. Third, *neutrality* is important to ensure that the impact of a tax on taxpayer behaviour is minimised. Fourth, the tax should be *transparent and visible* so that taxpayers know how and when it is imposed on them. Fifth, the tax should *narrow the tax gap* of non-compliance. Sixth, the principle of *surety* is important; government has to be able to estimate revenue securely within reasonable margins.

Musgrave *et al.* (1967:10) argue that, although these properties of a good tax system provide useful guidelines, they need to be constantly re-evaluated to assess the gaps in feasibility between theory and practice. Roa (2000:60) states that the philosophy of tax reform has changed over the years: from only raising revenue, to financing expenditures, to minimising the economic distortions it causes. Distortions are minimised by lower tax rates, by broadening the tax base, and by having a simple and transparent tax system. According to Creedy (2010:140), a broad tax base with few exemptions and low tax rates provides the basic framework for a good tax system. Bird (2008:10) proposes that an increase in tax incentives creates inefficiency and inequity in the tax system. It complicates tax administration while facilitating tax evasion and corruption. Therefore tax incentives should be simple, and should be continuously re-evaluated.

McLure (1991:7) states that, for developing countries, the objectives of tax policy should be equity, economic neutrality, and simpler administration. According to Foster (2011:1), tax reforms should make taxes simpler by expanding the base and lowering marginal rates, thus becoming more economically neutral, cost-effective to administer, transparent, and fairer. Surrey (1973) believes that tax incentives alter the horizontal and vertical equity of the tax system by allowing exemptions and deductions. He also recognises the importance of a fair distribution of the tax burden.

2.3.5 Disadvantages of tax reform

Designing and implementing tax reform can be a difficult task (Bird, 2003:1), and Pechman (1990:9) warns that while tax reform might be good for some, it might not be so for others. As stated earlier, tax reform aims to improve equity and economic performance by benefitting a particular group disproportionately while others pay a disproportionate share of the cost (Alm *et al.*, 2004:6).

However, such a tax reform reduces the fairness of the tax system, and could actually lower the efficiency of the tax. The disproportionate effects of tax reform require that its impact on redistribution also be assessed in a dynamic setting. Businesses and individuals adjust their behaviour in the short term by postponing their investment decisions until a more favourable tax reform is implemented. Such a scenario could have a negative effect on the economy (OECD, 2010:49).

Fundamental tax reform makes radical changes to the tax base, and can significantly change the composition of the tax burden. To enhance the performance of labour and productivity, PIT progressivity should be reduced, along with a reduction in the top marginal PIT rates (OECD, 2010:21). Bahl (2008:10) states that in the 1970s, developing countries' tax revenue bases were limited due to low economic growth rates, poor tax administration, and a large informal sector. Developing countries also preferred to borrow or to use seigniorage, leading to higher debt levels.

Implementing tax reform that eliminates all deductions and allowances and imposes lower marginal tax rates seems like a good idea in the short-term, but the long-term consequences have to be considered. What often happens is that, after a while, marginal rates have to be increased again without introducing deductions, leaving taxpayers worse off (Slemrod *et al.*, 2008:2). Roa (2000:60) warns that tax reform that promotes relatively high marginal tax rates usually affects the productivity of taxpayers negatively.

The PIT revenue base is vulnerable to increases in marginal tax rates, economic growth, and government debt. In most countries, higher income groups contribute a higher proportion of tax revenue, and thus an increase in the progressivity of the tax codes will increase the volatility of revenue fluctuations and increase future deficits (Du Plessis, Smit

& Sturzenegger, 2007). An indication of the level of progressiveness of a tax structure is when the marginal tax rate exceeds the average tax rate. Progressivity through increased marginal rates is limited though, because of the possibility of both tax avoidance and tax evasion practices.

Both of these concepts will be explained in more detail later in this study; but in general terms, they simply mean that individuals will either switch from one tax regime to another, or hide some or all of their income in order to dodge their tax liabilities. For example, Tanzi *et al*. (2001) state that, if the highest personal income marginal rate exceeds the corporate marginal rate, some individuals would rather register as small businesses in order to benefit from the lower taxes and the various tax incentives enjoyed by such entities. The implication is that a good tax system should align the top marginal rate of individuals with company tax rates.

Stephens (1993:46) states that New Zealand's 1980 tax reform was the result of a political agenda, indicating the shortcomings of the tax system. The main problem was that the tax regime was not effective in collecting sufficient revenue to cover the relatively high levels of government expenditure. The efficiency and equity criteria were not met due to high tax incentives and expenditures, with PIT being the dominant source of revenue. The high marginal rates led to tax avoidance, tax evasion, and economic inefficiency, with higher inflation caused by fiscal drag (Tanzi, 1987:3).

2.3.6 Tax reform lessons

An intensive scrutiny of the relevant literature shows that there does not seem to be a single optimal tax structure, because there are differing economic conditions, objectives, culture, and history. However, lessons can be learned by looking at reforms from the past, or by looking at other countries' tax reform experiences. In particular, the following issues can be identified in order to learn from the impact of tax reforms: 1) brain drain of taxpayers, 2) changes in revenue flows, 3) optimal non-taxable thresholds, 4) optimal tax rates, 5) the usefulness of flat rate taxes, and 6) taxes and health reform – all of which will be discussed in the next section.

2.3.6.1 *Brain drain of taxpayers*

As already pointed out, taxes could affect the economy in various ways. Excessively high taxes influence the size of savings: individuals prefer not to work overtime, and spending patterns are also influenced (Slemrod *et al.*, 2008:4).

Van Velthoven *et al.* (1991:65) observe that after 1970, Latin American economies experienced an increase in real interest rates, a decline in international credit supply, and a fall in international commodity prices. The high tax rates caused highly skilled taxpayers to leave the country, causing a fiscal and brain drain. Tax reform mostly involves simplifying the tax system by lowering the marginal tax rates and by broadening the tax base with fewer tax brackets. It also incorporates the reduction of exemptions and revenue-neutrality (revenue remains unchanged before and after a tax reform).

The International Monetary Fund (IMF) recommended simplifying tax systems by broadening the tax base and simplifying the administration of tax collection. Mexico adjusted the PIT taxable income bands with inflation, and decreased the marginal tax rates below those of OECD and Latin American countries (Sanchez, 2006:775).

Governments in Latin American countries were compelled to adjust their own tax systems to prevent the migration of tax capacity to other countries. The brain drain motivated most Latin American governments to respond to such tax reforms by lowering government expenditures and by implementing revenue-increasing policies. The recent wave of tax reforms is fortunately more simplified, more efficient, and more horizontally equitable (Sanchez, 2006:775).

It is therefore important for government to structure tax policy in such a way that a balance is achieved between taxes on higher income earners and increased social and health benefits. Countries imposing high marginal tax rates cause high income earners to emigrate to lower tax countries, causing the tax revenue base to decline and so creating a loss in economic growth (Bhagwati & Hamada, 1982; Mohapatra, Moreno-Dodson & Ratha, 2012:4).

2.3.6.2 *Improving revenue flows*

Reforming the tax system improves revenue flows and ensures a sufficient tax revenue base to strengthen the economy. The equitable redistribution of income ensures a fairer tax structure and a lower Gini-coefficient. Bird (2008:12) finds that good tax policy in developing countries could enhance revenue flows, but it requires a tax structure that minimises efficiency losses; therefore the tax base should be broadened together with lower marginal rates. The tax code should be simple, more cost effective, transparent, and fair. It should also be acknowledged that efforts to evade and avoid taxation lead to an erosion of the tax base over time (Foster, 2011:2).

2.3.6.3 *Non-taxable threshold and taxable income brackets*

From previous tax reforms it is evident that tax allowances and credits should be reduced, since they erode tax revenue and complicate the administration process. Lowering the tax burden for the poor could be an important goal for developing countries as they strive to reduce poverty levels.

Peter *et al.* (2010:457) point out that tax reform could relieve the burden on lower income individuals by using the GDP per capita as a benchmark for the non-taxable threshold. The authors used the GDP per capita to compare different countries' non-taxable thresholds and the top taxable income bands. They concluded that, in order to improve the equity of the tax system, the non-taxable threshold should be set equal to the GDP per capita amount, or twice the GDP per capita in the case of developing countries where tax administration is not efficient.

These findings are supported by Saunders (2007) and the World Bank (1991:2-6). Peter *et al.* (2010:457) state that the proxy for the highest taxable income band for high income, upper middle income, and low income countries is three, 18, and 83 times the GDP per capita, respectively. The authors also conclude that the average number of tax brackets for upper-middle income countries should remain at 4 to 6 brackets, making the tax systems simpler to understand and administer.

2.3.6.4 *Tax rates*

Peter *et al.* (2010, 456) calculate the highest marginal tax rates for high income, upper-middle income, and low-income countries for the period 2001 to 2005 at 39, 30, and 32 per cent, respectively. It is suggested that the highest marginal rate for PIT be set between 30 and 50 per cent, and the lowest rate between 10 and 20 per cent, with a few intermediate tax rates. The highest personal income marginal rate should be in line with companies' marginal tax rate to avoid tax arbitrage. If the highest PIT rate is lower than the company tax rate, companies will redistribute their profits to wages or give ownership of assets to individuals (Saunders, 2007; World Bank, 1991:2-6).

Alm *et al.* (2004:27) conclude that trends and developments in developing countries show that constant marginal tax rates lower tax shifting. Broader tax bases allow for lower marginal rates, and the effective collection of taxes is done by withholding taxes at the source. These actions are effective with a scheduler system (different sources of income taxed at different rates), and lower compliance and administration costs.

OECD countries have implemented lower marginal tax rates and a reduction in the number of income brackets over the past 30 years. The largest increase in the top marginal rate since 1987 has been in the United Kingdom (UK): from 40 to 50 per cent in 2010. It is interesting to note that the top marginal rate of 50 per cent is applied to a top taxable income band at 4.3 times the GDP per capita, whereas with the 40 per cent rate the top taxable income band is only 1.3 times the GDP per capita. Therefore it is important to compare countries not only according to their marginal rates, but also according to the taxable income bands and the number of tax brackets (OECD, 2012:32).

Gwartney (2008) also finds empirical evidence to conclude that marginal rates of more than 50 per cent have a negative impact on the economy over the long run. According to this research, a 10 per cent reduction in the highest marginal tax rate will increase economic growth by 0.3 per cent.

Hall & Rabushka (1995) propose a flat rate tax with a single rate imposed on all individuals earning an income. A flat rate tax should have tax free allowances to provide tax relief to the poor. The disposable income of individuals with a flat rate tax will be much higher, and will increase consumption patterns and stimulate economic growth. Therefore a flat rate tax appears to be simpler, fairer, and more efficient (Slemrod *et al.*, 2008:8).

2.3.6.5 *Taxes and health care reform*

In 2008, deductions and exclusions accounted for 83 per cent, and tax credits for 16 per cent, of major individual income tax expenditures in the US. The largest tax expenditure is the contribution to medical care. Medical provision contributions are excluded from the employee's gross income, and the employer may deduct the cost as a business expense. The second-largest deduction is to pension funds (Joint Committee on Taxation, 2006:3).

The cost of health care is a concern in most countries (Nuijten, Szende, Kosa, Mogyorosy, Kramberger, Nemecek, Tomek, Oreskovic & Laskowska, 2003:286). The Canadian Medical Expense Tax Credit is similar to a subsidy for out-of-pocket health expenditures, by reducing the after-tax price of expenditures. In the literature, the price elasticity of demand for health insurance is inelastic, and ranges between -0.2 and -0.7. In the year 2000, Canadians could claim 17 per cent of the amount above the threshold of either US$1 637 or 3 per cent of the individual's net income. A tax credit could not be more than the tax liability. The 17 per cent was equal to the marginal rate of the lowest income band, and was a benefit for low income earners (Smart & Stabile, 2003:4 & 8).

Slemrod *et al.* (2008:222) state that medical insurance faces some market failures. Medical insurance companies base their premiums on the average individual risk level (even though some people are healthier than others), causing a problem of adverse selection. A tax deduction for large out-of-pocket medical expenses (more than 7.5 per cent of taxable income) causes a moral hazard: people consume extra medical costs to benefit from a lower taxable income. Another moral hazard is that low income earners receive free care from public hospitals, and so do not take out medical insurance. Medical deductions improve horizontal equity, but for higher income earners with larger out-of-pocket expenses, the tax liability is lower. An important objective for governments is to help low income earners to afford medical aid. A deduction for medical expenses is not applicable to those who are not liable for paying taxes, and is more a benefit to individuals with high marginal tax rates. Therefore, implementing a tax credit with a cap is a tax reform policy to assist low income earners to afford medical insurance. The cap ensures that people do not overspend or buy insurance that is too expensive. A medical credit system is more efficient, but would need to be carefully designed (Helms, 2005:7).

2.3.7 Main insight and concluding remarks

Tax reform involves changes to tax rates, income bands, and a more equal distribution of income. The optimal structure differs from country to country; and by looking at other countries, especially upper-middle income countries, valuable lessons can be learned. Tax reform is therefore important to prevent a brain drain of highly-skilled income earners, and should be carefully planned to accommodate all income earners within a fair and efficient tax system.

A tax system should also be kept simple to eliminate tax evasion and tax avoidance. To explore the possibility of simplifying the tax system and lowering the incentive of tax evasion, it is important to consider lower marginal tax rates, a broadening of the tax base, and fewer deductions. Recently, countries such as Hungary and Paraguay have implemented a flat rate tax system for PIT. However, it is also known that a flat rate tax on PIT can be regressive, and therefore such a policy should be supported by changes in allowances for lower income earners. Other tax reforms include changes in the health system to provide relief to the poor so that they can afford medical services.

The following section analyses the structure of tax systems in other countries, focussing on marginal tax rates, threshold levels, and income bands, and the importance of PIT as a revenue source.

2.4 COMPARATIVE OVERVIEW OF TAX STRUCTURES AND TAX REFORM IN A SELECTION OF OTHER COUNTRIES

This section analyses the PIT revenue base and the PIT/GDP ratios of a number of selected countries. The focus is on the minimum and maximum marginal tax ratios and on the GDP per capita, which are used in the literature to determine the non-taxable threshold and the top income band in a tax system.

The total tax revenue base is mainly sourced from direct taxes such as PIT, corporate income tax (CIT), social security, and indirect taxes on goods and services such as VAT. Developing countries concentrate more on indirect taxes, because the direct taxes have a broader tax base but with a higher administrative cost; whereas developed countries tend to prefer direct taxes as a primary source of income. Alm *et al.* (2004:7) conclude, on the basis of evidence from developed countries (United States, Europe, etc.), that individual income tax is more important there than in developing countries (Africa, Asia, and the Middle East), which prefer to tax goods and services, trade income, and company revenue.

2.4.1 Minimum and maximum tax rates, and PIT to GDP tax rates

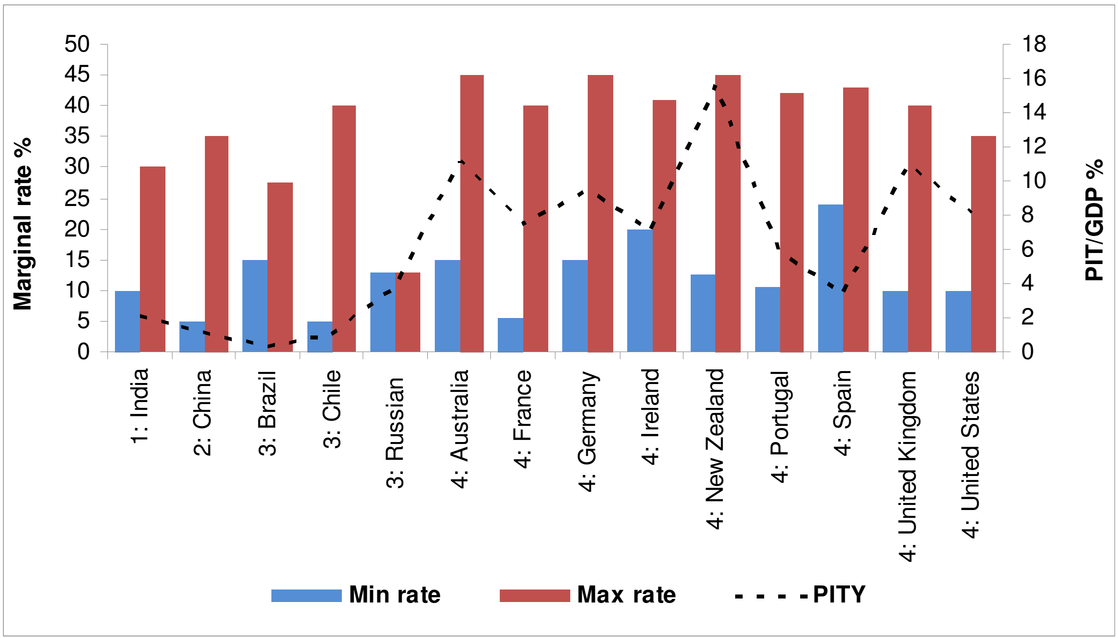
Peter *et al.* (2010:469) explain that PIT is the product of the tax rate and taxable income; therefore the trend of tax revenue will be the proxy for taxable income. The PIT/GDP ratio indicates the tax burden of a country. If the ratio declines with an increase in the marginal tax rates, it indicates tax evasion.

Figures 1 and 2 illustrate the PIT/GDP ratio and the maximum and minimum marginal tax rates for 14 countries[1] in 2008/2009 and 2010/2011. China's maximum tax rate increased from 35 to 45 per cent, and the PIT/GDP ratio decreased from 1.2 to 0.7 per cent, indicating potential tax evasion and avoidance of the higher marginal tax rate.

New Zealand's total PIT/GDP ratio was the highest at 13 per cent in 2008/2009 and 2010/2011, while the maximum marginal tax rate declined from 45 to 33 per cent. The other countries' maximum marginal tax rates were unchanged from 2008/2009 to 2010/2011. In Brazil, the minimum tax rate decreased from 15 to 7.5 per cent, with an increasing PIT/GDP ratio from 0.2 to 2.1 per cent.

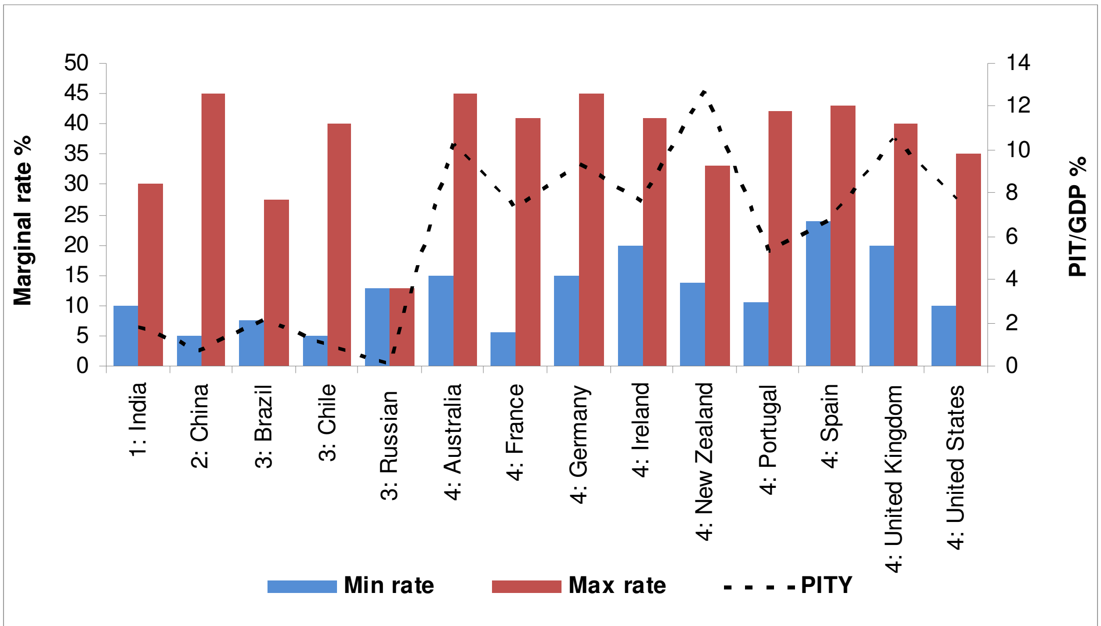
[1] 1: Low income country; 2: Lower-middle income country; 3: Upper-middle income country; 4: High income country.

Figure 1: Minimum and maximum marginal rates and PIT/GDP ratios, 2008/2009



Source: USAID (2009)

Figure 2: Minimum and maximum marginal rates and PIT to GDP ratios, 2010/2011



Source: USAID (2011)

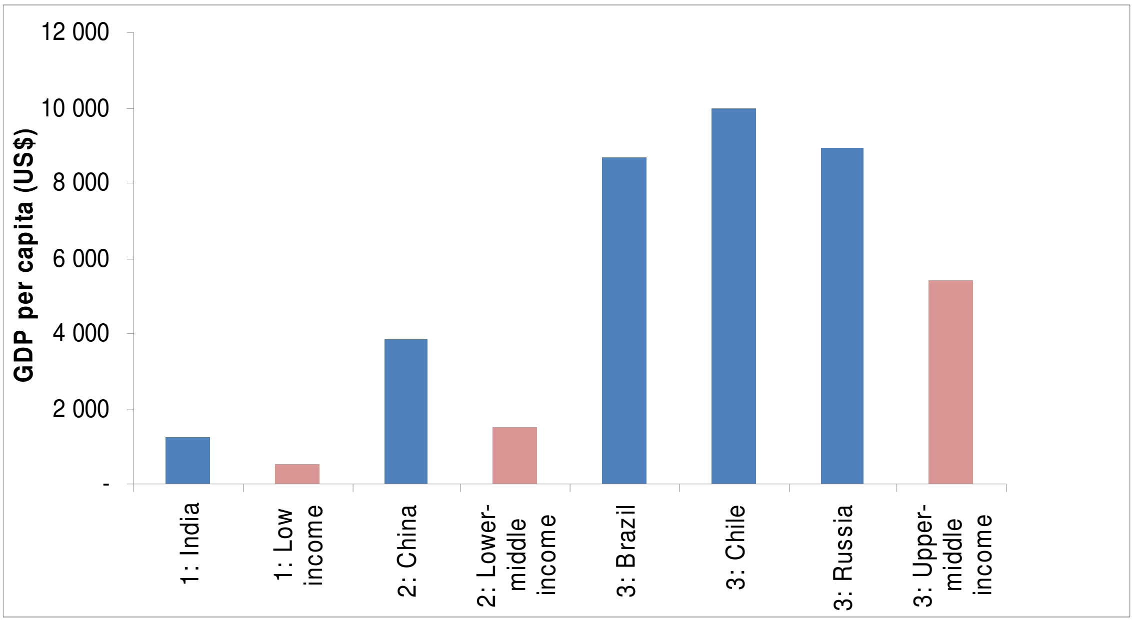
In China, Australia, and Germany, the maximum marginal rate was 45 per cent, while a minimum marginal tax rate of 5 per cent was recorded in China and Chile. Russia had a flat personal income tax rate of 13 per cent. On average, the minimum marginal tax rate for upper-middle income countries was 12 per cent, while the average maximum rate was

26 per cent. The maximum marginal rate in Brazil was in line with the average marginal rate of upper-middle countries, but Chile's maximum marginal rate was much higher than the average. A substantial difference in the PIT/GDP ratios between higher and lower income countries is evident. In lower and upper-middle income countries, the ratio is less than 4 per cent, indicating that PIT is a less important source of income. In high income countries, the ratio is more than 4 per cent (United States Agency for International Development [USAID], 2011).

2.4.2 <u>Non-taxable thresholds and GDP per capita</u>

The previous section explains a rule of thumb for determining the non-taxable threshold. It seems that it should be equal to the GDP/capita, or twice the GDP/capita in the case of developing countries. A non-taxable threshold greater than GDP/capita increases progressivity, and should be considered with care (Saunders, 2007; World Bank 1991:2-6).

Figure 3: GDP/capita for lower- and upper-middle income countries, 2009/2010



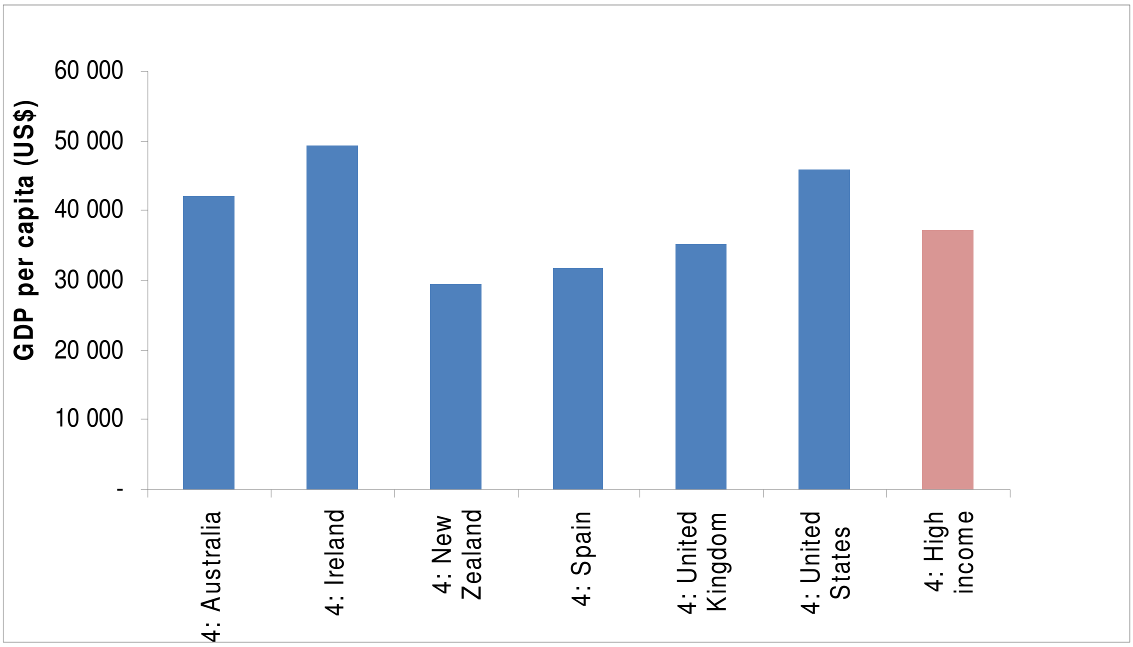
<u>Source</u>: World Bank (2010)

Figure 3 illustrates the actual GDP/capita values for lower and upper-middle income economies for the 2009/2010 fiscal year. For upper-middle income countries, the average GDP/capita is US$5 390. Chile, an upper-middle income country, has the highest

GDP/capita of almost US$10 000. If the GDP/capita is set to equal the non-taxable threshold, the Brazilian and Chilean tax systems seem to be more progressive than in other countries.

Figure 4 illustrates the GDP/capita for high income economies for the 2009/2010 financial year. The average GDP/capita for these countries is US$37 171, which is much higher than in developing countries.

Figure 4: GDP/capita for high income countries, 2009/2010



Source: World Bank (2010)

Table 2 shows the indicator (expressed as a multiple of GDP/capita) for the non-taxable threshold (PITMINL), as well as for the highest income group where the top marginal tax rate is applied (PITMAXL). For upper-middle income economies, the lowest and highest indicators are 1.30 and 3.91, respectively. On average, the highest indicator is lower than expected, because it includes upper-middle income countries with a flat tax rate (with no or very small thresholds) (USAID, 2010).

Table 2: Lowest and highest level of income indicators for 2009/10

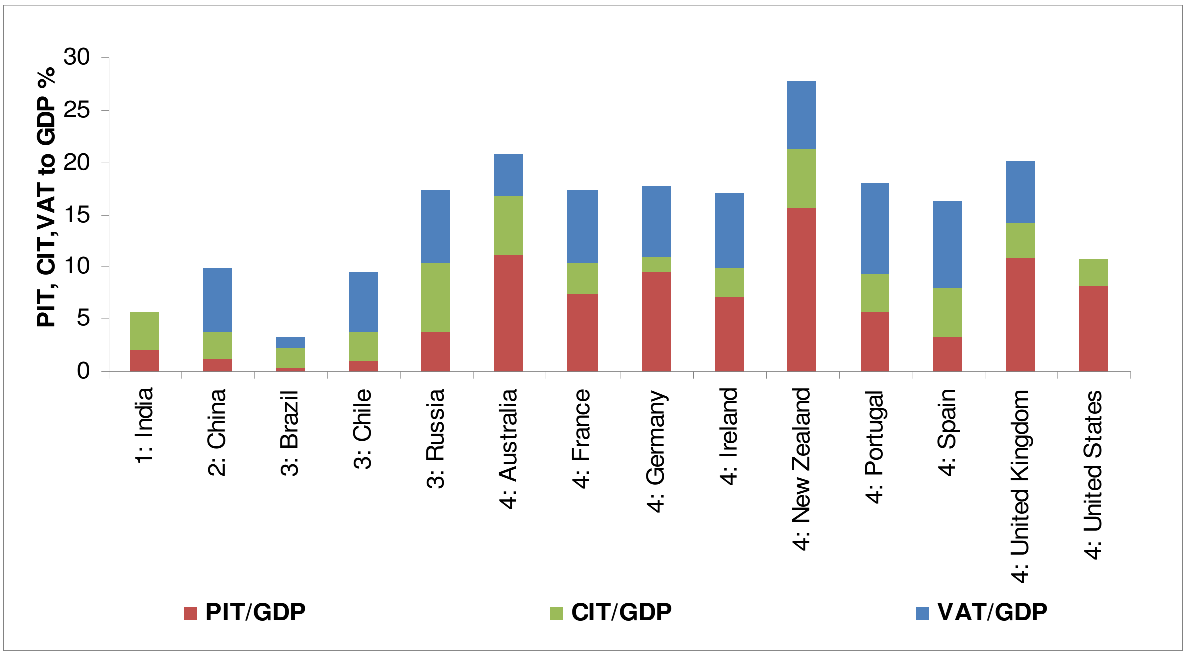
Country	PITMAXL	PITMINL
1: India	5.65	2.48
2: China	52.99	0.27
3: Brazil	3.28	1.31
3: Chile	12.08	1.09
3: Russia	0.02	0.02
4: Australia	3.29	0.11
4: Ireland	1.51	0.54
4: New Zealand	1.66	0
4: Spain	2.45	0.22
4: United Kingdom	1.81	0.27
4: United States	7.99	0.18
1: Low-income economies	21.98	2.66
2: Lower-middle income economies	9.45	1.17
3: Upper-middle income economies	3.91	1.30
4: High income economies	3.05	0.30

Source: USAID (2010)

Figure 5 and Figure 6 illustrate the PIT, CIT, and VAT to GDP ratios for low, lower-middle, upper-middle, and high income countries[2]. In most of the high income countries, PIT is the main source of income. In the upper-middle income countries, revenues are mainly derived from VAT. The PIT ratio increased significantly in Chile and Brazil, and decreased in Russia from 2008/2009 to 2010/2011.

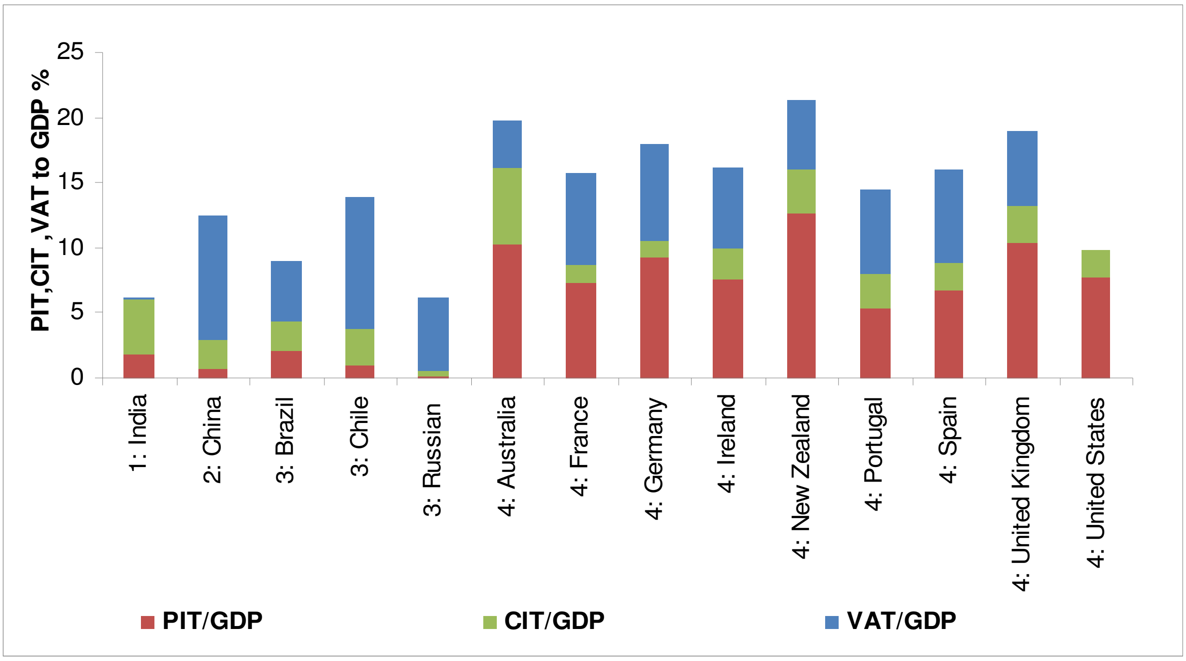
[2] 1: Low income country; 2: Lower-middle income country; 3: Upper-middle income country; 4: High income country

Figure 5: Tax mix to GDP, 2008/2009



Source: USAID (2011)

Figure 6: Tax mix to GDP, 2010/2011



Source: USAID (2011)

2.4.3 Main insight and concluding remarks

Looking at the total tax revenue base, upper-middle income countries' tax bases are mainly sourced from VAT, and high income countries' from PIT. For upper-middle income countries, the average GDP/capita is US$5 390, with a non-taxable threshold and upper band margin of 1.3 and 3.91 times the GDP/capita. Upper-middle income countries' average minimum and maximum tax rates are 12 and 26 per cent, respectively. The PIT/GDP ratio for upper-middle income countries is less than 4 per cent, and therefore a less important source of tax revenue for government. If the marginal rates increase and the PIT/GDP ratio declines, it indicates possible tax evasion and avoidance.

2.5 CONCLUSION

This chapter starts with an overview of the definitional issues related to individual income tax and tax reform. There is no single optimal tax structure because of differing economic conditions, objectives, culture, and history. Tax reform should be equitable, efficient, simple, cost effective, neutral, and transparent. Tax reform lessons can be learned by looking at reforms from the past, or by looking at other countries' tax reform experiences.

Evidence from different countries shows a significant shift towards simpler income tax structures and lower tax burdens, especially at the top end of the income distribution. Over the past 30 years, governments have been moving away from complex tax systems featuring multiple tax brackets and high marginal tax rates. It is apparent that developing countries reform their tax systems towards a greater emphasis on higher indirect taxes and, at the same time, lower PIT marginal rates. More countries have attempted to experiment with flat tax rates in order to simplify complicated tax systems.

Gross income mainly consists of wages and salaries. Allowances and deductions are tax expenditures that decrease gross income to give taxable income. Tax liability is then calculated on taxable income. Tax reform involves changes to tax rates and income bands, and a more equal distribution of income. Valuable tax reform lessons can be learned from upper-middle income countries. A tax reform should accommodate all income earners to ensure a fair and efficient tax system. Other tax reforms include changes in the health system to provide relief to the poor, enabling them to afford medical services.

The PIT/GDP ratio for upper-middle income countries is less than 4 per cent; therefore PIT is a less important source of tax revenue for those governments. The average GDP/capita for upper-middle income countries (US$5 390) is used to determine the non-taxable threshold and band margins. For upper-middle income countries, the non-taxable threshold and upper taxable income band is 1.3 and 3.91 times the GDP/capita, respectively. Upper-middle income countries' average minimum and maximum tax rates are 12 and 26 per cent, respectively.

Table 3 summarises some tax reforms that are discussed in the previous sections, and that could be relevant to South Africa.

Table 3: Summary of tax reforms that could be relevant to South Africa

Main tax reforms	Reason
1. Best practice in upper-middle income countries seems to be a lowest marginal rate of between 10 and 20 per cent, with the highest marginal tax rate between 30 and 50 per cent and the average marginal rate at 30 per cent.	Lower rates ensure that taxpayers have little incentive to under-report income and are more willing to save, work, and invest.
2. The number of tax brackets should remain between 4 and 6.	Too many brackets complicate the tax system and accelerate the effect of bracket creep.
3. The non-taxable threshold for upper-middle income countries should equal the GDP/capita, with the highest income band at 18 times GDP/capita.	GDP/capita is used as a benchmark to assess tax capacity; income bands also play an important role in the progressiveness of the tax structure.
4. International tax reforms show a strong emphasis on the revision of tax expenditures, of which health care and retirement benefits are the most important.	To assist lower income individuals to afford medical insurance, a medical tax credit is preferred over a deduction; but it is important to design the tax credit carefully.

Taking cognisance of tax reform lessons learned from other countries the next chapter outlines the structure of, and changes to, the South African tax system over a period of more than four decades. At the end of the chapter, a list is compiled of tax reforms that could be further exploited in order to improve the current tax structures, considering fairness, efficiency, and the optimisation of revenue and economic growth.

CHAPTER 3

TAX STRUCTURES IN SOUTH AFRICA

3.1 INTRODUCTION

This chapter focuses mainly on the tax structure and history of tax reform in South Africa, with comparisons from the literature overview of international best practice in the previous chapter. The objective is to identify weak elements in the current tax structure, especially from an excess burden point of view, that could be investigated through the use of the MS tax model.

3.2 HISTORICAL OVERVIEW OF INCOME TAX PRACTICES IN SOUTH AFRICA

The South African fiscal stance has gone through different changes, with the most prominent being the recommendations made by the three main commissions: the Franzsen Commission (1970), the Margo Commission (1987), and the Katz Commission (1994). The main objectives of all three commissions were to reduce income tax ratios and to shift the tax burden more towards expenditure taxes, expecting the shift to increase productivity and social welfare and, therefore, economic growth as well.

The Franzsen Commission pointed out that by the late 1960s, only 8 per cent of the population was paying income taxes, with only about 6 per cent responsible for two-thirds of total tax revenue. The Commission recommended a reduction in the progressiveness of taxes on individuals, and the top marginal rate for individuals was reduced from 66 to 60 per cent. A capital gains tax of 20 per cent was recommended, but rejected by Parliament. In 1978, sales duties were replaced by a general sales tax (GST) of 4 per cent. GST was followed by the introduction of Regional Services Council levies in 1985 (Franzsen Commission, 1970).

The Margo Commission introduced some major tax reforms in 1987. At the time the South African tax system discriminated on the grounds of gender and marital status. Women did not register as separate taxpayers, as the income they earned was regarded as additional to the household income. This joint income was taxed at higher marginal rates. The Commission proposed that the tax base be broadened: lower tax rates and taxation on fringe benefits were implemented, and men and women were taxed separately. The Commission rejected a capital gains tax, suggesting a reduction in specific tax expenditures. VAT was introduced in 1991 to replace GST at a standard rate of 10 per cent, increasing to 14 per cent in 1993. Company tax was reduced with the introduction of a secondary tax on companies in 1993 (Margo Commission Report, 1987).

After the first democratic elections in 1994, social and political processes began to normalise in South Africa. A priority was to restructure government expenditure in favour of increased flows towards social services to address the backlog in social infrastructure that was especially evident in previously disadvantaged communities. The Katz Commission was appointed in 1994 to analyse the tax structure of South Africa, investigate the collection efficiency of the tax system, and make recommendations to reform the tax structure. The Commission avoided fundamental reforms such as replacing the direct tax system with an indirect tax system. After consulting international practices and tax structures, the Commission made several recommendations on reforming the tax system (First Interim Report, 1994).

The Commission recommended that an independent revenue authority, the South African Revenue Service (SARS), be established to deal with tax administration and to maintain a modern and effective tax system. SARS implemented a modernisation programme (Efiling), and tax administration improved significantly with on-time filing up from 58 to 81 per cent between 2008/2009 and 2010/2011 (Tax statistics, 2011:26). During 2010 SARS required all formally-employed individuals to register, thanks to improved tax administration. Previously only individuals above the threshold level were liable to register. USAID compares different tax administration systems using a tax administration cost coefficient. The coefficient is calculated by dividing the total cost of administration by the total revenue base. A low indicator indicates a more efficient system of collecting taxes. The tax administration cost indicator for South Africa in 2008/2009 was 0.98, and improved to 0.15 in 2010/2011. The average tax administration indicator for sub-Saharan and upper-middle income economies in 2010/2011 was 2.93 and 1.04, respectively (USAID, 2011).

The Commission also recommended raising the minimum tax threshold to exclude lower income earners from having to pay tax. The tax brackets and thresholds have been adjusted continuously to compensate for inflation. The Katz Commission supported a tax/revenue ratio of not more than 25 per cent of GDP. These recommendations enhanced the progressivity of PIT (Katz Commission, 1999:9).

Adjusting the PIT marginal rates and income bands is a powerful fiscal policy tool for government to provide tax relief. In 1993/1994 there were 10 income bands, and individuals were taxed at minimum marginal and maximum marginal rates of 17 and 43 per cent, respectively. In 1995/1996 the highest marginal rate increased to 45 per cent, and individuals were only differentiated as 'natural' or 'other than natural' persons. In 1997/1998 the lowest marginal rate increased to 19 per cent, and the income bands decreased to 7. The non-taxable threshold differentiated between individuals younger than 65 years and those older than 65 years. The child rebate was also removed. In 1998/1999, income tax bands were reduced to six, and marginal tax rates ranged between 19 and 45 per cent. In 2000/2001 the top marginal rate decreased to 42 per cent, and in 2001/2002 the rate decreased further to 40 per cent. The decrease in the top marginal rate also lowered the ratio of PIT to total tax revenue to 34 per cent. After 2000 South Africa switched from a residence base to a source base tax structure, meaning that individuals are now taxed on their global income (National Treasury, 2003).

In 1994 PIT as a ratio of GDP was 9 per cent, and it increased to 10 per cent from 1997 to 1999 because of higher marginal tax rates. After 2003 the top marginal rate decreased and the PIT/GDP ratio declined to 8 per cent (National Treasury, 2003). From 2002/2003 to the present, the marginal tax rates have remained unchanged at between 18 and 40 per cent. In 2010/2011 an additional non-taxable threshold for individuals above 75 years of age was introduced (National Treasury, 2011).

3.3 CONCEPTUAL ISSUES RELATED TO INDIVIDUAL INCOME TAX IN SOUTH AFRICA

This section provides an overview of the sources of individual income in South Africa, trends in the minimum and maximum marginal tax rates, the PIT/GDP ratio, a comparison of inflation and growth in taxable income, and the GDP/capita trend. South African trends are then compared to international trends and tax reform lessons, which were discussed in the previous chapter.

3.3.1 A profile of sources of household income

According to the South African tax system, spouses are taxed separately within the household. Individual income from different sources is aggregated to total income, and grants are excluded since they do not form part of taxable income and thus of the tax base. Table 4 indicates the income sources defined and used in the 2005/2006 IES for the South African population. Gross income, excluding imputed rent, is divided into five main groups; income from work, income from capital, pensions and annuities, social insurance and grants, and other income.

Gross income mainly represents income from employment (wages and salaries), along with self-employed income and business income, these being 71.3 and 10.8 per cent of the total gross income, respectively. About 1 per cent is income from capital; almost 3 per cent is income from pensions and annuities; almost 7 per cent is income from social insurance and grants; and a further 7 per cent is from other income.

Wages and salaries make up the principal source of income. Pension income in South Africa, according to survey data, amounts to 3 per cent, whereas in many of the other countries investigated it ranges between 11 and 20 per cent of total income. This can be due to a reporting problem, in that pensioners do not recall what they receive when supplying data during surveys, or simply the fact that a small percentage of retirees actually receive a pension, and that, if they do, the pension is very small.

Table 5 shows the sources of income of tax filers for the 2011 tax year from the SARS database. Wages and salaries comprise 68 per cent of total income. It is also clear that social grants do not contribute to the revenue base, since these income groups fall below the tax threshold.

Table 4: Sources of individual gross income

Source	R (billion)		%
Income from work:	690.8		82.1
Salaries and wages		599.9	
Self-employment and business income		90.9	
Income from capital:	10.8		1.3
Interest received		4.2	
Dividends		1.6	
Rent income		4.9	
Royalties		0.1	
Private pensions and annuities:	24.3		2.9
Pensions from previous employment		19.8	
Annuities from own investment		4.5	
Social insurance and grants:	56.8		6.8
Old age and war pensions		25.3	
Disability grants		10.4	
Family and other allowances		20	
UIF, Workmen's Compensation		1.1	
Other income:	58.3		6.9
Alimony, palimony and other allowances		11.1	
Other income from individuals		3.9	
Benefits, donations and gifts, and cash lobola		3.7	
Tax refunds received		1.7	
Other : Letting of fixed property, annuities, hobbies, gratuities, income from gambling		37.9	
Gross income (excluding imputed rent on owned dwelling)	841		100

Source: Stats SA (2008:9)

Table 5: Sources of individual taxpayers' income

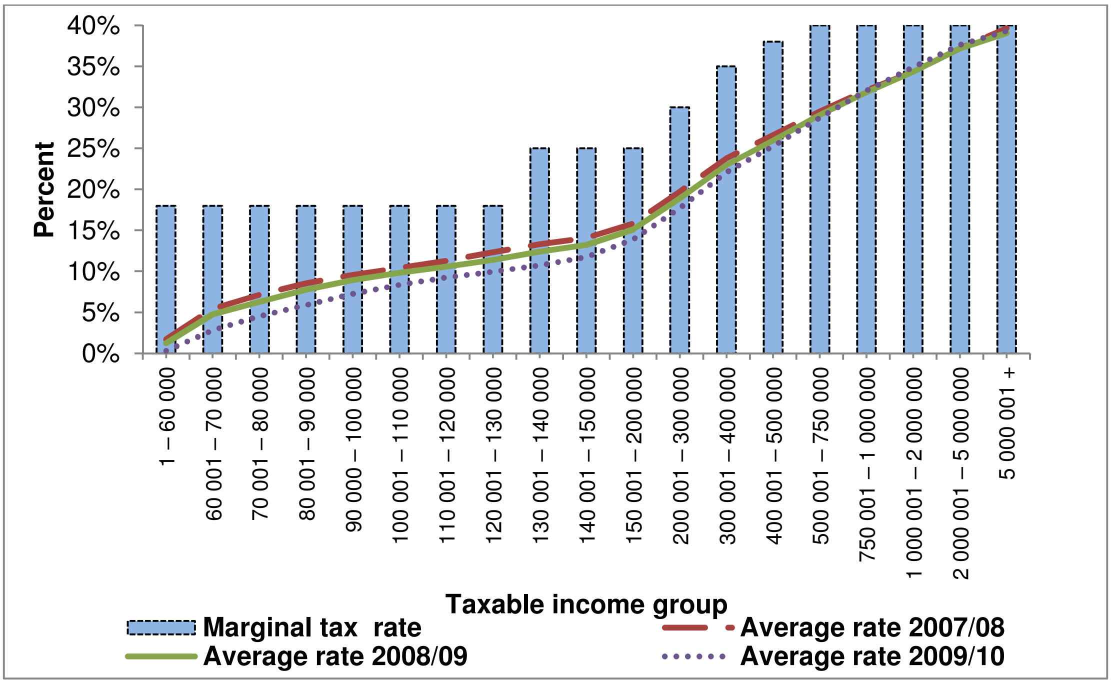
Code	Source of income	%	Taxable income (R million)
3601	Income (salaries, wages, remuneration)	67.5	432 813
3605	Annual payment	0.9	69 989
4201	Local interest	3.0	19 036
3607	Overtime	3.5	22 150
3615	Director's income	5.1	32 824
3606	Commission	3.6	22 975
3603	Pension income	3.1	20 083
	All other sources of income	3.3	21 142
Total		100	641 012

Source: Tax Statistics (2012:50)

3.3.2 A profile of tax rate changes

As stated earlier, South Africa's minimum and maximum marginal tax rates have been fixed at 18 and 40 per cent, respectively since 2002/2003. Figure 7 illustrates the progressiveness of the South African tax system by comparing the average and marginal tax rates per income group for income tax filers from 2007/2008 to those of 2009/2010. In 2009/2010 the non-taxable threshold increased to R54 200 for those individuals younger than 65 years of age. The average tax rates for individuals with a taxable income less than R750 000 decreased from 2007/2008 to 2009/2010 because of increased tax relief and a broader tax base. PIT as a percentage of taxable income for the three tax years is around 21 per cent.

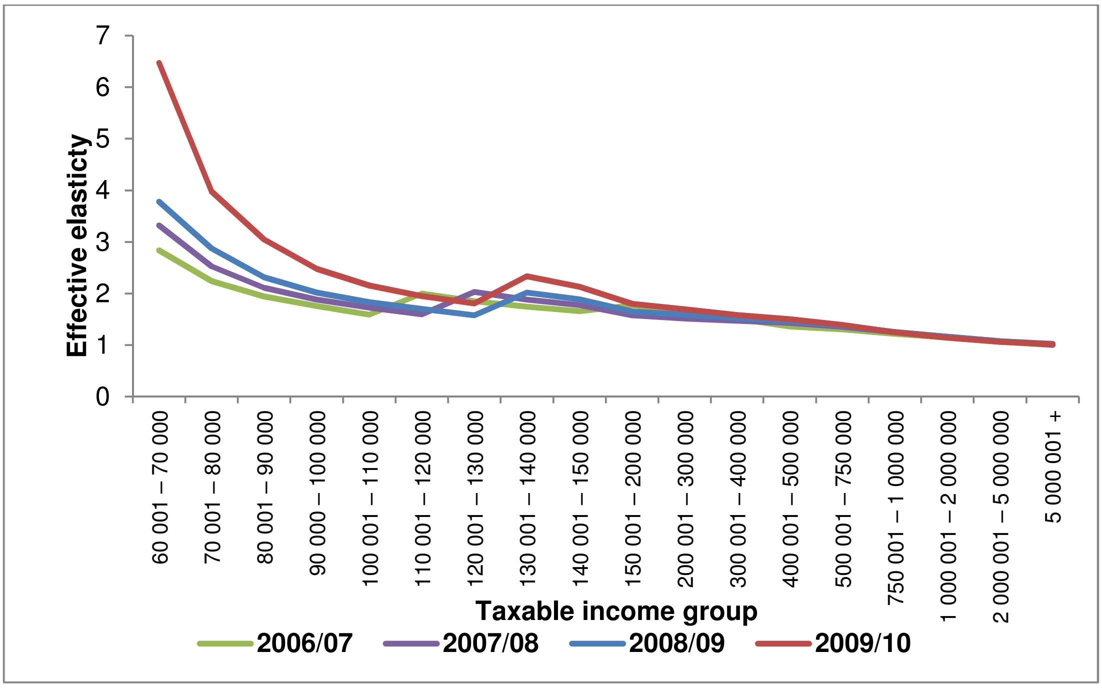
Figure 7: Marginal and average tax rates per income group



Source: Tax Statistics (2011)

Figure 8 shows the effective elasticity (marginal tax rate/average tax rate) from 2006/2007 to 2009/2010. This ratio is higher (average rate is less than marginal tax rate) in the lower income groups because these individuals receive more tax relief. In 2009/2010 the elasticity is much higher in the lower income groups, indicating more tax relief than in the previous years. Also, in 2009/2010 elasticity increased in the case of income groups within the R130 000 to R200 000 categories, and this group enjoyed an increase in the amount of tax relief compared to previous years. During this period, unitary elasticity was the feature of higher income groups.

Figure 8: Effective elasticity



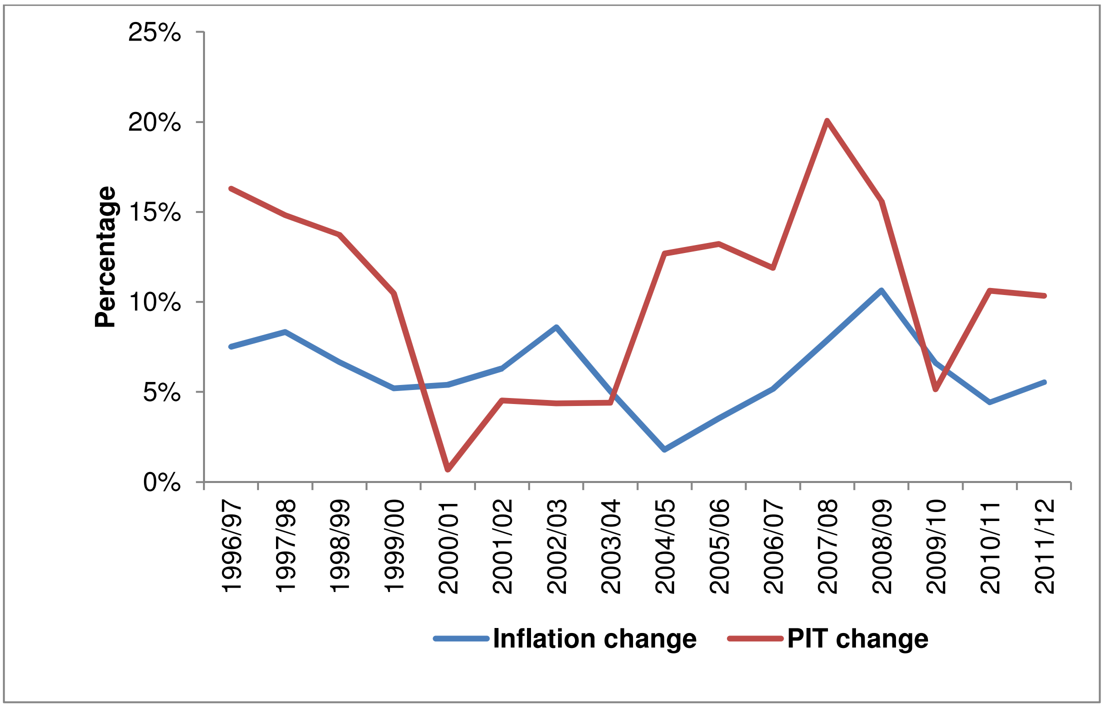
Source: Tax Statistics (2011)

The South African tax system appears to be extremely progressive, with a relatively high top marginal rate. Thus it does not seem viable to increase these marginal rates further; rather, the revenue base should be expanded to include more taxpayers in the tax net. It might also be worthwhile investigating the possible impact of such a progressive tax structure on tax behaviour in the form of evasion and avoidance.

3.3.3 Inflation and personal income tax growth

Figure 9 shows the percentage change in inflation and PIT for the period 1997 to 2012. From 1997 to 2001, 2005 to 2009, and after 2010, PIT and taxable income growth exceeded the inflation rate. Thus individuals receiving inflation-adjusted wages now pay lower taxes, due to relief as a result of the tax brackets also being adjusted for inflation.

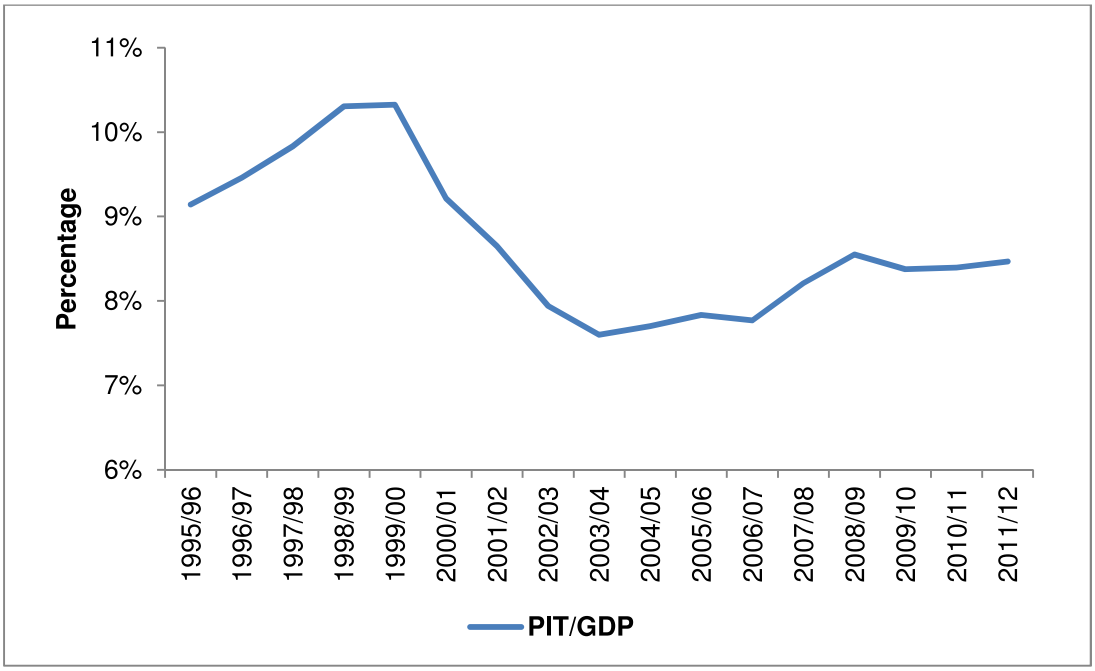
Figure 9: Inflation and PIT



Source: SARB (various sources)

3.3.4 Tax revenue/GDP ratio

Figure 10: PIT/GDP ratio



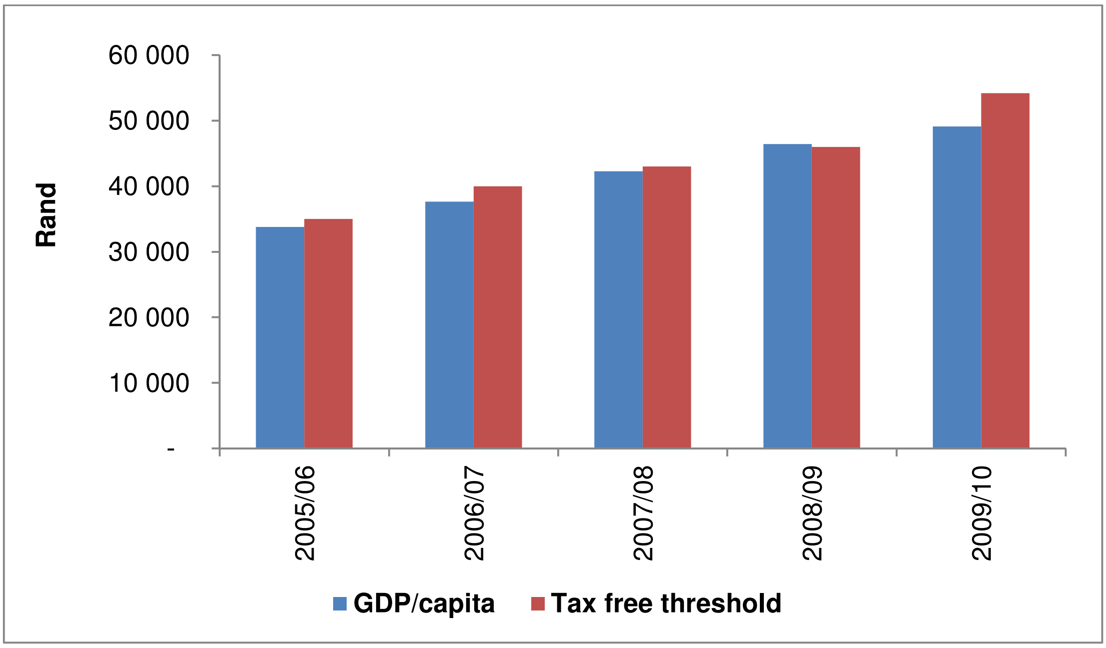
Source: National Treasury (2012) and SARB (various sources)

Figure 10 shows that South Africa's PIT/GDP ratio had been hovering between 7 and 11 per cent from 1995/1996 to 2011/2012. After the reduction in the top marginal tax rate to 40 per cent in 2003, the ratio declined to around 8 per cent.

3.3.5 Threshold and GDP per capita

From the previous chapter, the GDP/capita is used as a benchmark to determine the non-taxable threshold level. Figure 11 illustrates the GDP/capita and non-taxable threshold levels from 2005/2006 to 2009/2010. Through all these years the difference has been small, except for 2009/2010 when it reached about 10 per cent. The tax system is therefore more progressive, and includes more individuals in the revenue base.

Figure 11: GDP/capita and the non-taxable threshold

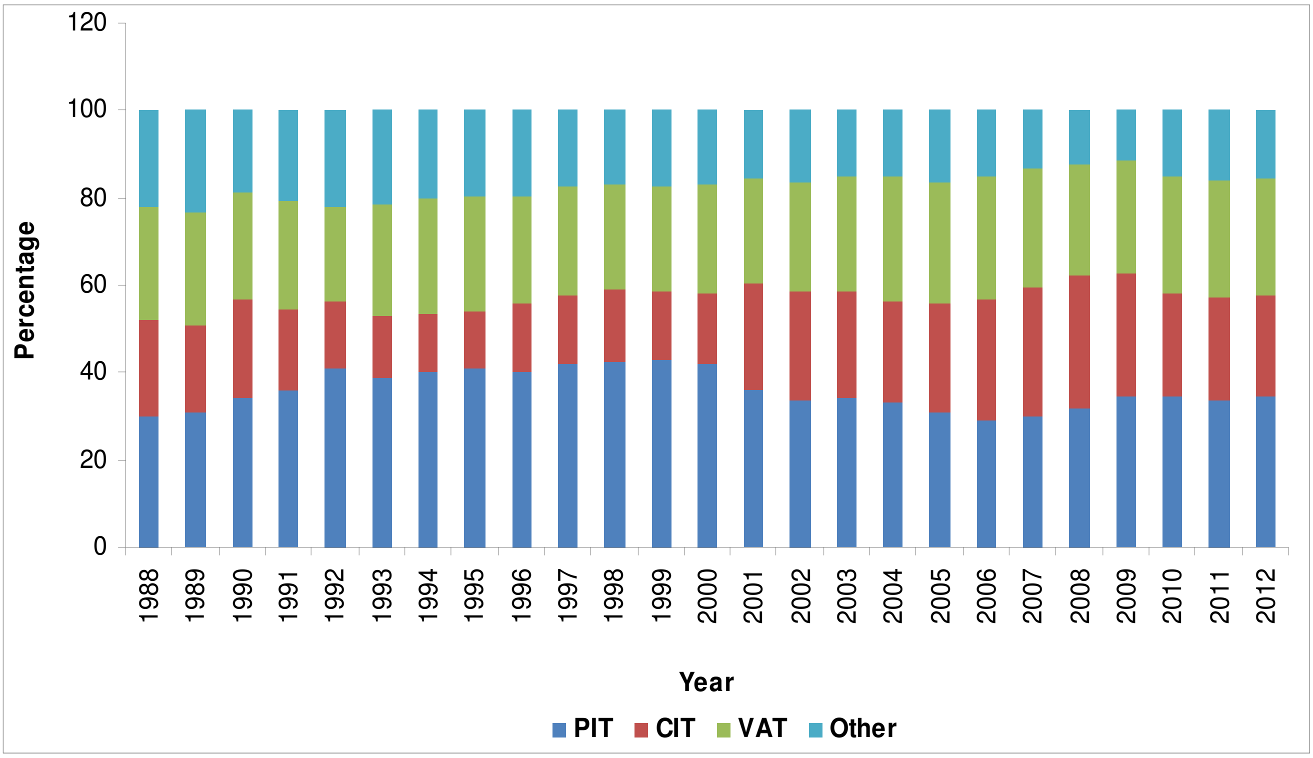


Source: National Treasury (2012) and SARB (various sources)

3.3.6 PIT as a major source of tax revenue

Figure 12 illustrates the relative importance of PIT as a major source of tax revenue for South Africa in the period from 1988 to 2011.

Figure 12: Tax mix of South Africa



Source: SARB (various sources)

In 1988 PIT accounted for 30 per cent of total revenue, increasing to 40 per cent in 1994 as a result of the increase in the number of individuals formally excluded from being taxed under the previous political regime. The individual income tax share decreased after 2000, and in 2001 the ratio was 34 per cent of total tax revenue. The lower ratio is because of lower marginal tax rates and the broadening of the tax base.

3.3.7 Leakages from the revenue base due to tax expenditures

As explained in the previous chapter, tax expenditures mainly consist of indirect government expenditures and tax provisions that reduce the tax revenue base. In Table 6 the PIT tax expenditures are identified, and using the 'revenue forgone' method, the amount of revenue that would have been collected in the absence of the tax expenditure is calculated.

The behavioural response of taxpayers remains unchanged. A comparison of the ratio of tax expenditures to total PIT shows that it declined from 19.2 per cent in 2005/2006 to 15 per cent in 2008/2009, indicating the broadening of the taxable income base of individuals with fewer deductions and allowances. The contribution of pension and medical deductions to expenditure taxes accounts for the dominant share in all four years. Since 2006, medical tax credits have been implemented gradually to replace medical deductions. The shift can clearly be seen in medical tax expenditures, declining from 44 per cent to 23 per cent of the total tax expenditures.

Table 6: Tax expenditures of South Africa

Tax expenditures	**2006 (R million)**	**%**	**2007 (R million)**	**%**	**2008 (R million)**	**%**	**2009 (R million)**	**%**
Pension and retirement annuity	12 722	53	13 538	47	15 464	63	18 349	63
Medical	9 155	38	12 841	44	5 753	23	6 742	23
Interest exemptions	1 290	5	1 715	6	2 283	9	3 033	10
Secondary rebate	739	3	739	3	769	3	828	3
Donations	141	1	178	1	230	1	282	1
Capital gains tax	74	0.3	98	0.3	121	0.5	69	0.2
Total PIT tax expenditures (a)	24 122	100	29 109	100	24 620	100	29 303	100
PIT Revenue (b)	125 645		140 578		168 774		195 115	
GDP	1 603 805		1 808 883		2 057 238		2 285 111	
PIT expenditures as % of PIT revenue (a)/(b)	19.2		20.7		14.6		15	
PIT expenditures as % of GDP	1.5		1.6		1.2		1.3	

Source: National Treasury (2011:18)

3.4 CONCLUSION

Taking cognisance of the lessons learned from other countries, the tax structure and tax reforms of South Africa are discussed. The South African tax system has gone through several tax reforms. Over the years income tax bands have decreased from 10 to 6. In the 1960s the top marginal tax rate was 66 per cent; in 1998/1999 the minimum and maximum tax rates declined to 19 and 45 per cent, respectively. In 2002/2003 the minimum and maximum marginal tax rate further declined to 18 and 40 per cent, respectively. It is also important to bear in mind that South Africa's PIT revenue originates from only 7 per cent[3]

[3] 3.5 million assessed taxpayers/midyear population 49.3 million in 2009 (Tax Statistics 2011 and Stats SA 2010).

of the population, while only 11 per cent[4] of the population are liable to submit a tax return. In 2009 almost 46 per cent of total taxes were paid by 6 per cent of the total number of taxpayers – those earning more than R500 000 per annum.

Since 2003 the PIT/GDP ratio of South Africa has been hovering around 8 per cent, which indicates the importance of PIT revenue as a major source of income. For other upper-middle income countries this ratio is, on average, below 4 per cent. If marginal tax rates increase and the PIT/GDP ratio declines, this is an indication of tax evasion and avoidance. After 1999/2000 this ratio showed a declining trend, with top marginal tax rates decreasing. From international evidence it seems that high marginal rates in the top income band lead to the emigration of taxpayers and a resultant loss to the revenue pool.

Tax reforms in other upper-middle income countries mainly take the form of adjustments for inflation to avoid bracket creep. This practice is also evident in South Africa, where taxable income bands and threshold levels are indexed for inflation every fiscal year. The inflation and PIT growth data shows that individuals receive tax relief almost constantly as a result of inflation-adjusted taxable income bands.

Medical, pension, and retirement annuity deductions are the largest leakages from the revenue base. In South Africa, medical deductions are in the process of being converted to a medical tax credit, which should reduce the leakage from the revenue base. Medical tax credits are also preferred, as they assist low income individuals to afford medical insurance.

Table 7 summarises the main tax reform lessons learned from other countries, as well as the policy scenarios to be tested in Chapter 6. The next chapter explains the methodology used to estimate the impact of changes in tax reform, such as changing the progressivity of the tax schedule and improving tax efficiency while also monitoring optimum revenue and economic growth.

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[4] 5.2 million registered taxpayers/midyear population 49.3 million in 2009 (Tax Statistics 2011 and Stats SA 2010).

Table 7: Summary of main tax reforms and policy scenarios

	Main tax reforms	Selection criteria
1.	Best practice in upper-middle income countries seems to be a lowest marginal rate between 10 and 20 per cent, and the highest marginal tax rate between 30 and 50 per cent, with the average marginal rate at 30 per cent.	South African marginal rates have declined over the years, but have been fixed between 18 and 40 per cent since 2003. These ratios are higher than in other upper-middle income countries.
2.	The non-taxable threshold for upper-middle income countries should be equal to the GDP/capita, with the highest income band 18 times GDP/capita.	There is no benchmark in South Africa to determine the threshold and income band level. The threshold and income bands do not conform to international best practice.
3.	Inflation causes tax bracket creep and the erosion of the PIT taxable income bands; therefore the tax structure should be adjusted accordingly.	The Katz Commission recommended that the income brackets and threshold be adjusted to compensate for inflation. The data shows that taxable income has been adjusted by more than inflation in most years, which is better than international best practice.
4.	International tax reforms show a strong emphasis on the revision of tax expenditures, of which health care and retirement benefits are the most important.	The South African government has introduced medical tax credits instead of medical deductions. This is recommended by international countries since it provides more tax relief to lower income earners. There is a need to quantify the revenue lost between medical deductions and medical credits though.
5.	The number of tax brackets should remain between 4 and 6.	From 1998/1999 to date, the income tax brackets have remained at 6, thus conforming to international best practice.

CHAPTER 4

MEASURING THE OUTCOMES OF TAX REFORM

4.1 INTRODUCTION

This chapter begins with an explanation of the methodology for determining tax efficiency, since efficiency also serves as one of the determining factors in estimating the impact of tax reform measures. It is known from the literature overview that taxes impact on the economy in various ways. For example, changes in marginal rates, allowances, and thresholds affect disposable income. This in turn affects the performance of the economy, which then impacts on the revenue base again. It is vitally important, therefore, to know the level of sensitivity between taxes and changes in the revenue base. Such sensitivity can be measured by quantifying relevant elasticities by means of simple ordinary least square regression (OLS), or through the process of differentiation using only changes in successive time periods.

This is followed by a discussion of specific elasticities that measure the sensitivity of economic growth and revenue flows to changes in marginal tax rates, tax thresholds, and tax liability, by changing the level of deductible allowances. The elasticity coefficients are used in the MS tax model (Chapter 6) to explain the impact of suggested tax reforms in South Africa. The relevant elasticities are also used to explain the impact of tax reform on tax efficiency, by measuring the changes in deadweight loss that accompany such tax reforms.

4.2 DEFINITION OF TAX ELASTICITY

Jenkins, Kuo & Shukla (2000:35) explain that a clear distinction should be made between tax buoyancy and tax elasticity. Tax buoyancy measures the aggregate changes in tax revenues due to changes in the tax base; thus it measures the change in revenue as a result not only of changes in taxes, but also of other relevant changes such as the characteristics of the taxpaying population, tax bands, allowances, deductions, etc.

Tax buoyancy therefore takes the following form:

$$\varepsilon_{T,TB} = (\%\Delta T)/(\%\Delta TB).TB/T \qquad (1)$$

where:

$\varepsilon_{T,TB}$ = buoyancy of tax revenue to the tax base

$\%\Delta T$ = change in tax revenue

T = tax revenue

TB = tax base

$\%\Delta TB$ = change in tax base

Tax elasticity, on the other hand, is the ratio of the percentage change in tax revenue to a percentage change in the tax base, assuming that nothing else has affected the tax base. Tax elasticity is therefore often used to illustrate the dynamics of the tax structure such as policy simulations and revenue forecasting (Jenkins *et al.*, 2000:39). In this analysis tax elasticity is also used to derive optimal revenue- and growth-maximising tax ratios. In the next section the concept tax elasticity is further refined to more specific forms of tax elasticity.

Tax elasticity takes the following form:

$$\varepsilon_{T,TB} = (\%\Delta T)/(\%\Delta TB) \qquad (2)$$

where:

$\varepsilon_{T,TB}$ = elasticity of tax revenue to the tax base

$\%\Delta T$ = change in tax revenue

$\%\Delta TB$ = change in tax base (taxable income/GDP)

Elasticities greater than one indicate an elastic tax system: tax revenue changes exceed changes in the tax base (taxable income or GDP in this analysis). If the elasticity is less than one, the tax system is inelastic, and revenue changes less than changes in the tax base. Such a scenario enhances the impact on revenue of more stringent policy changes to the tax base (Fonseca & Ventosa-Santaulària, 2011:89).

4.3 DIFFERENT TAX ELASTICITIES

This section discusses the different tax elasticities used in this study, including gross tax liability/GDP elasticity (also adjusted for changes in the output gap), revenue/tax base elasticity (adjusted for tax allowances and deductions) and taxable income elasticity with respect to net-of-tax rate.

4.3.1 Personal Income Tax elasticity

As indicated, tax liability can be derived by applying the tax structure to the tax base (income) but since data on income (obtained from surveys) may not be available and sometimes also not very reliable, the broadest form of income namely GDP is often used to represent changes in the tax base. The elasticity of personal income tax (tax) with respect to the GDP ($\varepsilon_{t,GDP}$) consists of the multiplied sum of two different coefficients (Girouard & André, 2005:7).

First, the elasticity ($\varepsilon_{t,tby}$) of PIT (tax) to taxable income (tby) is estimated. If the elasticity of tax liability is greater than unity, the tax system is progressive (marginal tax rates increase with taxable income). Thus, tax liability is positively correlated with taxable income. The function used to estimate PIT is expressed in logarithmic form:

$$\mathrm{ltax} = \mathrm{f}(\overset{+}{\mathrm{ltby}}) \tag{3}$$

Second, the elasticity ($\varepsilon_{tby,GDP}$) of taxable income (tby) to GDP has to be determined. Due to cyclical changes in the GDP (tax base), this elasticity coefficient can be further refined also to account for structural changes as reflected in the output gap. Since taxable income is positively correlated with GDP, the function to estimate taxable income takes the logarithmic form:

$$\mathrm{ltby} = \mathrm{f}(\overset{+}{\mathrm{lgdp}}) \tag{4}$$

Third, the elasticity of PIT to GDP is derived by multiplying the elasticity of tax liability to taxable income and the elasticity of taxable income to GDP.

$$\varepsilon_{t,GDP} = \varepsilon_{t,tby}\varepsilon_{tby,GDP} \tag{5}$$

Tax elasticities are normally constant over time, but the business cycle could impact on such elasticities due to changes in the output gap (less or excess income growth compared to trend) (Machado & Zuloeta, 2012:1). Bornhorst, Dobrescu, Fedelino, Gottschalk & Nakata (2011:9) state that, while the composition of revenue broadly remains constant, the share of income tax to total income tends to increase during an economic boom and to fall during a recession. The elasticities of PIT are affected by tax policy changes, influencing the cyclical sensitivity of fiscal variables. Van den Noord (2000:4) supports the view that the cyclical sensitivity of the fiscal position is mostly determined by the size of government. The higher the government expenditure ratio to GDP, the more sensitive the fiscal position is to changes in the economy. Taxes fluctuate with the business cycle, and the progressivity of taxes and the level of unemployment determine the cyclical sensitivity of the fiscus (Perotti, 2007:35). As indicated, tax elasticities measure the sensitivity of total revenue to changes in income, but this could also be further refined to include elasticities specific to various revenue components (Bornhorst *et al.,* 2011:5).

Table 8: Elasticities of Personal Income Tax

	Elasticities		
Country	**PIT to taxable income**	**Taxable income to GDP**	**PIT to adjusted GDP**
28 OECD countries	1.5 to 2.0	0.6 to 0.9	1.0 to 1.7
Brazil	3.4	0.8	2.7
Mexico	2.0	1.5	3.0
Chile	2.5	1.4	3.5

Source: Daude *et al.* (2010:17); Girouard *et al.* (2005:7)

Table 8 compares PIT elasticities for various countries based on a study by Girouard *et al.* (2005:7). They estimate the average elasticity coefficient for tax revenue relative to taxable income for 28 OECD countries to be between 1.5 and 2.0 (thus, relatively elastic). In addition, the elasticity of taxable income to GDP ranges between 0.6 and 0.9. When the latter coefficients are discounted, the elasticity of tax revenue relative to GDP ranges between 1.0 and 1.7, compared to the OECD average of 1.2.

Daude, Melguizo & Neut (2010:17) estimate similar elasticities for Brazil, Mexico, and Chile, which are 3.4, 2.0, and 2.5, respectively. The elasticity of revenue relative to the output gap is 0.8 for Brazil, 1.5 for Mexico and 1.4 for Chile. When accounting for these elasticities, the revenue/GDP elasticities for Brazil, Mexico, and Chile are 2.7, 3.0, and 3.5, respectively.

4.3.2 Tax elasticities with tax allowances and deductions

Tax allowances and deductions reduce the tax revenue base – a loss for government, but a gain for taxpayers. Peter *et al.* (2010:464) and the OECD (2010:12) confirm that a complex tax system with many deductions results in tax evasion, which impacts negatively on the efficiency of the tax regime. Thus a simpler tax system requires the elimination or reduction of tax allowances (Van Velthoven *et al.*, 1991:63). Tanzi *et al.* (2001) further state that "... tax relief through deductions is particularly egregious because these deductions typically increase in the higher tax brackets. Experience compellingly suggests that effective rate progressivity could improve by reducing the degree of nominal rate progressivity and the number of brackets and reducing exemptions and deductions...". The elasticity coefficient for allowances (β) can be estimated as the logarithm of income tax allowances ($\ln a'_{kj}$) with respect to the logarithm of taxable income ($\ln y_j$) in equation 6 (Creedy & Gemmell, 2004:60):

$$\ln a'_{kj} = \alpha + \beta \ln y_j \qquad (6)$$

Peter *et al.* (2010:467) investigated 189 countries and found that the elasticities for PIT allowances for upper-middle income countries amounted to 0.248. Creedy *et al.* (2004:62) estimated an allowance elasticity of 0.264 for the UK.

4.3.3 Tax elasticity with changes in the tax rates

Another commonly used coefficient used in tax policy is the elasticity of revenue with changes in tax rates (normally marginal (mtr) and the average (atr) tax rates). In this case, the marginal rate is not only the statutory rate, but also includes the effects of deductions and allowances.

$$\eta_{T_y, y_i} = \frac{mtr_i}{atr_i} \quad (7)$$

Creedy *et al.* (2004:69) use individual income data in the UK to estimate an elasticity of 5.8 for the lowest income earners and 1.1 for the highest income earners. This indicates that the lower income groups benefit more from deductions and allowances than the higher income groups. The allowance elasticities are summarised in Table 9, and will be calculated in the next chapter, where different scenarios of tax expenditures are tested.

Table 9: Summary of the different elasticities

Type of elasticity	Country	Elasticity
Total PIT allowances and deductions	Upper-middle	0.248
	United Kingdom	0.264
Income groups tax revenue elasticity	United Kingdom	
- lowest income group		5.8
- top income group		1.1

Source: Creedy *et al*. (2004:69); Peter *et al*. (2010:467)

4.3.4 Taxable income elasticity with respect to net-of-tax rate

Individual income (Y_{it}) is also used to estimate the elasticity of taxable income (ε) with respect to the net-of-tax rate $(1-\tau_{it})$.

$$\Delta \ln(Y_{it}) = \varepsilon \Delta \ln(1-\tau_{it}) \quad (8)$$

When deriving taxable income elasticity, the mechanical and behavioural effects on tax revenue should both be considered (Saez, 2004:127). First, the mechanical effect is the product of the change in the tax rate $(d\tau)$, the number of taxpayers (N), and the taxable income (z) above a specific threshold ($\bar{z}$).

$$dM = N[z-\bar{z}]d\tau \quad (9)$$

Then the behavioural effect is calculated as the number of taxpayers (N) multiplied by the elasticity (ε) of taxable income with respect to the net-of-tax rate, taxable income (z), and the marginal tax rate (τ):

$$dB = -N.\varepsilon.z.\frac{\tau}{1-\tau}d\tau \qquad (10)$$

Equation 11 combines the mechanical and behavioural effects.

$$dR = dM + dB = Ndt(z-\bar{z}.).[1-\varepsilon.\frac{z}{z-\bar{z}}.\frac{\tau}{1-\tau}] \qquad (11)$$

The Pareto parameter (a) measures the thickness of the income distribution and can be defined as the specified level of income divided by the difference of the specified level of income (z) and the average income ($\bar{z}$). Therefore a = ($\frac{z}{z-\bar{z}}$) (Piketty, Saez & Stantcheva, 2011:6).

Equation 12 gives the marginal excess burden in terms of extra taxes collected.

$$-\frac{dB}{dR} = \frac{\varepsilon.a.\tau}{1-\tau-\varepsilon.a.\tau} \qquad (12)$$

when

$\tau \ = \tau^*$

then

($1-\varepsilon.a.\frac{\tau}{1-\tau}$) is equal to zero, and simplifies to the revenue-maximising tax rate (τ_h) (Piketty *et al.,* 2011:6):

$$\tau_h = \frac{1}{1+a.\varepsilon} \qquad (13)$$

4.3.5 <u>Main insight and concluding remarks</u>

Estimating elasticities provides a clearer understanding of the properties of the tax revenue base, and how the tax structure can be adjusted to ensure revenue growth. Elasticities are an important benchmark when comparing different countries' tax systems. In the next section, relevant elasticities for South Africa are calculated.

4.4 PERSONAL INCOME TAX ELASTICITIES FOR SOUTH AFRICA

4.4.1 Tax revenue to GDP

One approach to calculating the average elasticity over a time period is a simple OLS. The tax liability elasticity is estimated on an aggregate level. For elasticity purposes, a simple procedure with time series data is used (SARB[5]). The study uses 29 observations, resulting in the number of feasible methods being limited. Differencing the series once, the ADF unit root test confirms the stationarity of the series (all series are I(0)). The income elasticity of taxes (t) with regard to taxable income (tby) is defined as follows (Girourd *et al.*, 2005:7):

$$\varepsilon_{t,GDP} = \varepsilon_{t,tby}\varepsilon_{tby,GDP} \tag{14}$$

The elasticity ($\varepsilon_{t,GDP}$) of tax liability (tax) with respect to the GDP consists of the multiplied sum of two different coefficients. First, the elasticity of tax liability (tax) to taxable income (tby) is estimated $\varepsilon_{t,tby}$. Again, macro data from the national accounts in Table 10 is used.

A dummy variable is included to account for the structural break in the data series caused by major tax reforms in 2001 (see Nyamongo & Schoeman, 2007:482). The elasticity of tax liability is expected to be greater than unity because of the progressive tax system of South Africa (marginal tax rates increase with taxable income). Tax liability is positively correlated with taxable income (tby). The function used to estimate PIT takes the logarithmic form:

$$\mathrm{ltax} = \mathrm{f}(\overset{+}{\mathrm{ltby}})^{6} \tag{15}$$

[5] A detailed description of the data is provided in Table 10.
[6] The variables are co-integrated at a 10 per cent level of significance. All the variables included in the ECM were originally I(1). Differencing them once transformed them into I(0) series. The error correction coefficient is negative and statistically different from zero. The Adjusted R-square value indicates that 65 per cent of the variation in taxes is explained by the ECM. Thus, given the diagnostic results at a 1 percentage level of significance, it is reasonable to conclude that the residuals do satisfy the assumptions of the classical normal linear regression model. The adjusted coefficients are statistically highly significant, as their respective t-statistics are all larger than 1.96 in absolute value terms.

Table 10: Selected variables used for estimating PIT revenue

Abbreviation	Description	Transformation used
GDPn	gross domestic product at market prices	R millions current prices
Pitrev	PIT as % of total revenue	Percentage
revGDP	total revenue as a percentage of GDP	Percentage
Tax	PIT	pitrev/100*revGDP*100*GDPn
Coe	compensation of employees	R millions current prices R millions current prices
Propinc	property income	R millions current prices
Tbinc	taxable income	coe + propinc
Taxratio	tax ratio	tax(-1)/tbinc(-1)*100
Dum	structural break from 2000	

Source: SARB (various issues)

Second, the elasticity of taxable income to GDP ($\varepsilon_{tby,GDP}$) is determined. Since taxable income is positively correlated to GDP, the function used to estimate taxable income takes the logarithmic form:

$$\text{ltby} = \text{f}(\overset{+}{\text{lgdp}}) \tag{16}$$

Table 11 shows that the elasticity of taxable income amounts to 0.95. Finally, the elasticity of tax liability to GDP is derived by multiplying the above-mentioned two estimated elasticities. The results are combined, and the calculated tax liability to output is 1.07. Thus a 1 per cent increase in GDP would lead to a 1.07 per cent increase in revenue. These results are in line with the results obtained by Jooste (2009:16), who estimated the coefficient at 1.08 using the GDP to account for structural changes. Table 11 shows that the elasticity coefficients of tax liability for the macro and MS models are 1.13 and 1.35, respectively.

Table 11: Elasticities

Elasticity	Macro data	MS model data (Only taxpayers)
Elasticity of tax liability to taxable income	1.13	1.35
Elasticity of taxable income to GDP	0.95	n/a
Elasticity of tax liability to GDP	1.07	n/a

Source: Own calculations

4.4.2 Using taxable income elasticity to calculate PIT efficiency

Harberger (1964:26) defines deadweight loss as a measure of the cost of the economic inefficiency of a tax regime. Harberger uses labour supply elasticity to calculate such inefficiency (known as deadweight loss) in a tax reform. Feldstein (1995:2) incorporates tax avoidances caused by exclusions and deductions, and rather uses the taxable income elasticity in his deadweight loss calculation, which gives a much larger deadweight loss value than the labour supply elasticity. It seems that a tax system with a broader base and thus fewer deductions will reduce tax avoidance and evasion opportunities. With a broader tax base, lower elasticities reflect the behavioural response of individuals, thus producing a more efficient and equitable tax system (Saez, Slemrod & Giertz, 2012:42). As already stated, the deadweight loss (economic efficiency) depends on the behavioural response (Feldstein, 2008:1).

The elasticity of taxable income can therefore be used as an indicator to capture revenue losses due to behavioural changes (efficiency of the tax measured as deadweight loss). Thus deadweight loss is a cost to the economy on top of what is collected in the form of taxes Harberger (1964:26). The elasticity reflects the behavioural response to tax changes, and therefore also determines the size of the deadweight loss. Such behavioural responses reflect adjustments in labour supply or leakages from the revenue base due to positive or negative taxpayer behaviour. These behavioural changes determine the size of the taxable income elasticity (Saez *et al.*, 2012:4).

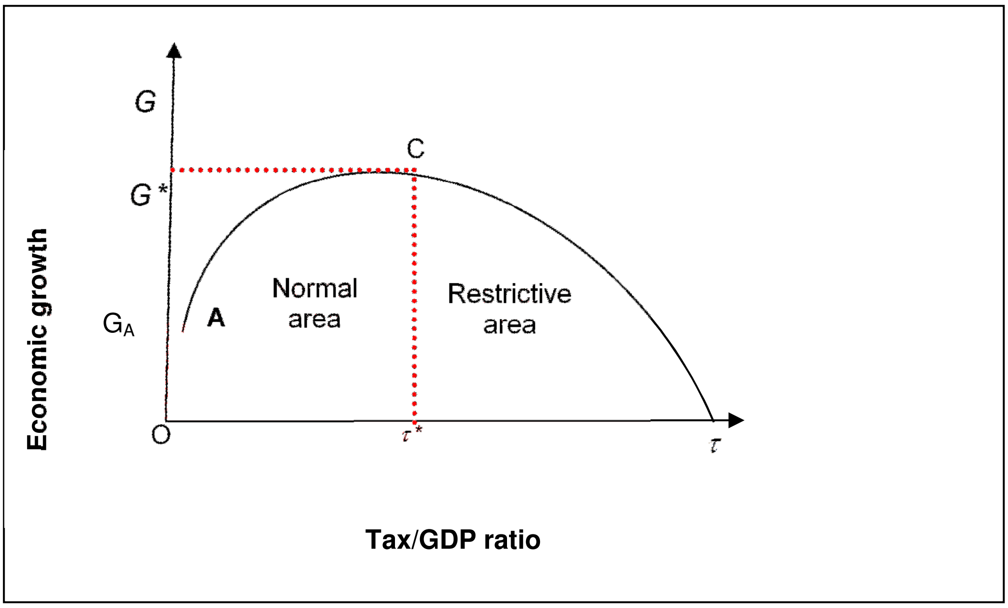
4.4.2.1 *The use of elasticities in estimating tax optimisation*

To achieve the objectives of a successful tax structure and to maximise the efficiency of taxes implemented, such taxes have to be optimised. An optimum tax rate is best designed to avoid distortion and inefficiency, and thus to optimise economic growth and government revenue (Mirrlees, 1971).

Scully (1991) states that government revenue will grow up to a certain optimum point, after which productivity and economic growth will be reduced. He also illustrates the impact that taxes have on the revenue base and on economic efficiency. High tax rates divert resources from the private sector, encourage tax avoidance and evasion, and channel resources into a less productive shadow economy to escape the high taxes.

The Growth-maximising[7] curve, which illustrates the tax/GDP ratio that maximises growth, is shown in Figure 13. Economic growth is shown on the vertical axis, with the tax/GDP ratio on the horizontal axis. With an increasing tax rate the economies of scale become evident. The AC line in the curve shows that, in the first part of the figure (normal range), economic growth changes exceed proportional changes in the tax rate. However, the marginal increase in economic growth flattens off, and eventually it reaches level zero at point C. Thus the optimum level of tax to GDP ratio is reached at (τ *), after which the marginal return on such a ratio in terms of value added becomes negative and enters the restrictive area (Scully, 1994:6).

Figure 13: Growth-maximising curve



Source: Chobanov and Mladenova (2009:9)

The literature overview has also indicated that a similar correlation exists between tax rate changes and revenue collected. Lindsey (1987:173) finds that tax rates higher than the revenue-maximising tax rate will cause an infinite excessive burden. He reaffirms the view that, if the tax base varies with the level of rates imposed on it, there is a tax rate above

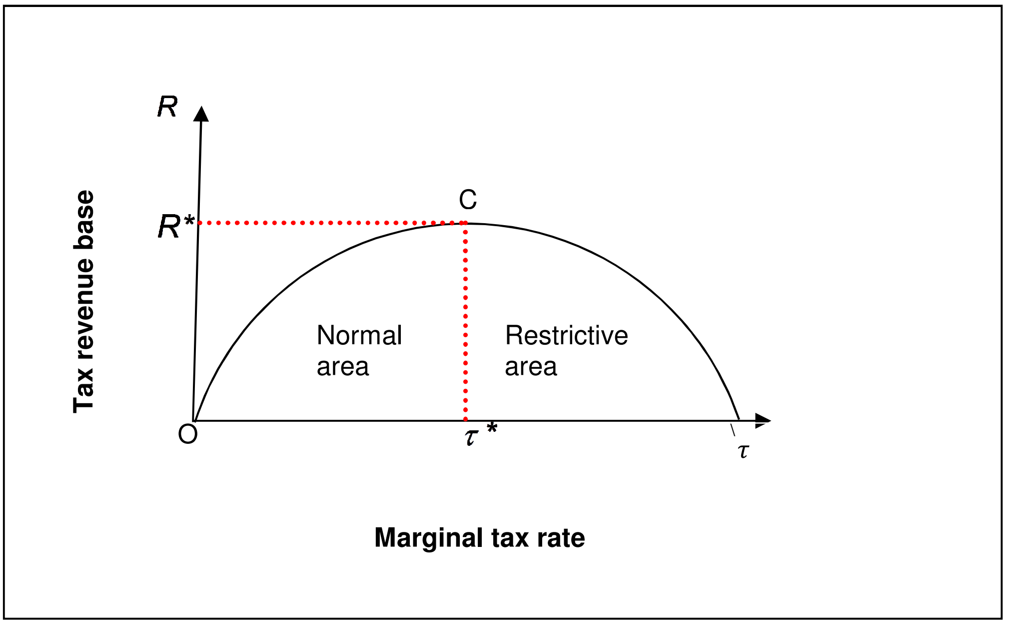
[7] Chobanov and Mladenova (2009:8) refer to Figure 13 as the BARS Curve after Barro, Armey, Rahn, and Scully who did theoretical and empirical research on the optimal size of government as depicted by an inverted U curve. In this study a balanced budget approach is assumed and therefore government expenditure is financed with taxes.

which revenue starts to decrease. Given the usual objectives of tax design, such as minimising the excess burden of taxation subject to a revenue constraint, tax rates above the revenue-maximising level define an upper bound on the range of socially optimal tax rates.

This trend is illustrated in Figure 14, which shows the relationship between revenue collected and marginal tax rates (also known as the Laffer curve). The tax revenue base is shown on the vertical axis, while the marginal tax rate is on the horizontal axis. With an increasing marginal tax rate the economies of scale become evident. The OC line in the curve shows that at first, increases in taxes contribute to a more than proportional increase in revenue, but such marginal increases flatten off as in the previous figure, and eventually reach a maximum where the marginal return on tax increases becomes zero at point C.

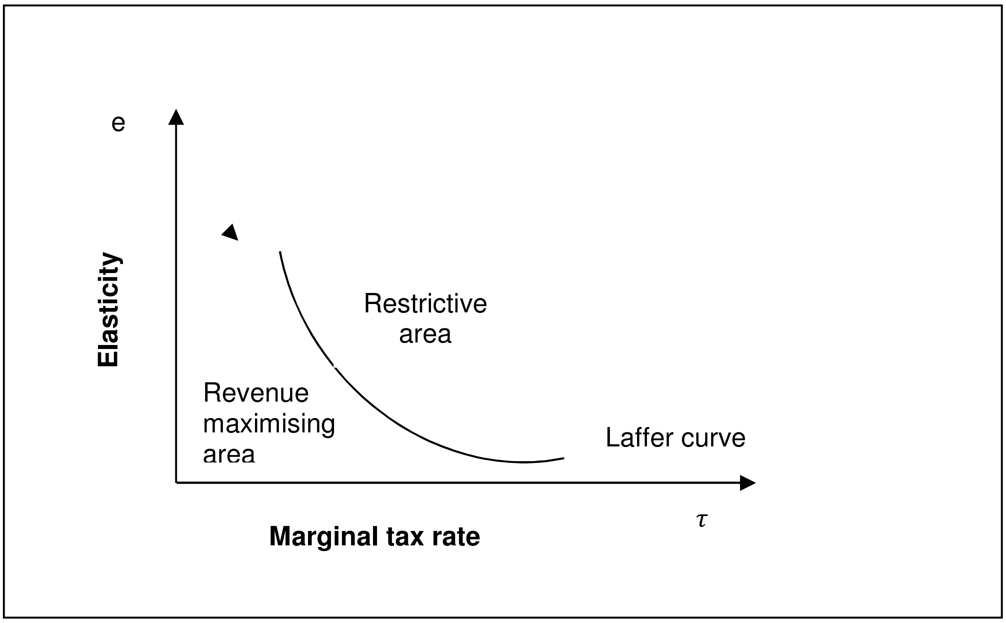
Thus the optimum marginal tax rate is reached at (τ*), after which the marginal return on such a tax rate in terms of value added becomes negative and enters the restrictive area (Ballard, Fullerton, Shoven & Whalley, 1985:189).

Figure 14: Revenue-maximising curve



Source: Ballard *et al.* (1985:189)

Figure 15: Elasticities and marginal tax rates



Source: Ballard *et al.* (1985:193)

Barlett (2012:1014) states that the Laffer curve provides not only for a single marginal tax rate and for taxable income elasticity, but also for different marginal tax rates and elasticities for each income distribution. This is illustrated in Figure 15, which shows the Laffer bound curve, and thus the maximum level of marginal tax rates for different tax elasticities. The socially optimal tax rates fall in the area below the curve, where higher tax rates increase total revenue, given the elasticity of revenue at that tax rate. Tax rates above the curve fall into the restrictive area, where higher tax rates only produce unchanged or even lower levels of revenue. A high revenue-maximising tax rate coincides with low taxable income elasticity, and low revenue-maximising rates with higher taxable income elasticity and a larger number of taxpayers (Ballard *et al.,* 1985:192).

4.4.2.2 *Methodology to determine the efficiency (deadweight loss) of a tax reform*

Using the Feldstein (1995:3) framework, individuals maximise their utility functions by finding an optimal mix of leisure (L) and disposable income (equal to consumption) (C) in equation 17.

$$\max U(L, C) \tag{17}$$

Equation 17 is subject to a linearised budget constraint where consumption equals the after tax $(1 - t)$ amount of wages (w) less exclusions (E) and deductions (D) (in equation 18).

$$C = (1 - t)[w(1 - L) - E - D] \tag{18}$$

Taxable income ($taxinc_i$) is:

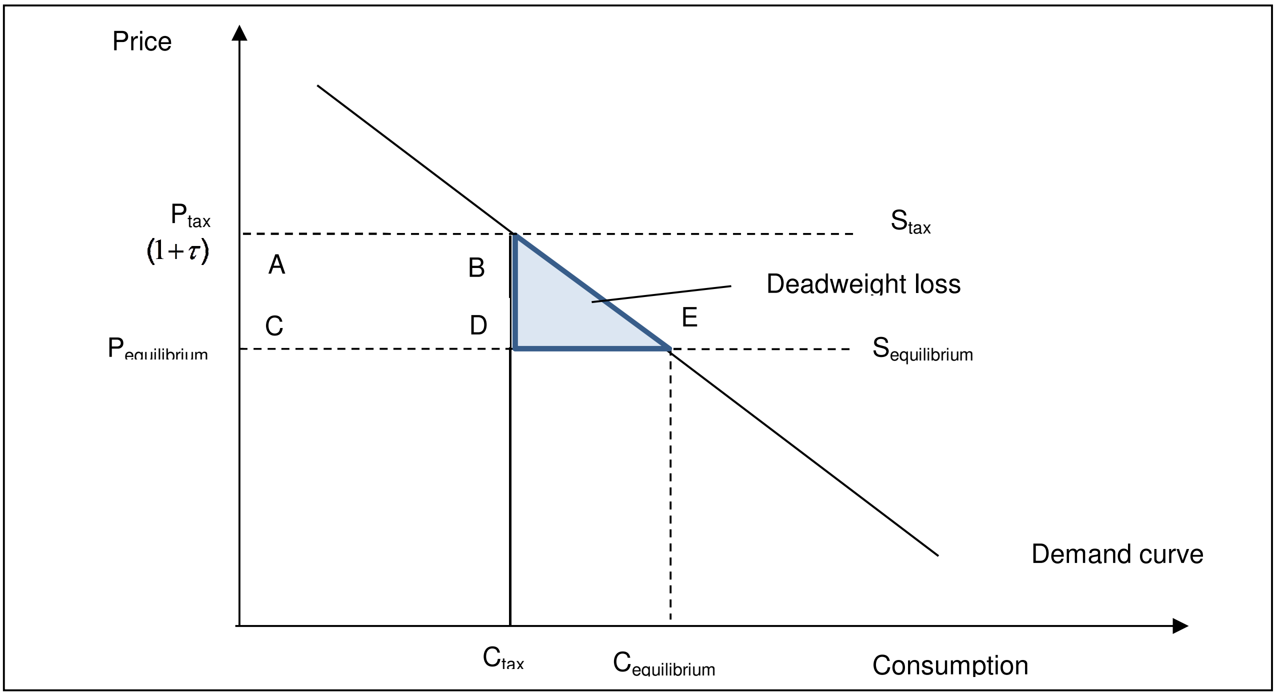
$$[w(1 - L) - E - D] \tag{19}$$

Therefore

$$C = (1 - t)[taxinc_i] \tag{20}$$

Figure 16 illustrates the derivation of the deadweight loss using a simple consumer surplus methodology. The demand curve indicates the trade-off between disposable income and leisure in the figure. The opportunity cost (P) of disposable income used for consumption increases with an increase in the tax rate (P_{tax}).

Figure 16: Deadweight loss area



Source: Feldstein (1995:6)

The deadweight loss of income tax for an individual, the triangle BDE, can be expressed as the product of 0.5 times the tax, (τ)/(BD) times the decrease in consumption (DE).

Therefore

$$\begin{aligned} dwl &= -0.5\tau C_{tax} \\ &= -0.5\tau[C_{tax}/(1+\tau)]d\tau \\ &= -0.5(\tau/1+\tau))[(1+\tau)/C_{tax}][C_{tax}/(1+\tau)]\tau C_{tax} \\ &= -0.5(\tau/(1+\tau))\varepsilon_c \tau C_{tax} \end{aligned} \tag{21}$$

Then

$$1/(1+\tau) = (1-\tau) \text{ thus } (\tau/(1+\tau)) = t \text{ and } \tau = t/(1-t) \tag{22}$$

simplify equation 21:

$$\begin{aligned} dwl &= -0.5(t)\varepsilon_c(t/(1-t))C_{tax} \\ &= -0.5(t^2)\varepsilon_c(1-t)^{-1}C_{tax} \end{aligned} \tag{23}$$

The compensated labour supply elasticity is replaced by the compensated elasticity of taxable income with respect to the net-of-tax share (ε_t) and with labour income replaced by taxable income (taxinc) is equivalent to:

$$dwl = 0.5(t^2)(1-t)^{-1}\varepsilon_t taxinc \tag{24}$$

The deadweight loss of PIT therefore depends on taxable income and the elasticity of taxable income with respect to the net-of-tax share (that is, the difference between 100 minus the marginal tax rate). The deadweight loss changes with behavioural changes; so if the tax rates increase to raise revenue, it will affect the level of the deadweight loss as well.

To calculate the revenue-maximising tax rate, the Pareto parameter and taxable income elasticities are required. The Pareto parameter models the distribution of taxable income. Due to the unavailability of individual tax data in some countries, the Pareto parameter is calculated based on published tabulated data, where the number of taxpayers, taxable income, and tax liability are grouped in taxable income groups. Interpolation is then used with a distribution function to calculate the shares of the income distribution to derive the Pareto coefficient (Atkinson, Piketty & Saez, 2011:12; Steenekamp, 2012a:4).

From the literature, the inverted Pareto-Lorenz coefficient (λ) is preferred to the normal Pareto-Lorenz (a) coefficient (Alvaredo & Atkinson, 2010:13).

Atkinson, Piketty, & Saez (2011:13) estimate the inverted Pareto parameter (λ) in equation 25, where (z_t) is the threshold and (z_a) the average taxable income. Thus the average taxable income for all individuals above a specified income level is divided by the specific income level.

$$\lambda = \frac{z_t}{z_a} \qquad (25)$$

Atkinson *et al.* (2011:13) explain that the inverted Pareto parameter measures the thickness of the income distribution. The thicker the distribution, the larger is (z_t) to (z_a) and the smaller the value of the inverted Pareto parameter. Saez (2001:211) graphically illustrates the inverted Pareto distribution of US taxpayers with a high value of 5 for low income earners, falling to around 2 for high income earners. Atkinson *et al.* (2011) show a declining trend of the inverted Pareto from 11 to 1.11 over the increasing income levels.

With the unavailability of micro tax data to estimate taxable income elasticity with the difference-in-differences methodology, which is the more common methodology used (Saez, 2004:127), another approach is followed in this study. The Scully model (1991:9) uses macro time series data to calculate revenue-maximising and growth-maximising tax rates. The revenue-maximising tax rate is then used to calculate the taxable income elasticity.

Using a balanced budget approach similar to that of Scully[8] (1994:11), a Cobb-Douglas type production function is estimated with both a government (g) and a non-government ((

[8] The author is aware that critique can be raised in respect of the derivations in the Appendix to the Scully model. For example, it does not always provide clear guidelines on its reasoning and the regressions appear to suffer from a number of weaknesses. The theoretical relationships are also not that clear and involve inference from time-series with an indication of unit-root in both the dependent and independent variables. However, despite these weaknesses the model does provide a solid framework for empirical analysis within

$((1-\tau)Y)$) sector. The government sector provides goods produced with capital and labour, thus government expenditure, and financed from tax revenue, that is $g=\tau Y$, or a balanced budget. The amount spent by the non-government sector is determined by the rate of taxation and that period's national output. Both government and non-government goods contribute to output in time (t).

Non-linear Cobb-Douglas production function:

$$Y_t = \alpha(g_t)^{\beta}((1-\tau)Y_t)^{\delta} \tag{26}$$

where

α	= total factor productivity
g_t	= government expenditure current period
Y_t	= GDP current period
τ	= tax ratio.

As mentioned the model assumes a balanced budget, with government expenditure = government revenue, thus:

$$g_t = \tau Y_t \tag{27}$$

Substitute (27) into (26):

$$\begin{aligned} y_t &= \alpha(\tau(y_t))^{\beta}((1-\tau)y_t)^{\delta} \\ &= \alpha(\tau)^{\beta}(1-\tau)^{\delta}(y_t)^{\beta+\delta} \end{aligned} \tag{28}$$

Substitute (28) in (27):

$$g_t = \tau(\alpha(\tau)^{\beta}(1-\tau)^{\delta}(y_t)^{\beta+\delta}) \tag{29}$$

Take logarithms of equation (29):

$$\ln g_t = \ln\tau + \ln\alpha + \beta\ln\tau + \delta\ln(1-\tau) + (\beta+\delta)\ln(y_t) \tag{30}$$

---

the constraints of a balanced budget approach and the results proved to be in line with similar analyses done in other studies (see Table 12).

From (30) differentiate g_t w.r.t. τ and set equation equal to zero:

$$\frac{\partial \ln(g_t)}{\partial \tau} = (\tau)^{-1} + \beta(\tau)^{-1} + \delta(1-\tau)^{-1}(-1) = 0$$

$$\frac{1+\beta}{\tau} = \frac{\delta}{1-\tau}$$

$$\frac{1-\tau}{\tau} = \frac{\delta}{1+\beta}$$

$$\frac{1}{\tau} = \frac{\delta}{1+\beta} + 1$$

$$\frac{1}{\tau} = \frac{1+\beta}{1+\beta} + \frac{\delta}{1+\beta}$$

$$\frac{1}{\tau} = \frac{1+\beta+\delta}{1+\beta}$$

Optimum tax ratio that maximises revenue: $\tau^{**} = \dfrac{1+\beta}{1+\beta+\delta}$ (31)

To calculate the growth-maximising tax rate,

Economic growth rate:

$$1 + eg_t = \frac{y_t}{y_{t-1}} \quad (32)$$

Substitute (28) in (32):

$$1 + eg_t = \frac{y_t}{y_{t-1}} = \alpha(\tau)^{\beta}(1-\tau)^{\delta}(y_t)^{\beta+\delta}(y_{t-1})^{-1} \quad (33)$$

Constant returns to scale $\beta + \delta = 1$ (34)

Therefore:

$$1 + eg_t = \alpha(\tau)^{\beta}(1-\tau)^{\delta}(y_t)^{1}(y_{t-1})^{-1} \quad (35)$$

The logarithm form of (35):

$$\ln(1 + eg_t) = \ln\alpha + \beta\ln(\tau) + \delta\ln(1-\tau) + \ln(y_t) - \ln(y_{t-1}) \quad (36)$$

Differentiate (36) w.r.t. tax:

$$\frac{\partial \ln(1+eg_t)}{\partial \tau} = \beta(\tau)^{-1} + [\delta(1-\tau)^{-1}(-1)] = 0 \qquad (37)$$

$$\frac{\beta}{\tau} = \frac{\delta}{1 - \tau}$$

$$\frac{1 - \tau}{\tau} = \frac{\delta}{\beta}$$

$$\frac{1}{\tau} - 1 = \frac{\delta}{\beta}$$

$$\frac{1}{\tau} = \frac{\beta}{\beta} + \frac{\delta}{\beta}$$

Optimum tax rate that maximises growth:

$$\tau^* = \frac{\beta}{\beta + \delta} \qquad (38)$$

The rate at which revenue is maximised exceeds the rate that maximises growth. This is the case because of the way in which the equations for these two optimum rates are calculated. The revenue-maximising equation adds one to both the numerator and the denominator, but adds proportionately more to the numerator (beta plus delta) than to the denominator (beta). Hence, the revenue-maximising ratio must always exceed the growth-maximising ratio.

4.4.2.3 *Evidence on the magnitude of revenue-maximising tax rates and taxable income elasticity*

Table 12 summarises the growth-maximising tax ratios, Pareto parameters, and tax elasticities for a number of selected countries. Scully (1991) estimates that, for the US, the optimal level of federal, state, and local government revenue combined is around 19 to 23 per cent of GDP (expenditure equals revenue in a balanced budget approach). The Scully model estimates a growth-maximising tax/GDP ratio for the years 1927 to 1994 at an average of 19.7 per cent for New Zealand (Caragata, 1998). Mackness (1999) estimates the optimum size of the tax/GDP ratio for Canada at about 20 to 30 per cent.

Mavrov (2007) finds the optimum ratio for government expenditure as a percentage of GDP in Bulgaria to be 21.4 per cent. All of these studies find that the optimum tax rates are much lower than the actual tax rates.

Table 12: Summary of growth-maximising tax ratio's, Pareto parameters, and tax elasticities

Countries	Growth-maximising tax ratio (%)	Pareto	Tax elasticity
US	19 - 23	1.5	0.88 - 1.15 0.4 - 1
New Zealand	19.7		
Canada	20 - 30		
Bulgaria	21.4		
	Revenue-maximising tax ratio (%)		
United States of America			
Lowest income group	53		0.7
Highest income group	34		2
United Kingdom	56.6 55.6	1.67	0.46
excluding VAT, social security	41	1.6	0.5
South Africa	70 54 37	1.75	0.2 0.4 0.8

Source: Alvaredo *et al.* (2010:13); Brewer & Browne (2009:9); Caragata (1998); Goolsbee (1999:13); Lindsey (1987:202); Mackness (1999); Mavrov (2007); Saez (2004:129); Saez *et al.* (2012:6); Scully (1991); Steenekamp (2012a:18)

Lindsey (1987:202) estimates revenue-maximising tax rates from taxable income elasticities for the US. According to his findings, taxable income elasticity increases in direct proportion to income, with the average elasticity ranging between 0.7 and 2 over the four income groups. The average revenue-maximising tax ratios (reflecting the tax rate) amount to 53 per cent and 34 per cent for the lowest and highest income groups, respectively. Brewer and Browne (2009:9 & 11) estimate a revenue-maximising tax rate for the top 1 per cent income group in the UK at 56.6 per cent, with Pareto parameter and elasticity coefficients of 1.67 and 0.46, respectively. They then exclude the VAT and social security rates to acquire a marginal tax rate of 41 per cent.

Saez (2004:129) also estimates a revenue-maximising tax rate of 55.6 per cent for the UK, with Pareto and tax elasticity coefficients of 1.6 and 0.5, respectively.

Alvaredo *et al.* (2010:13) use South African tax data to show that the inverted Pareto coefficient for South Africa in the 1980s hovered around 1.5, and increased to 1.75 in 2005. Due to data constraints in South Africa, Steenekamp (2012a:18) chooses three taxable income elasticities (0.2, 0.4, and 0.8) from the literature to calculate the revenue-maximising tax rate as 70, 54, and 37 per cent, respectively. Once the effected marginal tax rate (40 per cent) exceeds the Laffer bound rate of 37 per cent it will not be relevant to calculate the deadweight loss at an elasticity of 0.8 given the negative value that equation 12 would produce.

From the literature studied, it seems that because of changes in marginal tax rates, behavioural changes are more prominent in top income groups – clearly because of the skew distribution of income. For example, in the US in 2006, the top quintile earned 39 per cent of the total income and paid 86 per cent of the total taxes. For this kind of analysis it is therefore important to focus on the top marginal tax rate income group. The top income groups are Pareto distributed, and in the US this parameter has recently been set at 1.5.

4.4.3 Main insight and concluding remarks

Taxable income elasticity is used to calculate efficiency cost (deadweight loss) as well as the revenue and growth-maximising tax rates. Efficiency cost is minimised by optimal tax policies. The taxable income elasticity indicates by how much tax rates should increase to maximise revenue. Efficiency cost comes from the distortion of individual behaviour that becomes evident with rising taxes.

From the literature, calculated taxable income elasticity ranges between 0.2 and 1.15. With the lack of micro tax data in South Africa, a different methodology is used to derive the taxable income elasticity with the optimum tax rate and the inverted Pareto parameter.

International literature estimates growth-maximising tax rates of between 20 and 30 per cent. The revenue-maximising tax rate is estimated at between 54 and 70 per cent, with Pareto coefficients ranging between 1.5 and 2.

In the next section, the growth- and revenue-maximising tax rates are calculated for South Africa followed by the calculation of the inverted Pareto coefficients and taxable income elasticities.

4.5 CALCULATION OF THE REVENUE- AND GROWTH-MAXIMISING TAX RATES AND THE DEADWEIGHT LOSS FOR SOUTH AFRICA

In the previous section, the estimated taxable income elasticity is used to calculate the revenue-maximising tax rate. It has already been indicated that due to the unavailability of micro data to calculate the elasticity, another approach is followed using Scully's production function in equation 26. To calculate the revenue- and growth-maximising tax rates, the data used is explained first, followed by the estimation techniques and results.

4.5.1 Data

Table 13 provides an overview of the time series data used. The data is obtained from the SARB for the period 1982 to 2012.

Table 13: Data and description

Series	Abbreviation	Description	Transformation used
KBP7032J	CPI	Consumer price index	Yearly index, Base year 2000 = 100
KBP6006J	Y /gdp	Gross domestic product at market prices	Yearly, current prices
KBP6008J	Consg	Final consumption expenditure by general government	Yearly, current prices
KBP6180J	Capt	Gross capital formation	Yearly, current prices
KBP6181J	Capg	Gross capital formation: general government	Yearly, current prices
KBP6007J	Consng	Final consumption expenditure by households: Total	Yearly
KBP6013J	X	Exports of goods & services	Yearly
KBP6014J	Z	Imports of goods & services	Yearly
Calculated	Zg	Imports of goods & services: general government	15%*50%*consg
Calculated	Zng	Imports of goods & services: non-government	z - zg
Calculated	Capng	Gross capital formation: non-government	capt - capg
Calculated	G	Government expenditure	consg + capg -zg
Calculated	Ng	Non-government expenditure	consng + capng + x -zng
Calculated	Rgdp	Real gross domestic product	(gdp/cpi)*100
Calculated	Rg	Real government expenditure	(g/cpi)*100
Calculated	Rng	Real non-government expenditure	(ng/cpi)*100
Calculated	Dum	Sanctions	1982-1992

Source: SARB (various sources)

4.5.2 Estimation technique

The appropriateness of the estimation technique has to be weighed against the availability of data. This study uses 31 observations, so the number of feasible methods is limited. Differencing the series once, the augmented Dickey-Fuller (ADF) unit root test confirms the stationarity of the series (all series are I(0)).

Co-integration involves combining economic data series (although I(1)) through a linear combination into a single series, which is itself stationary. This process provides an indication of the variables that affect GDP in the long run. The Engle-Granger (1987) two-step procedure and the error correction paradigms are adopted, despite potential defects. This technique entails the determination of the long-term co-integration relationship through testing for stationarity of the residuals using ADF tests. Any non-stationarity is then corrected by means of a short-term error correction model (ECM). If co-integration is present, the spurious regression problem is avoided and an equilibrium relationship exists.

Another defect of the Engle-Granger two-step estimation technique is that the test is based on the assumption of one co-integrating vector. The number of variables ($n = 3$) in the model is greater than 2, and as a result there can be more than one co-integrating relationship. The Johansen multivariate co-integration technique is more powerful than the Engle-Granger technique, but requires more observations. Testing for co-integration by using the Johansen methodology indicates at most one co-integration equation at a 0.05 level of significance. The ADF test statistics also have some defects: they have low power and tend to under-reject the null of a unit root. Other tests for unit root, such as the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) and Ng-Perron (NP) methods are more powerful than the ADF, but also require more observations (Harris, 1995).

The preference in the literature is the autoregressive distributed lag (ARDL) technique, an unrestricted form which is a more simple manner to estimate the long-run parameters. The advantages of the ARDL method are that the long-run parameter estimates are no longer inefficient and the estimated standard errors are no longer biased (Pesaran & Shin, 1998). If the variables have unit roots and are not co-integrated, the variables are differenced and estimated with the ARDL technique. The ARDL estimation, tends to provide parameter estimates which, on average, are more heterogeneous than those estimated using the

Engle-Granger two-step method. The ARDL approach to co-integration involves a single equation and with the Engle and Granger method any mistake introduced in the first step is carried forward in the second step (Enders, 2010:407). Hassler and Wolter (2005:12) find that the co-integrating vector and the residuals computed from the ECM are numerically identical to the ones constructed from the ARDL regression.

Abeysinghe and Boon (1999:645) find that the main problem with the OLS estimator is the standard error which tends to be biased when residuals are correlated but once the long run parameters are non-zero, it is preferred to formulate the Engel-Granger two-step method which gives better elasticity estimates than the other five estimation techniques, including the ARDL. Using the ARDL procedure in this study, the estimated coefficients are different from the coefficients in the Engle-Granger two-step method. The optimal revenue maximising and growth maximising tax rates are higher with the ARDL than with the Engle-Granger method. As a result it was decided to apply the Engle-Granger two-step method which gives better interpretable ratios which are also more in line with ratios from other studies. The variables are co-integrated and provide an effective formal framework for estimating long-run economic relationships from time-series data.

4.5.3 Empirical results

The empirical production function for the South African economy used in this study is as follows (van Heerden, 2008):

$$rgdp = \int(\overset{+}{rg}, \overset{+}{rng}) \qquad (39)$$

where

rgdp = real gross domestic product;

rg = real government expenditure;

rng = real non-government expenditure.

An increase in government and non-government input is expected to lead to an increase in output. Constant returns to scale are enforced, and the long-term equation is estimated as follows:

$$\ln(rgdp) = c + \beta \ln(rg\ ) + (1-\beta)\ln(rng\ ) \qquad (40)$$

The long-term results are contained in Table 14:

Table 14: Output coefficients for the long-term co-integration equation

Dependent variable: lnrgdp		
Variables	**Coefficient**	**t-statistic**
Lnrg	0.21303	6.36822
Lnrng	0.80798	22.6353
Dum	-0.00090	-1.60265
C	0.30473	3.90280
Adjusted R^2	0.99845	

Source: Own calculations

The signs and magnitudes of the variables in the long-term equation conform to a priori expectations. It is expected that an increase in real government expenditure (lnrg) will increase economic growth until it reaches a maximum optimum point. Beyond that point, growth is lowered at a diminishing ratio (Scully, 1994).

An increase in real non-government expenditure (lnrng) has a positive impact on economic growth because of increased expenditure. A 1 per cent increase in real government expenditure leads to a 0.21 per cent increase in economic growth, and a 1 per cent increase in real non-government expenditure leads to a 0.81 per cent increase in economic growth.

The residuals from this regression are tested for stationarity as follows:

H_0 : no co-integration

H_1 : co-integration

Table 15: Testing stationarity of the co-integrating residuals

Series	**Model**	**Lags**	τ
res_lr_{t-1}	Constant, no trend	0	-6.75

Source: Own calculations

The variables are co-integrated at a 1 per cent level of significance, as the coefficient of -6.75 is smaller than the calculated MacKinnon (1991) critical value of -4.7912[9]. The null hypothesis is thereby rejected at a 1 per cent level of significance, indicating co-integration. The presence of co-integration makes it possible to estimate the ECM in the next step.

The error correction model, which incorporates the short-run effects on economic growth, corrects the stochastic residuals from the long-term co-integrating regression. The results are shown in Table 16, where (ln) preceding a variable indicates natural logs and Δ indicates a first difference.

Table 16: Regression output of the error correction model for rgdp

Dependent variable: Δlnrgdp				
Variable	**Coefficient**	**Standard error**	**t-Statistic**	**p-Value**
res_lr_{t-1}	-0.640306	0.144328	-4.43646	0.0001
Δlnrg	0.277806	0.041910	6.628673	0.0000
Δlnrng	0.711904	0.049482	14.38699	0.0000
Adjusted R^2		0.912114		
S.E. of regression		0.003881		

Source: Own calculations

All the variables included in the ECM were originally I(1). Differencing them once transformed them into the I(0) series. The lagged error correction coefficient is negative and statistically different from zero to support the existence of co-integration. It shows that 64 per cent of disequilibrium is corrected for every year. The adjusted R squared value indicates that 91.2 per cent of the variation in growth is explained by the ECM.

All the diagnostic tests are performed on the ECM, with the following results:

[9] See Appendix 4.

Table 17: Selected diagnostic results of the short-term model estimating growth

	Test	Test statistic	p-value	Conclusion
Normality	Jarque Bera	JB = 0.14	0.93	Normally distributed
Serial correlation	Ljung-Box Q	LBQ = 20.6	0.19	No serial correlation
	Breusch-Godfrey	nR2 = 2.7	0.10	No serial correlation
Heteroscedasticity	ARCH LM	nR2 = 0.29	0.59	No heteroscedasticity
	White (no cross)	nR2 =6.18	0.10	No heteroscedasticity
Specification	Ramsey RESET	LR = 0.22	0.64	Indicative of stability

Source: Own calculations

With the diagnostic results at a 5 per cent level of significance, all tests performed are significant. Therefore it seems reasonable to conclude that the residuals do satisfy the assumptions of the classical normal linear regression model.

4.5.4 Calculating the ratios

The empirical results are then used to calculate the revenue and growth-maximising tax rates. The optimum average tax ratio that maximises revenue is calculated from equation 31:

$$\tau^{**} = \frac{1+\beta}{1+\beta+\delta}$$

$$= \frac{1+0.21}{1+(0.21+0.81)} * 100$$

$$= 60\%$$

The revenue-maximising tax ratio of 60 per cent applies to total tax revenue collected by government. Obviously, total revenue includes revenue from all sources of income, including PIT, CIT, and VAT. However, since the focus of this study is only on PIT, it had to be assumed that tax changes only originate from changes in income tax on individuals, and that other taxes remain at current 'optimal' levels. This strong assumption is questionable – especially given the findings outlined earlier, that tax reforms internationally feature mainly a movement away from direct income tax towards indirect taxes. However, in the case of corporate taxes, the current level in South Africa (28 per cent) compares favourably to that of most other countries, and could therefore be assumed to be close to optimum from a growth point of view. As far as VAT is concerned, the regressive nature of the tax, and the political resistance against such a tax, limits the scope for adjustments in the VAT rate. Therefore, the current rate of 14 per cent with zero ratings and exemptions (which are also low compared to most other countries) does not leave much room for policy experimentation, and should therefore also be regarded as optimal at its current levels. As a result it is assumed that both corporate tax and indirect tax could be deducted from the total optimum tax level, which then only reflects the optimum rate for individual tax at 43[10] per cent. Steenekamp (2012:16) states that the effective marginal tax rate of the highest income group is more than the statutory rate of 40 per cent. Adding VAT of 14 per cent gives an effective marginal tax rate of 47.4[11] per cent. Brewer *et al.* (2009:4) add national insurance of the employee and employer to the statutory marginal rate of 45 per cent, and thus derive an effective marginal tax rate of 53[12] per cent.

Table 18: Tax revenue-maximising rate for personal income tax

Taxable income group	Revenue-maximising tax rate (%)
0 – 80 000	43.0
80 001 – 130 000	42.5
130 000 – 180 000	42.0
180 001 – 230 000	41.5
230 001 – 300 000	41.0
>300 000	40.5

Source: Own calculations

As previously illustrated in Figure 14, higher revenue-maximising tax rates (Laffer bound curve) coincide with lower taxable income elasticity, and a lower revenue-maximising rate coincides with a higher taxable income elasticity. Thus, it is assumed that the elasticities

[10] (x+0.28+0.14)/1+(0.28+0.14)=0.60
[11] (0.4+0.14)/1.14
[12] (0.45+0.015+0.133)/1.133

vary directly with income. Due to data constraints, Table 18 shows the revenue-maximising tax rates for the taxable income groups that hover around 43 per cent (calculated from macro data).

The coefficients of the model are now used to calculate the optimal growth-maximising tax ratio by solving equation 38:

$$\tau^* = \frac{\beta}{\beta + \delta}$$

$$= \frac{0.21}{0.21 + 0.81} * 100$$

$$= 20.5\%$$

According to the model, the optimum tax revenue/GDP ratio for South Africa is 20.5 per cent. The actual level of total tax revenue as a share of GDP for 2007/2008 was 27.6 per cent; in 2011/2012 it decreased to 24.6 per cent. Thus, the tax ratio that maximises growth is substantially lower than the 2011/2012 realised rate. The growth-maximising tax ratio of 20.5 per cent might appear to be on the low side if measured against the revenue required to finance the government's budget.

However, the challenge lies in fuelling economic growth that automatically inflates the tax base. Such a decline in the revenue/GDP ratio might not be too far off the mark. Since 2002, the PIT/tax revenue ratio has been stable between 30 and 36 per cent; therefore, assuming an average of 33 per cent of total revenue, the optimal PIT/GDP[13] ratio is 33 per cent of 20.5 per cent, or 6.7 per cent.

4.6 INVERTED PARETO ESTIMATE

In South Africa, tax data is published in tabulation format with information on the number of taxpayers, gross income, taxable income, and deductions by taxable income groups. Similar to the study of Steenekamp (2012a), tabulated published data by SARS – Tax Statistics (2010) for the tax year 2005/2006 – is used.

[13] tax revenue/GDP x PIT/tax revenue = PIT/GDP

As mentioned earlier, the inverted Pareto parameter measures the thickness of the income distribution. The thicker the distribution, the larger is (z_t) to (z_a) and the smaller the inverted Pareto value (β). For each of the 23 positive income groups, an inverted Pareto coefficient is calculated. The inverted Pareto coefficients for the 23 income groups are then grouped into 6 taxable income groups in Table 19.

Table 19: Inverted Pareto estimates

Taxable income group	Inverted Pareto
0 – 80 000	3.45
80 001 – 130 000	2.27
130 001 – 180 000	2.14
180 001 – 230 000	2.03
230 001 – 300 000	1.99
>300 000	1.89

Source: Own calculations

4.7 TAXABLE INCOME ELASTICITY

Calculating the elasticity of taxable income to the net-of-tax rates using the difference-in-differences methodology for South Africa is not possible due to the lack of historic micro tax data for the years when marginal tax rates changed significantly. The Alvaredo & Atkinson (2010:5) study on top income in South Africa over the period 1903 to 2005 confirms the unavailability of published tabulated data from 1994 to 2001.

The study of Steenekamp (2012a:20) also confirms the unavailability of tax data, and the latter author instead uses three elasticities for the top income group: 0.2, 0.4, and 0.8 for total taxable income as derived from the literature. The elasticities are derived by using the difference-in-differences methodology with micro data, and range between 0 and 1. For the sensitivity of the elasticities, Steenekamp does not use an average elasticity, but rather chooses three scenarios with a lower and a higher elasticity.

A different route is therefore followed by deriving elasticities from an analysis of optimum tax performance, as shown in Table 20. Equation (13) is adjusted to calculate the elasticity per taxable income group. The optimum and inverted Pareto estimates per taxable income group in the previous sections are then used. Therefore, the magnitude of the elasticity differs across taxable income groups, and can be used to calculate efficiency as reflected in a deadweight loss coefficient.

Table 20: Inverted Pareto and taxable income elasticity per taxable income group

Taxable income group	Inverted Pareto	Revenue-maximising tax rate (%)	Taxable income elasticity
0 – 80 000	3.45	43.0	0.38
80 001 – 130 000	2.27	42.5	0.61
130 001 – 180 000	2.14	42.0	0.66
180 001 – 230 000	2.03	41.5	0.71
230 001 – 300 000	1.99	41.0	0.74
>300 000	1.89	40.5	0.79

Source: Own calculations

4.8 THE USE OF ELASTICITIES IN MEASURING PROGRESSIVITY (FAIRNESS OF THE TAX)

Progressivity is affected by marginal tax rates, thresholds, and allowances. The first measurement of progressivity is where tax revenue is a function of taxable income (equation 15). A coefficient in excess of 1 indicates a progressive tax.

Another progressivity measurement is the elasticity of revenue with changes in tax rates: the marginal tax rate divided by the average tax rate (equation 7). The ratio increases if government allows more tax relief through an increase in deductions, therefore decreasing progressivity.

A last progressivity measurement is the GDP/capita multiple of the top income band. If the multiple of the top income band increases, then progressivity decreases (Steenekamp, 2012b:45). These progressivity measurements are applied in the next chapter to affect tax reform scenarios and to estimate and compare the progressivity of taxes.

4.9 CONCLUSION

Tax elasticities explain the structure of the tax system, and are used to estimate and forecast tax revenue. The main elasticities are discussed, along with an overview of relevant elasticities derived in other studies. South African tax elasticities are then calculated and compared to international trends. The results show that tax elasticity relative to taxable income is positive (relatively elastic) at 1.35. The ratio is relatively large, and confirms the progressivity of the PIT system of South Africa. Thereafter, the efficiency of tax reform is outlined with calculations of deadweight cost. The figures show that the deadweight cost is significant. Tax policy changes should therefore be carefully considered, as they could easily reduce revenue collections. Specific value is added by using an alternative methodology for calculating tax elasticity, by starting with optimum tax performance and the thickness of the income distribution.

The results show that the optimum ratio to maximise PIT is about 43 per cent. Given this optimum level, taxable income elasticity amounts to 0.38 for the lowest income group, and increases to 0.79 for the highest income group. These ratios are in line with international best practice as discussed in the previous sections. The taxable income elasticities will be used in Chapter 6 to calculate the deadweight loss (tax efficiency) in each scenario. The optimum PIT/GDP ratio is estimated to be 6.7 per cent to maximise economic growth. In Chapter 6 the different tax reform scenarios for PIT/GDP ratios will be compared to the optimal ratio to determine the best scenario. In the next chapter, the methodology of MS models will be discussed, followed by the structure of the MS model for South Africa.

CHAPTER 5

MICRO-SIMULATION MODELLING FRAMEWORK

5.1 INTRODUCTION

This chapter focuses on the literature and structure of MS models used internationally and in South Africa. The differences and limitations in the use of these models and their linking or layering to CGE models are explained. Lastly, the construction of the South African MS tax model is discussed.

5.2 A LITERATURE OVERVIEW OF THE STRUCTURE AND USE OF MICRO-SIMULATION TAX MODELS

5.2.1 Differences between macro- and micro-simulation models

Macro-simulation and MS models are applied in quantitative analyses to examine the inter-relationships between subjects and objects in the economy. Macro-models focus on simulating the behaviour of aggregate output, employment, and growth, without considering the micro characteristics and features of the subjects and objects involved. Typical analysis includes movements in growth rates, price trends, and interest rates. On the other hand, MS models focus on the behaviour of individuals, households, and firms in the economy, and reflect the decision-making behaviour of these micro units. In public economics, micro-models are typically used to compute tax elasticities and the impact of changes in tax policies on taxpayer behaviour. For example, a macro-model analyses the 'grossed-up' income and expenditures of all individuals working as sourced from the national accounts, thus following a top-down approach. Micro-models analyse the different sources of income of an individual, and on which specific items the individual spends his/her disposable income (Abel & Bernanke, 2005:11).

5.2.2 Limitations associated with micro- and macro-models

The data base of an MS model consists mainly of survey data that provides details of the behaviour and characteristics of individuals. Conducting surveys for MS modelling is costly and challenging, given the large amount of detail necessary to feed into the model. A poor response from respondents, with large gaps in data reporting, complicates the weighting proceedings; benchmarking the survey to the populations' estimates is required. The data is available periodically, and was only published long after the survey had been conducted (Citro & Hanushek, 1991:21).

Weighting procedures are applied to the survey sample to benchmark the survey to the populations' estimates. Primary datasets do not contain all the information needed to simulate fiscal policies. Some variables are therefore imputed. This limitation leads to difficulty in accurately replicating the data (Buddelmeyer, Creedy & Kalb, 2007:7).

Macro-simulation models mostly use time-series data. In the case of developing countries (especially African countries) this offers many challenges. In many instances, the series are dated and/or lack quality data. Distributional variables are not normally incorporated in macro-economic models (Vaqar & Cathal, 2007:2).

In the field of taxation, MS models are used internationally for the empirical analysis of the effect of tax policy changes on revenue collection and expenditure, especially health care and retirement, as well as on other socio-economic expenditures (Buddelmeyer *et al.*, 2007:3). They allow for individual characteristics, such as the composition of the taxpaying population in terms of age, gender, and income levels, and are especially useful to simulate individual income and expenditure behaviour to policy changes that affect revenue (Citro *et al.,* 1991:15). This is in contrast to macro–models, which are structured on an aggregate level without the detailed information of individuals/households captured in the micro-model (Štěpánková, 2002:36).

Furthermore, static models should be distinguished from dynamic models. In a static MS model, the demographic characteristics of a particular survey are kept unchanged; in a dynamic model, the demographic characteristics are adjusted over time (the data ages). However, in the domain of public economics, both procedures are useful to simulate the effect of a fiscal policy change on revenue and expenditure patterns within households. Static models are preferred though, given the sensitivity of dynamic models and the sometimes extreme results as a result of small policy changes (Merz, 1991:79).

In general, MS procedures involve data validation, imputation of data, re-weighting, and the up-dating of data to characterise the population as closely as possible (Redmond, Sutherland & Wilson, 1998:4).

A variety of different MS models have been documented in the literature (Arntz, Boeters, Gürtzgen & Schubert, 2008; Ballas & Clarke, 2000; Brownstone, Englund & Persson, 1988; Chernick, Holmer & Weinberg, 1987); and in particular, tax-benefit MS models (Buddelmeyer *et al.,* 2007; Štěpánková, 2002; Wagenhals, 2004). Orcutt (1957) pioneered micro-analytic models, and his first static MS model was acknowledged in the US. He simulated the behaviour and characteristics of individuals by analysing the impact of fiscal and economic policy changes.

Zellner (1990:44) explains how Orcutt realised the need for MS models: "… there was not much information in aggregate data to provide powerful tests of the many hypotheses imbedded in mathematical models of national economies, economic sectors, regional economies and industries. This fact led many to imbed insecure, untested, a priori assumptions in their econometric models, perhaps with the hope that errors in these tenuous assumptions would 'average out' through operation of a special law of large numbers. Such a 'solution' was completely unpalatable to Orcutt. His solution was to promote the development of more adequate data bases for use in economic statistical analyses…".

Orcutt identifies three types of MS models. The first model is a static tax-benefit calculator, allowing for fiscal policy changes and behavioural responses to changes in tax and benefit rates. Second, updating of the characteristics of each individual in the model is done using a dynamic model. Third, outputs from MS models can be linked to macro-economic models and vice versa. This link captures the interactions between individual behaviour and macro-economic performance (Zaidi, Harding & Williamson, 2009:1).

Shortly after Orcutt's static MS model was published, other important models were constructed. The transfer income model (TRIM) was developed by the Urban Institute in Washington DC in the 1970s. The micro analysis of transfers to households (MATH) model is a static model of the government tax and transfer system developed by the Mathematica Policy Research Institute in the 1970s. In 1976, Orcutt developed a dynamic model of demographics, social benefits, taxes, and labour processes – the DYNASIM model – at the Urban Institute, Washington DC. In the 1980s, Lewin/ICF Inc. developed a household income and tax simulation model (HITSM). This is a static model of government tax and transfer programmes. The social policy simulation database (SPSD/M) is a static MS model of tax and transfer programmes developed by Statistics Canada in the 1980s (Citro *et al*., 1991:5).

Most developed countries have constructed tax-benefit MS models. For example, the EUROMOD model was constructed for 15 European Union countries (Immervoll & O'Donoghue, 2009:2). The GMOD and STSM models are tax-benefit models developed for Germany (Wagenhals, 2004:2); the TAXMOD and POLIMOD models were constructed for the UK; and the SPAD/M model was developed for Canada (Davies, 2009:4). The Melbourne Institute tax and transfer simulator (MITTS) and the National Centre for Social and Economic Modelling's (NATSEM) static incomes model (STINMOD) have been developed for Australia (Buddelmeyer *et al*., 2007:3).

5.2.3 <u>The construction and outlay of international MS models</u>

The following international static tax-benefit models were analysed. A brief summary of each of them is given in the following section. However, technical detail regarding the structure of the models is not available, mostly due to the confidentiality of such models. Therefore only the broad construction of the models and problems with their use will be discussed.

5.2.3.1 *Tax and benefit (TAXBEN) model for the United Kingdom*

The Institute for Fiscal Studies (IFS) constructed their static tax and benefit (TAXBEN) model in 1983, and have maintained it since that time. The model analyses fiscal policy in the UK. The TAXBEN model uses data from the annual Family Expenditure Survey (FES), which makes income and expenditure information available for analysis. The model is static and does not account for behavioural changes, and simulates only the direct outcome of a policy change. It is, however, integrated with a labour supply model to simulate the outcome of tax policy changes on motivation to work (Brewer, Browne & Sutherland, 2006:8).

Until 1993, TAXBEN used annual FES data. On average, the survey interviews 7 000 families from a random sample of 10 000 families per year. Detailed information on expenditure patterns is obtained from the survey to calculate weights for the retail price index (RPI). The RPI has been used as a measure of inflation in the UK since 1947, and in particular by the government to up-rate pensions and other benefits. Information on income and household characteristics is also obtained from the survey used in the tax-benefit model. The survey features a response rate of 70 per cent, and the survey data is inflated to reflect the total population (Giles & McCrae, 1995:15).

TAXBEN is coded in the computer program Modula2. The FES dataset consists of income and expenditure variables. A program written in Modula2 is used to impute missing variables and to calculate taxes and benefits. Direct taxes are calculated according to tax regulation in the UK (Giles *et al.*, 1995:3).

If the TAXBEN database lags one year or more, changes in income and expenditure are up-rated or down-rated to reflect current levels. Income is up-rated by the increase of average income over the lag period. For investment income, the capital amount is calculated. The capital value is up-rated to the current year values using a GDP deflator, as is the case with expenditures. Each variable, such as government rent and the state earnings-related pension scheme (SERPS), is up-rated or down-rated by the retail price index (RPI) factor (Brewer *et al.,* 2006:9).

To simulate tax policies, a range of tax income related variables are specified with options that the user can change. For example, the user can change the age categories or tax brackets. The basis of TAXBEN has been used to develop an MS model in Poland and the Czech Republic (Giles *et al.,* 1995:4-5).

5.2.3.2 *EUROMOD: Integrated European benefit-tax model*

The EUROMOD is a tax-benefit MS model for fifteen European countries, and was constructed during the period 1998 to 2001. The model is based on micro household data, and calculates disposable income per household. Disposable income, together with other variables, is simulated to evaluate the before and after effects of a policy change. Policy scenarios could include changes in government revenue, poverty, household features, tax rates, etc. These changes can be evaluated at both national and European level (Immervol, O'Donoghue & Sutherland, 2009:6).

The EUROMOD relies on micro data for information on gross income and personal characteristics. The European model is complicated by the fact that country data differs substantially in terms of quality and timeliness, in addition to different data sources, response rates, re-weighting methods, under-reported income, and comparability across countries. Other problems include the reference time period, the calculation of gross income, and tax evasion, that together obscure comparable figures. In order to address these problems, variables have been standardised to contain imputed comparable figures where necessary. For instance, in order to deal with the differences in periodical reporting, monthly income was chosen as the general reference period, since the shorter period fits best with the simulation of tax and social contributions for all the countries included. This allows for the modelling of each of the economies but also for the area as a whole (Sutherland, 2001:13).

The simulation model is programmed in Microsoft C++. The input and simulated data is stored in two different Microsoft Access databases, and all variable lists are stored as tables in Microsoft Excel. Gross income at an individual level is an important input for the EUROMOD. Most of the income data is net of income taxes and social contributions, and does not include data on taxes and contributions. An iterative approach is used to impute gross income for each household in nine countries. Tax and contribution regulations are applied to simulate taxes and contributions. These simulated values are deducted from gross income to give taxable income. It is then possible to compare whether the resulting simulated net income is a good approximation of net income as recorded in the original data (Sutherland, 2001:13).

The EUROMOD is a static model, and immediately simulates the before and after effects of a policy change. It is the first multi-country MS model, and excludes behavioural responses. It has been used extensively for analysis – for example, in social policy, fiscal drag, and welfare benefits. In 2006, four countries were added to the EUROMOD: Estonia, Hungary, Poland, and Slovenia (Sutherland, 2001:8).

5.2.3.3 *A static MS model of the Australian tax and social security system: STINMOD*

In 1993, NATSEM constructed an MS model for Australia, and since then the country has progressed to be one of the leaders in this field. STINMOD is a NATSEM static MSM for income taxes and government cash transfers. STINMOD is up-dated yearly to incorporate new tax regulations in income tax, and to up-rate the base dataset to the current year. The STINMOD simulation on the database is coded in the computer program Statistical Analysis Software (SAS). It can evaluate the direct impact of tax policy changes on personal income and government expenditure, and is therefore of great value for government institutes, policy makers, the public, and the academic environment (Bremner, Beer, Lloyd & Lambert, 2002:1).

STINMOD is a static model that estimates the before and after effects of a tax policy change on Australian households. The survey data used in the model is conducted in four- to five-year cycles. Behavioural patterns such as gender, education, income, settlement, household characteristics, and spending are all modelled, and the database consists mainly of several types of survey conducted by the Australia Bureau of Statistics (ABS). The first release of STINMOD, version 94A, used micro data from the 1990 ABS survey of income and housing cost and amenities (Bremner *et al*., 2002:3). The 96A version of STINMOD used the household expenditure survey (HES) data. The HES is conducted every four years, and contains information about the income and expenditure of households. Each household in the dataset carries a weight to gross up the total household figures reflecting the Australian population. For example, a weight of 250 implies 250 similar households in the Australian economy, each with similar characteristics. In the HES only private dwellings are included; prisons and nursing homes are excluded (Harding & Warren, 1998:3).

The ABS changed the method of conducting the income survey by collecting information on a continuous basis rather than a periodic basis, with the survey renamed to 'the survey of income and housing cost' (SIHC). The micro data is released yearly, and therefore the data does not have to be aged. The disadvantage is that the sample size is smaller, so the two most recent SIHC datasets have to be combined (Bremner *et al.*, 2002:3-4).

MS models developed in Australia benchmark their base data against the labour force survey (LFS). If the sample data weights differ from the LFS weights, the sample weights are replaced by the LFS weights. A detailed matrix containing similar variables (for example, gender, age, and states) in both datasets is used to cross-classify the population. The problem of non-responses in some instances causes records not to match; therefore the matching process has to be repeated by using fewer variables in the matrix and retaining the weights calculated in the previous matching stages. Alternatively, values are adjusted (corrected for inconsistency) simply by an inflation factor. This approach only deals with the variable in isolation, not at the aggregate level; so re-weighting seems to be a superior method (Landt, Harding, Percival & Sadkowsky, 1994:20).

Landt *et al.* (1994:16) adjusted the weights of the Australian base file as follows. If the base file data differs from the benchmark data, then the weights attached to the records in the base file are replaced by estimates taken from the benchmark data. First, the base file and benchmark file both have to contain the same matrix variables – for example, a matrix containing age, gender, labour force, and education. Depending on which variables are simulated, they will be included in the matrix and the different data sets will be matched. Should there be corresponding records in the LFS and income distribution survey (IDS) tables, the IDS weights have to be recalculated by allocating the LFS weights across the matching IDS cells. For example, if 10 people who responded to the IDS had a particular combination of variables (age, gender, state, labour, education) and the LFS found there were 3 500 people in Australia with these characteristics, then each of the ten records would be allocated a weight of 350 (3 500/10). Applying this methodology in the referenced study indicated that a significant proportion of records did not match. As a result, the matching process had to be repeated at a higher level of aggregation, by using matrices containing fewer variables.

The income and expenditure data of each household is up-rated in order to reflect the current year of analysis. Different adjustment factors are applied to income in the STINMOD-STATAX model. Disaggregated data from ABS' weekly earnings of employees distribution survey (WEEDS) are used to adjust wage and salary income. The adjustment is done with inflation factors calculated by quintile of income. Each expenditure item is inflated or deflated by the movement in the relevant detailed consumer price index (CPI). The process accounts for changes in the price of goods and services (Harding *et al.*, 1998:14).

Once the base file is re-weighted and up-rated, tax policy scenarios can be simulated. Computer codes are defined to simulate reforms. When simulating income taxes, it is assumed that individuals are fully compliant in paying taxes. A series of tax and welfare variables is generated for each household, including income tax paid, government cash transfers, and indirect tax paid. Missing values are simply imputed.

An issue of concern, according to the authors, is that re-weighting has its limitations. It assumes that the characteristics of the person who provided the information are exactly the same as those not surveyed. In reality, those not surveyed (the non-responders) might have different answers. Alternative approaches to re-weighting include the creation of records for non-responses, or the merging of the data with other data; but these are more complex methods. The authors also warn that re-weighting affects the standard errors of various sample categories. For lower standard errors, a close correlation is necessary between the variables in the original data (IDS) source and the benchmark (LFS) data (Landt *et al.,* 1994:9-10).

The weights are adjusted to match labour force statistics by state, age, gender, labour status, and education, using the re-weighting procedures. The weights that are calculated are a good match between the STINMOD and the ABS labour force survey. STINMOD-STATAX SAS macro CALMAR is used to adjust the weights to give better results (Harding *et al.*, 1998:13).

5.2.3.4 *Dutch MS models*

Van Sonsbeek (2011:1) states that the Netherlands Bureau for Economic Policy Analysis (CPD) uses the MIMOSI model to measure the behaviour of labour and the purchase power of individuals. Tilburg University has constructed a dynamic MS model, Nedymas, to simulate social security benefits and contributions, income, and taxation (Nellissen, 1993:225). The dynamic MS model SADNAP (Social Affairs Department of the Netherlands Ageing and Pensions model) estimates public pension reforms and the Dutch disability scheme. The model is dynamic, and therefore the characteristics of individuals change over time. This ageing of the database causes the size of the data set to be very large. The Monte-Carlo technique is therefore used to account for the large dynamic set of variables of individuals. This model has been instrumental in quantifying the impact of the ageing of the Dutch population (Van Sonsbeek, 2010:968).

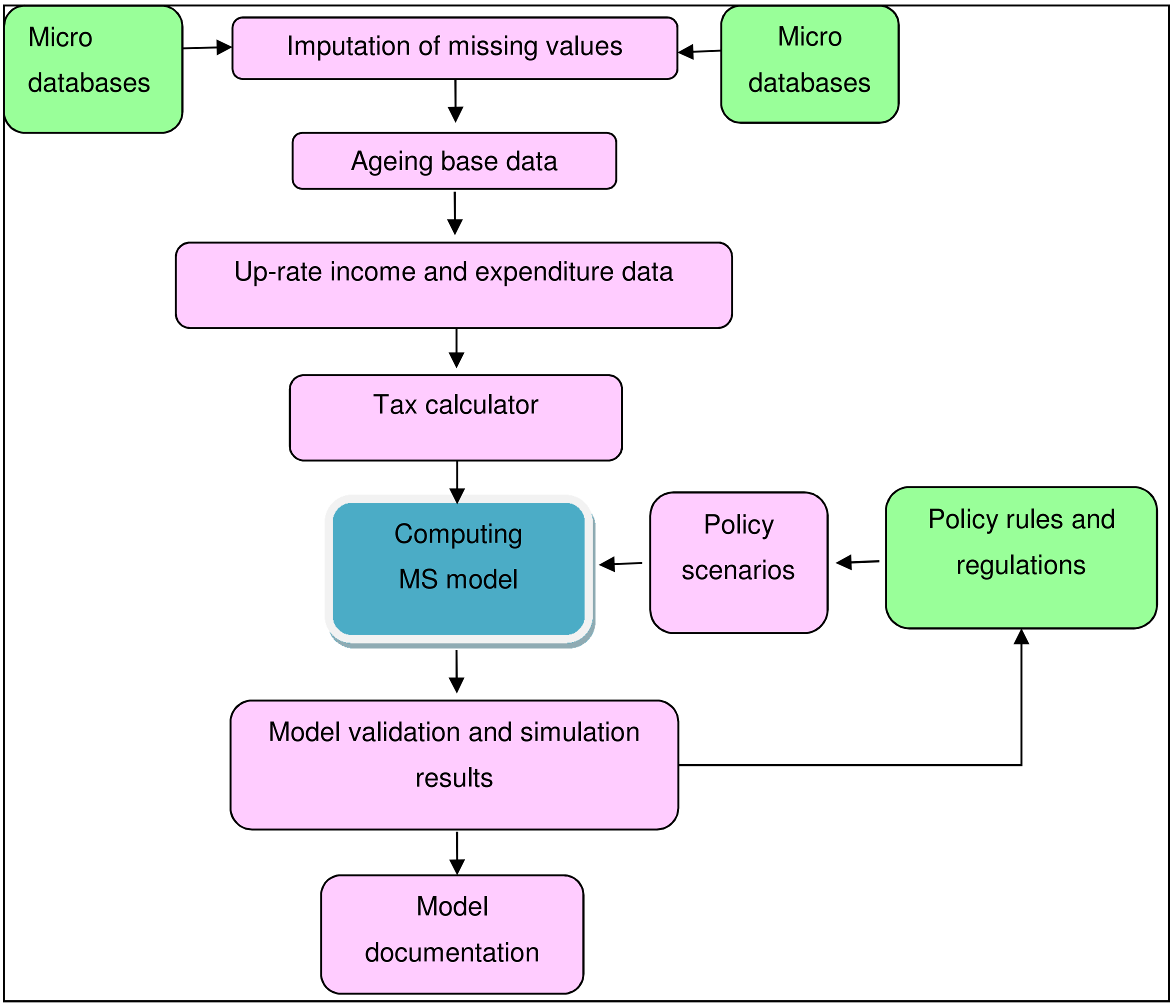
5.3 STRUCTURE AND APPLICATION OF MICRO-SIMULATION MODELS

An MS model can be broadly described as an empirical analysis by applying rules and calculators to the dataset. If the theory fits the data well, forecasting of new developments and alternative policy scenarios can be simulated and compared to each other. Simulation models consist of large datasets, mathematical relations, and equations that can be complex.

The simulations are typically coded in computer programming languages such as GPSS simulator, SAS, Matlab, Lingo, C++SIM, Simulat8, IBM SPSS Statistics 18, Gemcom Whittle, GAMS, GEMPACK, and EViews. Additional simulation packages are available on the market. A suitable simulation package is typically chosen, depending on the purpose of application, cost, and ability to simulate large datasets, as well as its user-friendliness (Merz, 1991:78).

In MS tax modelling, codes are applied to existing micro-data sets that contain observations described by taxpayer characteristics (Merz, 1991:79). These micro units can be firms, individuals, or families, and are identified by characteristics such as age, gender, population group, income, expenditure, and educational level.

Figure 17: Structure of an MS model



Source: Citro *et al*. (1991:2-4)

Figure 17 reflects the general structure of an MS model. A salient feature is that more than one database can be used for the model. As part of the process of constructing an MS model, the quality of the survey data is evaluated. The micro data available from surveys does not contain all the data from the population sample. To address this shortcoming, more than one survey of the same type of micro data can be used. If more than one survey is used, imputation techniques are used to replace missing values.

Re-weighting is used to alter the weight of the population to reflect the new population in the current year of evaluation. A tax calculator computes the PIT paid per individual. The current economic, tax, and social policies are simulated, and can be used as benchmarks for further policy analysis of the micro units concerned. Evaluating the quality of the output of the model against actual data is important in validating an MS model. An MS model should be maintained and updated regularly, as should its application to economic analysis. This implies the involvement of a strong team of analysts who specialise in the structure and different applications of the model. The model should be properly documented for use and further development (Citro *et al.*, 1991:2-4).

The tax calculator is structured so that it captures the continuous change in tax rates, income thresholds, and overall tax structures reflected in each year's tax policy proposals. Such a change in tax proposals is mainly due to the gradual enactment of tax reforms, informed by international best practice, or simply to adjust for bracket creep to protect taxpayers from the impact of inflation on their disposable income.

According to Redmond *et al.* (1998:153), MS model output might not exactly match the totals of other sources. This is because of structural changes that are not captured in the re-weighting of the survey. The survey does not cover the whole population, and excludes individuals in hospitals and old age homes, and military personnel. The micro dataset is incomplete, and does not have all the variables for analysis for a tax MS model. Simulating tax liability in the MS model does not account for provisional and refund payments. External data sources are also subject to imputation and sampling error.

Two types of MS models are used: static and dynamic. The former assumes unchanged population characteristics, and is widely used for shorter-term simulation exercises. Survey data used is conducted periodically, implying that data is usually dated when published. To adjust the database to the actual period of investigation involves a static ageing process. The structure of the sample has to be re-weighted with the sample size, age, and gender profile unchanged. Each micro unit now represents a different number (new weight) of individual units in the total population (Citro *et al.*, 1991:3).

Dynamic MS models age each micro unit based on probabilities such as the history of each individual, taking into account the whole life cycle from birth to death (a child ages until old enough to join the labour force; workers age to become pensioners; newborns are added to the population, etc). These changes affect the characteristics of the survey sample size and change the profile of the population, which is important for tax, pension, and social policy analyses (Merz, 1991:79-81). The tax calculator then considers all such changes before estimating the tax liability.

5.4 OTHER SOUTH AFRICAN MS MODELS

Only a few MS models have been developed for South Africa. One is a model that deals with globalisation, poverty, and inequality (Hérault, 2007:317; Wilkinson, 2009). Mabugu & Chitiga (2007) developed an MS model studying the effect of trade liberalisation and poverty. Adelzadeh, Alvillar & Mather (2001) built a static MS model for South Africa (DIMMSIM), and expanded it with dynamic properties. The main components of this model are its database and its tax and social policy components. The model uses data for individuals and households from the October household survey (OHS) (since 1995), the IES (1995 and 2000), the national census (1996 and 2001), and the biannual release of the LFS. The income tax module of the model estimates family level income tax for each period, and feeds the information into the equation for the calculation of households' disposable income. The MS model is used for socioeconomic and tax and transfer simulations. The results assess poverty income distribution affected by quintile, gender, family type, and province (Adelzadeh, 2001:1).

The framework for another static MS tax model was structured by Thompson & Schoeman in 2006. In this model the authors found that the simulated MS model results on taxable income, disposable income, and expenditure, using published data, are to a large extent an underestimate of the actual figures. They used the OHS conducted by Stats SA in 1999 as their data source.

Due to the confidentiality of MS models, technical details are not available. Only the SAMOD had more detailed information available. It is discussed in the next section.

5.4.1 <u>SAMOD</u>

The Centre for the Analysis of South African Social Policy (CASASP) at the University of Oxford developed SAMOD, a static MS model for South Africa. SAMOD is based on the EUROMOD model, and accounts for the unique characteristics of developing countries. The model simulates the impact of social benefits on income, poverty, and unemployment, and also tests the impact of different policy restructuring initiatives (Ntsongwana, Wright & Noble, 2010:2).

SAMOD gives model users the ability to change and up-date the input data themselves, and to test policy reforms. It is a static model that simulates the direct effects of adjustments in tax and benefit policy on poverty and redistribution. SAMOD addresses the gaps in social protection, poverty, and income inequality (Wilkinson, 2009:5).

In the SAMOD model, data is up-rated and aged as follows. First, the base data is improved by imputing the missing or non-response values (Wilkinson, 2009:8). Second, the data is aged to account for the latest population estimates, as the model was constructed in 2007. The CALMAR re-weighting method is used to re-weight the current weights, according to a few constraints. The population estimates of the Actuarial Society of South Africa are used to re-weight the survey to 2007 levels. These are the most recent population estimates (Wilkinson, 2009:9). Third, the income and expenditure data is up-rated to take price and income increases or decreases over the years into account. Families' income and expenditure is adjusted from the base year by up-rating factors. The ratio is calculated as follows. From the 2006 IES survey, the average family income per income quintile is calculated for each race group. The income trends are captured and used on a racial base, given the focus of the model on poverty and other socio-economic problems. An analysis of the data shows that some families report zero income because of their sensitivity about grants and tax obligations. In the model, such records have been excluded from the average income calculation. The benchmark figures are the 2000 IES, which includes individuals with no income reported. The missing income values are imputed, based on the figures for other families of the same race group within the income distribution category. By dividing the 2006 income average by the 2000 income average for each quintile, the ratio is used to calculate the growth rate per year. In the model, this ratio is used to calculate the average income for later years (Wilkinson, 2009:9-11).

Fourth, the aggregate wage income is validated and compared to the compensation of employees figure from the South African national accounts, and the income figures are then scaled up to the actual amount. Assuming that families have maintained the same expenditure patterns from 2000 to 2007, the mid-2007 consumer price index and a scaling factor are applied to each of the 2000 expenditure items to inflate or deflate them to a 2007 value.

The following socio-economic policies are included in SAMOD: child support grant, care dependency grant, foster child grant, disability grant, old age grant, grant-in-aid, PIT, VAT, excise duties, and the fuel levy. Because of inaccurate tax reporting figures, PIT is simulated in the model. The simulated tax seems to be close to the actual values, indicating that the technique followed in the up-rating of income is reasonably accurate. As a result of poor tax reporting, tax allowances, fringe benefits, and deductions are probably underestimated in the survey. Therefore the average allowance rates in the model are simulated using average rates from the 2008 Sanlam employee benefits survey. SAMOD assumes no tax evasion, and according to their calculations there are currently 4 million taxpayers (Wilkinson, 2009:14-16).

The output of the simulation model is validated against actual aggregate data. This determines the robustness of the MS model, and its weaknesses and strengths. The ageing and up-rating of variables have been kept to a minimum in order to ensure that the model results are not biased (Wilkinson, 2009:17).

5.4.2 Main insights and conclusion

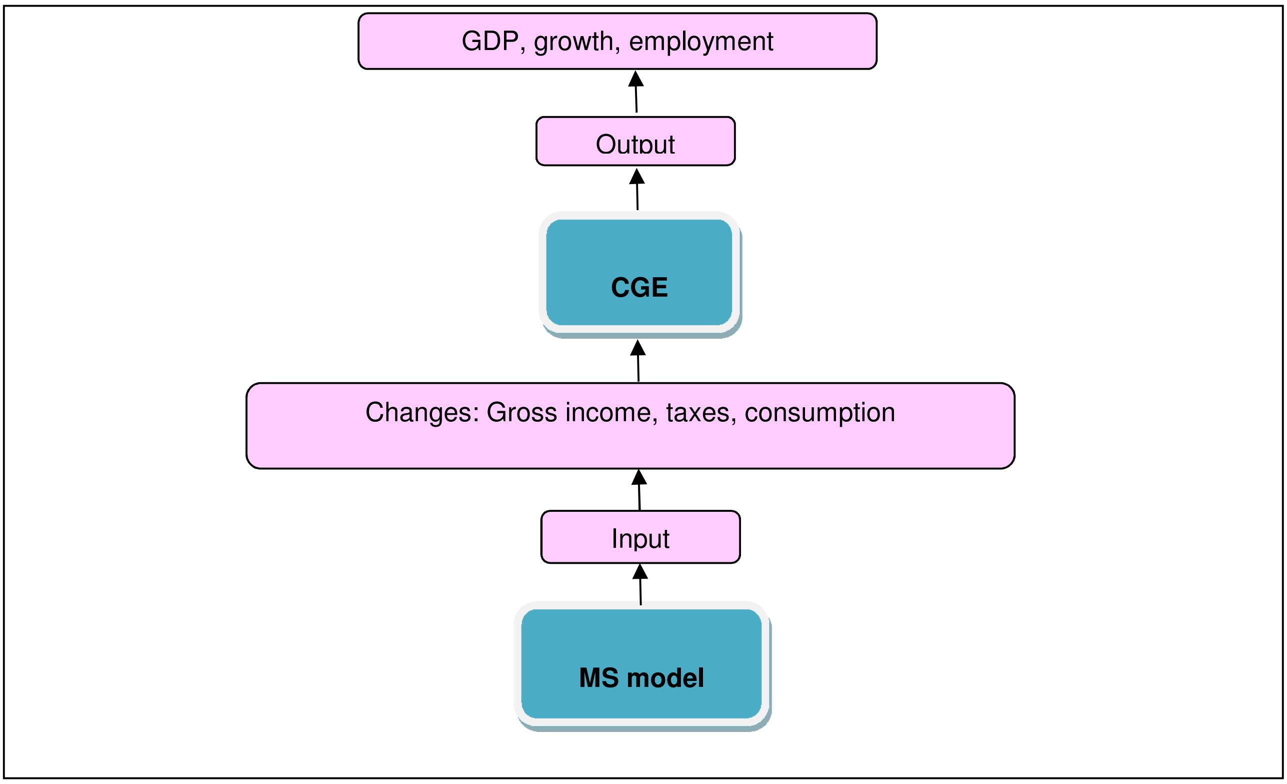
MS models operate on the level of individuals, and the micro data is mainly sourced from surveys. This section covers the thinking about imputation, re-weighting, and updating techniques in existing MS models. Important techniques are identified from the above models, and are used in the construction of the MS model used in this analysis. From the TAXBEN gross income and expenditure, values are up-rated to current levels by increasing gross income by GDP growth, and increasing expenditure by the inflation rate. The EUROMOD uses an iterative method to replace missing values. As in the STINMOD and SAMOD, CALMAR software is used to adjust the weight variable in survey data to current levels by using the age group, gender, and population variables.

5.5 LINKING CGE AND MICRO-MODELS

CGE models use actual macro-economic data to estimate the behaviour of economic agents, the economic environment, and how an economy might react to changes in policy, technology, or other external factors. CGE models are more dynamic on an aggregate level, whereas MS models give a more detailed outlay of the distribution of taxes (Åvitsland & Aasness, 2006:2). Linking an MS model to a CGE model captures aggregate wage and price effects, providing policymakers with a more powerful tool (Davies, 2009:1). The MS and CGE models are especially used to evaluate fiscal reform options and to estimate the magnitude of the effect of such policy changes on the income distribution of individuals and on economic indicators (Peichl & Schaefer, 2008:3).

Linking a CGE and an MS model allows for better calibration between the parameters of both models, and the accurate measure of the effects of fiscal policy reforms. A layered or integrated approach can be followed to link an MS model and a CGE model. The layered approach is preferable because it only requires plugging in percentage change link values between the models. This model is therefore sufficient when looking at the short-term effects. The integrated approach requires technical methods to integrate the MS and CGE models. This approach is recommended over the longer term.

Figure 18: MS model & CGE model bottom-up approach



Source: Peichl *et al.* (2009:12)

Figure 18 illustrates the top-down approach. The macroeconomic policy percentage changes (for example, wages and prices) in the CGE model are then plugged into the MS model, which changes individuals' income levels and directly affects the tax base. Following a bottom-up approach, the MS model models the first round effect. Policy changes in the form of tax changes affect disposable income and consumption in the MS model. The CGE model is then used to derive changes in aggregate variables such as GDP, employment, and wages. These are then linked back to the MS model. The iteration continues until convergence is achieved (Peichl *et al.*, 2009:11). A bottom-up approach is followed if the MS model is solved first, and the inputs are then used in the CGE model (Peichl *et al.*, 2009:53).

5.6 CONSTRUCTING AN MS BASE MODEL FOR SOUTH AFRICA

The individual revenue base in the MS model is disseminated using individual and household data from the IES survey of Stats SA. After substantial imputation, the data is brought into line with tax data published by SARS. An explanation is given for the data requirements and limitations, and how these were dealt with. Re-weighting and up-rating techniques are used to improve the quality and usefulness of the data. The structure of the static tax MS model for South Africa is discussed next, as this is then used as a tool to estimate the impact of tax policy changes and the efficiency of such policy changes.

5.6.1 Source data

It is difficult to find a single database containing complete and detailed information on income and expenditure (Xu, Ravndal, Evans & Carrin, 2009:297). MS models are as reliable as the micro datasets on which these models are based (Lau, Yotopoulos, Chou & Lin, 1981:175). In South Africa, data sources that are representative of the population feature a high level of versatility. Databases have missing values as a result of non-responses through refusal, unusable information, and disqualified answers. Incomplete surveys affect the quality of survey results, and need to be dealt with appropriately (Hérault, 2007:324).

The primary input data for MS tax models mainly originates from surveys with information on individuals' revenue collection and expenditure. In this case, the data should be useful for measuring and understanding the living standards, well-being, and consumption patterns of individuals, should there be changes in fiscal policy. Thus it should provide information on the economic behaviour of the individual in case of a tax policy change. Surveys show how much, and on what type of goods and services, an individual spends his/her disposable income. A survey includes lower and upper income individuals; therefore the spending patterns of the poor can be examined to measure poverty. The gainers and losers from the proposed changes in taxes and allowances can be identified, because it is possible to see from the survey how much individuals spend on direct taxes.

The 2005/2006 IES conducted by Stats SA serves as the primary dataset for the MS model used in this analysis. The data contained in the survey is the most appropriate, since it originates from the only primary official source providing detailed information on the income and consumption patterns of individuals. The survey is published every five years by Stats SA; the previous IES surveys were conducted in 1995/1996, 2000/2001, and 2005/2006. In 2010/2011 Stats SA conducted the most recent IES survey. However, this data is not yet available to the public, and so the 2005/2006 survey is used as the base year for the MS tax model in this study. Other surveys of Stats SA do not provide all the base data requirements for the MS tax model (Stats SA, 2008:1-2).

The IES survey sample consists of 3 000 primary sampling units (PSUs). Eight dwelling units were selected from each of the sampled PSUs. In total, 24 000 dwelling units were covered from 1 September 2005 to 31 August 2006. The survey includes all domestic households, holiday homes, mining hostels, and dormitories for workers. It excludes hospitals, prisons, old-age homes, student hostels, hotels, lodges, and guest houses. The non-coverage of some of the population is typical of household surveys, but this does not prevent one from using the data to make inferences. Each household in the survey stands proxy for a different number of households in the population. Weighted averages are calculated to match the population. These weights are included in the dataset. The weights are adjusted for non-response to the population estimates by using the CALMAR program in SAS. The micro data file therefore contains 22 617 households and 84 978 individuals, representing the South African population of 47 million in 2005/2006. The population level and sampling weights of the mid-year population estimate 2006 (P0302) survey are used in the 2005/2006 IES (Stats SA, 2008:1-2).

Various data files have been obtained from Stats SA in text format, and the data had to be converted into SAS 9.2 format to be imported into the MS model. The following data files are used: the individual's personal income and information file, household information files, and expenditure items per household file. The micro data and simulation results are stored in SAS and Microsoft Excel. The database construction and data analysis follow in the next sections.

5.6.2 Gross income

South Africa's current tax system is based on the individual as a tax entity, with no link between spouses. It is important that income information for each individual is calculated rather than the income per household. In order to calculate taxable income for each individual, the first step is to calculate the total gross income for each individual in the survey. The personal income text file includes all the different types of income earned per individual, and therefore the first step is to aggregate these incomes to obtain the gross income per individual.

5.6.3 Imputation of unspecified categorical values

The profile of individuals is explained through the categorical variables in the individuals' information text file (person_info). The categorical variables include gender, age group, education level, population group, and settlement. Some of the categorical information is unspecified, but these values cannot be excluded from the dataset because the individuals are included in the weights of the survey and will affect the population total. To improve the data, the problem of the unspecified values has been addressed through the imputation technique of Peichl *et al.* (2009:3). The technique replaces unspecified values in each categorical group by the mean value of the specified values in the categorical groups. This technique is also used by the modellers of EUROMOD, discussed in the previous section.

The gender variable differentiates between males and females, and shows the extent to which each group is represented in the survey. Also, each individual in the household is categorised within a specific population group: African/Black, Coloured, Indian/Asian, and White. Education groups range from no schooling, primary schooling, secondary schooling, to degrees and diplomas. Only qualifications already obtained are included. Diplomas and certificates only count if at least six months of a course has been completed. Age is captured in completed years to the nearest completed number, and categorised in five-year age groups. Settlement is where the dwelling unit is located. Urban areas include cities and towns characterised by higher population densities, economic activity, and infrastructure. Rural areas include farms and traditional areas characterised by low population densities, economic activity, and infrastructure (Stats SA, 2008:1-2).

For the categorical variables in the IES survey containing unspecified data, a frequency table was obtained for each variable to determine the distribution of the unspecified values. When computing values for the unspecified categorical variables, the frequency distribution of the original responses remained unchanged. This methodology is available in the SAS program known as RANUNI (uniform random number generator). Briefly, the algorithm is as follows:

In equation 41, R_i is the i^{th} random number, *b* is the multiplier, and *c* the percentage increase.

$$R_{i+1} = (bR_i + c)(\bmod m) \quad i = 0,1,2,....... \tag{41}$$

The RANUNI function then generates a random number using a generator developed by Lehmer (1951) from a uniform (0,m) distribution, and turns it into (0,1) by dividing by m. The number in parentheses is the seed/random number of the random number generator. If the seed is adjusted to a non-zero number, the same random numbers are generated every time the programme is activated (Fan, Felsovalyi & Keenan, 2002:26).

Table 21 shows that prior to imputation, male responses accounted for 47.1 per cent and females for 52.8 per cent of the total, while non-responses amounted to 0.1 per cent of the total population. Using the RANUNI statistical method, an unspecified value is replaced by a female response when the RANUNI is less than 52.8, or alternatively by a male response should the RANUNI be less than 47.1 per cent. It is evident that the female and male distribution before and after the imputation has only deviated slightly between males and females. After imputation, the male ratio only increased from 47.1 to 47.17 per cent, and the female ratio from 52.8 per cent to 52.83 per cent.

Table 21: Gender distribution

Gender	Distribution before imputation (%)	Distribution after imputation (%)
Male	47.1	47.17
Female	52.8	52.83
Unspecified	0.1	
Total	100	100

Source: Own calculations

In Table 22, the racial distribution before imputation is as follows: African 78.5 per cent, Coloured 13.6 per cent, Indian/Asian 1.6 per cent, and White 6.2 per cent. The non-response number amounts to 0.1 per cent for the total population in the survey. After imputation, the distribution between the racial groups changes only marginally. For example, the ratio for African/Black only increases from 78.5 to 78.6 per cent.

Table 22: Racial distribution

Racial	Distribution before imputation (%)	Distribution after imputation (%)
African/Black	78.5	78.60
Coloured	13.6	13.64
Indian/Asian	1.6	1.56
White	6.2	6.20
Unspecified	0.1	
Total	100	100

Source: Own calculations

Table 23: Age group distribution

Age (years)	Distribution before imputation (%)	Distribution after imputation (%)
0 – 14	33.07	33.15
15 – 24	21.34	21.38
25 -44	25.11	25.17
45 – 64	14.44	14.48
> 65	5.82	5.82
Unspecified	0.23	
Total	100	100

Source: Own calculations

Table 23 shows that before imputation the age group 0 to 14 years accounts for 33 per cent of the population. For the age groups 15 to 24 years, 25 to 44, 45 to 64, and 65 years and older, the distribution is 21.3, 25.1, 14.5, and 5.8, respectively. The non-response number is 0.23 per cent. Again, the age group distribution after imputation only adjusts marginally. For example, the age group 15 to 24 years increases from 21.34 to 21.38 per cent, while the age group 65 years and older increases from 5.81 to 5.82 per cent.

The distribution of the education categories before and after imputation can be seen in Table 24. The group with no schooling represents 20.7 per cent of the population. Those with primary and secondary schooling (Grade R to Grade 12) represent 73.8 per cent, while those with a national diploma represent only 3.6 per cent of the population, and those with a degree only 1.3 per cent.

After imputation, the distribution between the education groups only changes marginally. For example, the share of the group with no schooling increases from 20.7 to 20.8 per cent, while those with school education increases from 73.8 to 74.2 per cent.

Table 24: Highest level of education distribution

Level of education	Distribution before imputation (%)	Distribution after imputation (%)
No schooling	20.67	20.81
Grade R - 12	73.82	74.21
NTC/ Diploma	3.63	3.65
Degree	1.32	1.33
Unspecified	0.60	
Total	100	100

Source: Own calculations

The other categorical variables, province and settlement, are from the household information text file (house_info) and do not have unspecified values, and so imputation is not necessary.

Table 25 shows the distribution of households in the different provinces. Most individuals live in Gauteng, KwaZulu-Natal, and the Eastern Cape. Table 26 shows the distribution of households in rural and urban settlement areas, and concludes that almost 65 per cent of the population stay in urban settlements.

Table 25: Province

Province	Distribution (%)
Western Cape	10.21
Eastern Cape	13.83
Northern Cape	2.35
Free State	7.21
KwaZulu-Natal	17.77
North West	7.28
Gauteng	23.82
Mpumalanga	7.06
Limpopo	10.44
Total	100%

Source: Own calculations

Table 26: Settlement

Settlement	Distribution (%)
Urban	65.12
Rural	34.87
Total	100

Source: Own calculations

5.6.4 Re-weighting the population to the fiscal year 2005/2006

To validate the MS database against the 2005/2006 SARS filer data (Tax Statistics, 2010), a problem with different base years (calendar versus fiscal year) was encountered. Given the fact that the MS model is a tax model, the calendar year survey data had to be re-calculated to fiscal years. The IES data has also been re-weighted to take account of the population change for the fiscal year 2005/2006. The method used is the CALMAR re-weighting programme (Sautory, 1993), which recalculates the weights according to control totals, gender, race, and age group to match the population totals produced by Stats SA. The population total of the 2005/2006 IES equals the Stats SA midyear population survey of 2006. Therefore the 2005 midyear population survey is used with the 2006 midyear survey to rework the numbers to the fiscal year 2005/2006. The CALMAR method is also used by Stats SA and by the modellers of the EUROMOD and SAMOD models discussed in the previous section.

5.6.5 Up-rating individual income

Retrieving income data from individuals depends on the respondent's willingness to share information. Biases arose from gross income reported in the survey data because individuals under-reported their incomes either through forgetfulness or to hide income in fear of SARS auditing.

Total gross income of individuals (R749 billion) is compared to gross primary income (R1 014[14] billion) in the production, distribution, and accumulation accounts of South Africa (SARB, 2012). Primary income is adjusted to the fiscal year 2005/2006 and excludes business income of about 7 per cent to account only for households. Note that total gross income is lower than primary income obtained from the national accounts, because it only accounts for taxpayers who file a return, and not for the full population of income earners. A factor of 1.35[15] is calculated to up-rate individuals' gross income in the survey.

5.6.6 Tax allowances, deductions, and fringe benefits

Tax allowances, deductions, and fringe benefits are not accurately recorded in the IES. Thus SARS filer data serves as a benchmark based on the principle that it represents the closest proxy to the full tax base of the South African economy on a disaggregated level. The SARS published filer data for allowances and deductions in 2005/2006 (Tax Statistics 2010) has been used as a proxy to calculate a ratio for allowances, deductions, and fringe benefits, to be applied to each individual income group. Tax Statistics tables contain figures for the most important allowances, deductions, and fringe benefits, which are sufficient to calculate the allowance ratios. All the allowances, deductions, and fringe benefits are then added to taxable income to calculate the gross income per taxable income group (25 disaggregated groups). As mentioned earlier, total gross income is lower

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[14] Primary income (2005/2006) = [(1 070 *10/12)+(1 190 *2/12)]*93%
[15] Primary income (2005/2006)/IES gross income= 1 014 billion/749 billion

than primary income obtained from the national accounts, since it only accounts for tax filers and not the total income earned. It should be noted, though, that interest, exemptions, and capital gains tax exclusions have not been taken into account. The average allowance ratio (φ) is derived from allowances, deductions, fringe benefits ($allow_i$), and income before deductions (y_i) per taxable income group in equation 42.

$$\varphi = \frac{allow_i}{y_i} \tag{42}$$

Equation 42 is then applied to the SARS filer dataset, and the average allowance ratio is calculated for each of the 6 taxable income groups (Table 27).

Table 27: Allowance ratio

Taxable income group	Allowance ratio
R0 – R80 000	0.15
R80 001 – R130 000	0.14
R130 001 – R180 000	0.16
R180 001 – R230 000	0.19
R230 001 – R300 000	0.20
R300 001 and above	0.18

Source: Own calculation

These ratios by taxable income group (equation 42) are then applied to each individual IES gross income in equation 43 to calculate each individual's total allowance ($allow_i$).

$$allow_i = y_i * \varphi_i \tag{43}$$

Taxable income is then defined as gross income less allowances:

$$tby_i = y_i - allow_i \tag{44}$$

5.6.7 Tax liability

Due to the lack of tax liability data in the survey, liability is calculated for each individual in the MS model. Taxable income consists of gross income minus allowances, exclusions, and deductions. Tax liability is calculated by applying the tax rates and rebates to taxable income for the year of assessment ending 28 February 2006 (Table 28). According to the tax schedule, an individual with taxable income up to R80 000 pays tax at a fixed rate of 18 per cent. From there, income up to R300 000 is taxed at progressive rates to reach the maximum of 40 per cent for income in excess of R300 000. By deducting rebates from the gross tax liability, net tax liability is derived (National Treasury, 2006).

Table 28: Personal Income Tax structure 2005/2006

Taxable income brackets	Marginal rates of tax	
R0 – R80 000		18 % of each R1
R80 001 – R130 000	R14 400 +	25 % of the amount above R80 000
R130 001 – R180 000	R26 900 +	30 % of the amount above R130 000
R180 001 – R230 000	R41 900 +	35 % of the amount above R180 000
R230 001 – R300 000	R59 400 +	38 % of the amount above R230 000
R300 001 and above	R86 000 +	40 % of the amount above R300 000
Primary rebate: R6 300 Secondary rebate: R10 800 Tax thresholds for below 65 years: R35 000 Tax thresholds for 65 years and older: R60 000		

Source: National Treasury (2006)

The tax liability for each individual (*i*) is calculated in equation 45 by applying the official tax codes to taxable income:

$$pit_i = f(tby_i : \tau_{structure}) \qquad (45)$$

The model calculates tax liability given the existing tax codes, which can be adjusted for policy simulation purposes. It should also be mentioned that this procedure is, of course, a static method, and that behavioural changes are not accounted for. However, it allows policy simulations for thresholds, marginal tax rates, allowances, and income bands according to the 6 income categories. Obviously the impact of tax policy changes is much broader than only the static effects.

5.6.8 Functional structure of the model

Simplified functions are estimated to determine the effects of particular demographic characteristics of individuals on their level of disposable income. The objective is to model the impact of various changes in the characteristics of the taxpaying population and changes in the tax structure on disposable income, which serves as the revenue base for

PIT. During this process, various assumptions are made: since all of the continuous data is non-negative, the natural logarithms of these values are used. Natural logarithms have the advantage of smoothing out any irregularities in the data, and thus they simplify the interpretation of the model results. The regression procedure used is general linear modelling (GLM) for the base year 2005/2006.

The model provides a description of the relationship between the dependent, explanatory, and categorical variables. Using regular OLS analysis, the continuous explanatory estimators can be interpreted as follows. A one percentage change in the explanatory variable leads to a β percentage change in the dependent variable. Any explanatory variable that cannot be included in the regression is assumed to be included in the residual term. All data retrieved and used in the models is at current (nominal) prices. This is to achieve consistency throughout the procedures.

The categorical variables are numerical representations of the different levels of the categories. Using categorical variables is a way of incorporating qualitative effects into regression equations. Demographic characteristics in the MS model include the categorical variables age group (age); gender (gen); population (pop); settlement (set); education (edu); and taxable income group (taxgrp). For each categorical variable, dummy variables are created to represent the different levels of the categorical variable.

A regression function with an intercept term must have one less dummy variable than the number of categories in a categorical group, in order to have such an omitted group as the reference dummy. This is done to avoid the dummy variable trap and therefore perfect multicolinearity (Greene, 2010:152).

The coefficients of the dummy variables can be explained as the proportional difference between the dummies, and show how much higher or lower, on average, the dependent variable is for the specific categorical variable, keeping the other explanatory variables constant. Interaction terms are used when the effect of one of the explanatory factors on the dependent variable depends on the level of another of the explanatory factors.

Table 29: Reference groups for categorical variables

Taxgrp	Frequency	%		Taxgrp	New category
1	40 149	92	Reference	6	0 – 80 000
2	1 768	4		1	80 001 – 130 000
3	860	2		2	130 001 – 180 000
4	319	1		3	180 001 – 230 000
5	193	0		4	230 001 – 300 000
6	325	1		5	> 300 000
	43 614	100			
Age	**Frequency**	**%**		**Age**	**New category**
1	12 780	29	Reference	4	0 = age < 20
2	19 546	45		1	20<= age <50
3	6 614	15		2	50<= age <65
4	4 674	11		3	>=65
	43 614	100			
Gen	**Frequency**	**%**		**Gen**	**New category**
1	21 007	48		1	male
2	22 607	52	Reference	2	female
	43 614	100			
Pop	**Frequency**	**%**		**Pop**	**New category**
1	33 505	77	Reference	4	African/Black
2	6 300	14		1	Coloured
3	679	2		2	Indian/Asian
4	3 130	7		3	White
	43 614	100			
Set	**Frequency**	**%**		**Set**	**New category**
1	22 950	53	Reference	2	urban
2	20 664	47		1	rural
	43 614	100			
Edu	**Frequency**	**%**		**Edu**	**New category**
1	10 011	23	Reference	3	No School
2	30 312	70		1	Gr1 - Gr12
3	3 291	8		2	NIC, Diploma, Degrees
	43 614	100			

Source: Own Calculations

For the regression analysis, all the survey observations with unspecified income are excluded from the dataset, meaning that almost half of the survey individuals are excluded. These observations had to be excluded from the regression to avoid bias parameter estimates. Dummy variables in the multiple linear regression model are created for each of the categorical variables to indicate the presence of an effect in the categorical group, and zero for the remaining categorical variables. The coefficients of the categorical variables indicate the differences between them. Table 29 shows the categorical dummy variables and the reference group. The selection of the reference group for each categorical variable is made by choosing the most frequent category in the data, except for the age group and education group. In this case the reference groups are different, to simplify the interpretation of the coefficient (Hoffman, 2003).

The interactions between the categorical variables give insignificant results, and therefore the interaction terms are not included in the regression.

In the log-linear regression, the intercept gives the mean of disposable income of the omitted dummy variables. The coefficient of a dummy variable with the intercept gives the mean of disposable income for the particular dummy, and only the coefficient of the dummy variable indicates the difference in mean disposable income between the dummies in a specific categorical group. The exact change is illustrated in equation 46 (Greene, 2010:150).

$$\%\Delta Eldpinc / \Delta char = 100\%[EXP(\beta_i) - 1] \qquad (46)$$

5.6.9 Base model results

After simulating tax liability with the MS model, the results are compared to published SARS data, IES, and the Bureau of Market Research of the University of South Africa. Table 30 shows that, according to the MS model, tax liability of R132 billion is more than the SARS assessed tax liability of R111 billion (the actual amount collected was R125 billion), because the MS model accounts for the whole South African population and not only for assessed taxpayers. The results for gross income and tax liability are very similar to those of the Bureau of Market Research Bundles (2000:17). It should be noted, though, that the MS model only calculates tax liability, which differs from the actual amount collected due to advance and lagged payments.

Table 30: Comparison of IES, MS model, and SARS data for 2005/2006

Database	Gross Income (R million)	Taxable Income (R million)	Tax Liability (R million)
IES Survey data			
Total population	841 000	n/a	64 700
SARS Tax statistics			
90.2% assessed filer taxpayers	n/a	511 547	111 330
MS model			
Total population	1 014 408	846 961	132 832
Bureau of Market Research Bundles	1 166 035		156 626

Source: IES (2008:12); Bureau of Market Research Bundles (2000:17); Tax Statistics (2009:15); SARB (2012)

Table 31: MS model results 2005/2006

Taxable income group	Number of taxpayers	Gross income (R million)	Taxable income (R million)
Unspecified	22 656 489	-	-
0 - < 35 000	19 231 586	206 145	175 223
35 001 – 60 000	1 848 869	100 649	85 552
60 001 – 80 000	730 648	59 291	50 758
80 001 – 130 000	1 279 451	153 838	130 930
130 001 – 180 000	655 113	119 465	98 507
180 001 – 230 000	286 880	71 671	57 438
230 001 – 300 000	204 966	66 912	54 673
>300 000	329 544	236 438	193 879
Total	47 223 545	1 014 408	846 961

Source: Own calculations

Table 31 shows the MS model results. Almost half the population reports unspecified gross income, while approximately 19 million fall under the tax threshold of R35 000. About 1.8 million individuals earn income between R35 000 and R60 000. At the time, those earning less than R60 000 only qualified for the standard income tax on employees (SITE), and were not liable to file a tax return.

Generally, the income figures reported by SARS originate from activities in the formal sector, while income from the Stats SA data is more representative of both the formal and the informal sectors. Therefore one would expect the income levels of the survey data to be higher than in the SARS data. According to SARS, the number of individuals assessed (tax filers) for the tax year 2005/2006 came to 3.9 million (Tax Statistics, 2010). According to the LFS, the formal sector accommodated about 8.6 million jobs. Therefore 4.7 million of the individuals employed in the formal sector have not been accounted for in the SARS filer data. Obviously a large number of them only pay SITE, and fall below the threshold income level, and so are not registered as filer taxpayers (Stats SA, 2005).

Table 32 shows a summary of the number of taxpayers, taxable income, and tax liability by taxable income group, comparing SARS data and the MS model. A large number of taxpayers (almost 50 per cent of total taxpayers) fall within the lower income group (less than R80 000). The income groups (less than R130 000) in total earn 40 per cent of taxable income and pay 19 per cent of total tax liability. The highest income group, above R300 000, earns 29 per cent of taxable income and contributes 48 per cent of total tax liability. Tax liability is highly skewed to the higher income groups, indicating sensitivity to policy changes. The income group R180 000 to R230 000 comprises only 5 per cent of total taxpayers, but earns 9 per cent of taxable income and pays 9 per cent of total tax liability.

It is evident from Table 32 that the number of taxpayers, taxable income, and tax assessed per taxable income group (excluding SITE individuals) in the two different databases are close to each other, indicating that the adjusted IES data is sufficient for use in the MS model. The data shows that the survey income data seems to be biased towards the lower income groups, with their taxable income 8 per cent more than in the SARS data. In the case of the other income groups, the difference in taxable income between the two datasets only varies between 1 and 5 per cent.

Once the tax liability of the different income groups has been estimated and benchmarked against the SARS figures, the profile of the taxpayers is analysed based on gender, age groups, education, and race classification.

Table 32: Comparison of the MS model and SARS data by taxable income group

Tax year	2006 SARS *[90.2% assessed]*			Tax year	2006 MS model		
Taxable income group	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**	**Taxable income group**	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**
0 – 60 000	1 098 979	28 864	947	35 000 – 60 000	1 848 869	85 552	3 546
60 001 – 80 000	475 750	33 586	2 924	60 000 – 80 000	730 648	50 758	4 442
80 001 – 130 000	1 095 553	113 220	15 089	80 000 – 130 000	1 279 451	130 930	17 265
130 001 – 180 000	483 367	74 610	13 387	130 000 – 180 000	655 113	98 507	17 415
180 001 – 230 000	242 473	48 458	10 304	180 000 – 230 000	286 880	57 438	12 188
230 001 – 300 000	224 487	54 276	12 759	230 000 – 300 000	204 966	54 673	13 731
>300 000	297 652	173 427	55 919	>300 000	329 544	193 879	64 244
Total	**3 918 261**	**526 440**	**111 329**	**Total**	**5 335 470**	**671 738**	**132 832**
Percentage of total	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**	**Percentage of total**	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**
0 – 60 000	28%	5%	1%	35 000 – 60 000	35%	13%	3%
60 001 – 80 000	12%	6%	3%	60 000 – 80 000	14%	8%	3%
80 001 – 130 000	28%	22%	14%	80 000 – 130 000	24%	19%	13%
130 001 – 180 000	12%	14%	12%	130 000 – 180 000	12%	15%	13%
180 001 – 230 000	6%	9%	9%	180 000 – 230 000	5%	9%	9%
230 001 – 300 000	6%	10%	11%	230 000 – 300 000	4%	8%	10%
>300 000	8%	33%	50%	>300 000	6%	29%	48%
Total	**100%**	**100%**	**100%**	**Total**	**100%**	**100%**	**100%**

Source: Own calculations

Table 33 shows the number of taxpayers, taxable income, and tax assessed by age group; and the distribution between these groups is similar for both datasets. In the case of the first age group (younger than 18 years), the numbers included in the SARS data are close to the model data, but taxable income in the SARS data is about 31 per cent less than in the MS data. This is interesting but not unexpected, given that a number of young people are listed on the SARS data, and based on the fact that although they are not formally employed, they earn taxable income from inheritances, grants, or other sources of income that are not reflected in the IES data. In the case of all the other age groups (except the category above 65), the IES taxable income and tax liability data are close to the SARS data.

For the age group 25 to 34 years, the number of taxpayers as a percentage of total taxpayers hovers around 30 per cent, and they contribute about 21 per cent of total tax liability. The age group 35 to 44 years comprises 28 per cent of total taxpayers and contributes 27 per cent of total tax liability. The age group 45 to 64 years comprises 34 per cent of total taxpayers and is responsible for 47 per cent of total tax liability. As far as the age group above 65 years is concerned, in the MS data they only represent 2 per cent of total taxpayers, but in the SARS data they are 8 per cent of the total taxpayers. This clearly does not reflect the full number of taxpayers.

Table 34 shows that in the case of gender, SARS data report the taxable income of females to be approximately R168 billion, compared to the model calculation based on MS data of R213 billion. In terms of the number of taxpayers, the two sets of data are actually very close (1,6 million compared to 1,9 million). The average taxable income and tax liability based on the MS data is slightly higher than in the case of SARS data. The reason is probably the fact that more females fall into the lower taxable income groups, with the MS data slightly biased towards the lower income groups. As far as males are concerned, the IES data shows more males than the SARS data, with both taxable income and tax liability also higher. The reason is probably that, in the case of the former data set, more males are included who are not reflected in the official SARS database. Males account for almost 73 per cent of total tax liability, and comprise 63 per cent of the registered taxpayers earning 68 per cent of total taxable income. The data indicates the uneven distribution of taxable income between males and females (a difference of 36 per cent), despite the fact that the numbers only differ by 25 per cent.

For racial, educational, and settlement classification, data could not be validated against the published SARS data, and therefore only the MS model results are discussed. Table 35 shows the racial classifications, with the African/Black and White taxpayer groupings accounting for 47 per cent and 37 per cent of the total number of taxpayers, respectively. In the income group under R80 000, African/Black taxpayers account for the largest share (63 per cent) while Whites have the smallest share (24 per cent); Coloureds and Indians are on 57 per cent and 52 per cent, respectively. Taxable income and tax liability of the racial groups is shown in Tables 36 and 37, respectively. Whites contribute 56 per cent to total taxable income and pay 68 per cent of total taxes. Whites earning above R300 000 earn 24 per cent of total taxable income and pay 40 per cent of total tax liability. Besides this, the African/Black group earns 31 per cent of total taxable income and pays 22 per cent of total tax liability. About 63 per cent of this group falls in the group below R80 000, which only pays 16 per cent of total tax liability.

Tables 38, 39, and 40 contain the number of taxpayers, taxable income, and tax liability based on educational level. Four different groups are identified: No Education, Grade R to Grade 11, Grade 12, and Other after-school qualifications. The groups Grade 12 and Other qualifications comprise 30 per cent and 39 per cent of total taxpayers, earning 27 per cent and 56 per cent of total taxable income, and contributing 24 per cent and 66 per cent of total tax liability, respectively. Individuals with no education only comprise 1 per cent of total taxpayers, earning 1 per cent of total taxable income, and contributing only 1 per cent to total tax liability. This clearly shows the importance of education in expanding the tax base.

Table 33: Number of taxpayers, taxable income, and tax assessed by age group

Tax year	2006 SARS *[90.2% assessed]*			Tax year	2006 MS model		
Age group (years)	Number of taxpayers	Taxable income (R million)	Tax assessed (R million)	Age group (years)	Number of taxpayers	Taxable income (R million)	Tax assessed (R million)
Below 18	19 886	844	124	Below 18	37 212	2 628	277
18 - 24	129 906	8797	1 160	18 - 24	262 914	23 034	3 316
25 - 34	913 875	109 886	21 196	25 - 34	1 562 945	164 058	27 771
35 - 44	1 180 487	168 225	37 168	35 - 44	1 471 006	187 336	36 489
45 - 54	922 367	134 174	31 532	45 - 54	1 170 390	174 441	38 781
55 - 64	527 284	66 558	16 146	55 - 64	620 985	100 265	23 841
65 and older	312 661	23 063	4 003	65 and older	210 018	19 977	2 356
Total	**4 006 466**	**511 547**	**111 330**	**Total**	**5 335 470**	**671 738**	**132 832**
Percentage of total				**Percentage of total**			
Below 18	0%	0%	0%	Below 18	1%	0%	0%
18 - 24	3%	2%	1%	18 - 24	5%	3%	2%
25 - 34	23%	21%	19%	25 - 34	29%	24%	21%
35 - 44	29%	33%	33%	35 - 44	28%	28%	27%
45 - 54	23%	26%	28%	45 - 54	22%	26%	29%
55 - 64	13%	13%	15%	55 - 64	12%	15%	18%
65 and older	8%	5%	4%	65 and older	4%	3%	2%
Total	**100%**	**100%**	**100%**	**Total**	**100%**	**100%**	**100%**

Source: Tax Statistics (2009:45), Own calculations

Table 34: Number of taxpayers, taxable income, and tax assessed by gender group

Tax year	**2006 SARS** *[90.2% assessed]*			**Tax year**	**2006 MS model**		
Gender	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**	**Gender**	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**
Female	1 676 631	168 903	29 424	Female	1 991 366	215 218	35 685
Male	2 329 835	342 645	81 906	Male	3 344 103	456 520	97 147
Total	**4 006 466**	**511 547**	**111 330**	**Total**	**5 335 470**	**671 738**	**132 832**
Percentage of total				**Percentage of total**			
Female	42%	33%	26%	Female	37%	32%	27%
Male	58%	67%	74%	Male	63%	68%	73%
Total	**100%**	**100%**	**100%**	**Total**	**100%**	**100%**	**100%**

Source: Tax Statistics (2009:45), Own calculations

Table 35: Racial group – Number of taxpayers

Tax year	**2006 MS model**				
Taxable income groups	**African/Black**	**Coloured**	**Indian /Asian**	**White**	**Total**
35 000 – 60 000	1 180 017	245 361	96 758	326 732	1 848 868
60 001 – 80 000	406 831	80 972	51 058	191 788	730 649
80 001 – 130 000	564 234	131 971	53 360	529 886	1 279 451
130 001 – 180 000	214 569	66 869	26 238	347 436	655 112
180 001 – 230 000	57 007	18 280	26 251	185 342	286 880
230 001 – 300 000	22 998	12 379	14 822	154 766	204 965
> 300 000	40 588	9 877	14 725	264 353	329 543
	2 486 244	565 709	283 212	2 000 303	5 335 468
Percentage of total					
35 000 – 60 000	47%	43%	34%	16%	35%
60 001 – 80 000	16%	14%	18%	10%	14%
80 001 – 130 000	23%	23%	19%	26%	24%
130 001 – 180 000	9%	12%	9%	17%	12%
180 001 – 230 000	2%	3%	9%	9%	5%
230 001 – 300 000	1%	2%	5%	8%	4%
> 300 000	2%	2%	5%	13%	6%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations

Table 36: Racial group – Taxable income

Tax year	**2006 MS model**				
Taxable income groups	**African/Black**	**Coloured**	**Indian /Asian**	**White**	**Total**
35 000 – 60 000	54 167	11 284	4 473	15 628	85 552
60 001 – 80 000	28 031	5 650	3 598	13 480	50 759
80 001 – 130 000	57 008	13 615	5 612	54 697	130 932
130 001 – 180 000	32 155	10 011	3 868	52 473	98 507
180 001 – 230 000	11 358	3 645	5 368	37 067	57 438
230 001 – 300 000	5 873	3 221	3 939	41 640	54 673
> 300 000	22 076	5 213	7 155	159 435	193 879
	210 668	52 639	34 013	374 420	671 740
Percentage of total					
35 000 – 60 000	26%	21%	13%	4%	13%
60 001 – 80 000	13%	11%	11%	4%	8%
80 001 – 130 000	27%	26%	16%	15%	19%
130 001 – 180 000	15%	19%	11%	14%	15%
180 001 – 230 000	5%	7%	16%	10%	9%
230 001 – 300 000	3%	6%	12%	11%	8%
> 300 000	10%	10%	21%	43%	29%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations

Table 37: Racial group – Total tax liability

Tax year	2006 MS model				
Taxable income groups	**African/Black**	**Coloured**	**Indian /Asian**	**White**	**Total**
35 000 – 60 000	2 258	472	193	623	3 546
60 001 – 80 000	2 465	502	325	1 151	4 443
80 001 – 130 000	7 515	1 828	752	7 170	17 265
130 001 – 180 000	5 682	1 772	678	9 283	17 415
180 001 – 230 000	2 413	775	1 157	7 843	12 188
230 001 – 300 000	1 441	791	989	10 510	13 731
> 300 000	7 193	1 687	2 268	53 096	64 244
	28 967	7 827	6 362	89 676	132 832
Percentage of total					
35 000 – 60 000	8%	6%	3%	1%	3%
60 001 – 80 000	9%	6%	5%	1%	3%
80 001 – 130 000	26%	23%	12%	8%	13%
130 001 – 180 000	20%	23%	11%	10%	13%
180 001 – 230 000	8%	10%	18%	9%	9%
230 001 – 300 000	5%	10%	16%	12%	10%
> 300 000	25%	22%	36%	59%	48%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations

Table 38: Education group – Number of taxpayers

Tax year	**2006 MS model**				
Taxable income groups	**No Education**	**Grade R-11**	**Grade 12**	**Other qualification**	**Total**
35 000 – 60 000	54 093	957 822	551 371	285 583	1 848 869
60 001 – 80 000	13 126	258 365	243 270	215 886	730 647
80 001 – 130 000	12 906	241 394	450 612	574 538	1 279 450
130 001 – 180 000	1 463	51 390	187 214	415 045	655 112
180 001 – 230 000	629	26 275	72 731	187 244	286 879
230 001 – 300 000	396	13 543	48 469	142 558	204 966
> 300 000	2 917	19 614	63 696	243 316	329 543
	85 530	1 568 403	1 617 363	2 064 170	5 335 466
Percentage of total					
35 000 – 60 000	63%	61%	34%	14%	35%
60 001 – 80 000	15%	16%	15%	10%	14%
80 001 – 130 000	15%	15%	28%	28%	24%
130 001 – 180 000	2%	3%	12%	20%	12%
180 001 – 230 000	1%	2%	4%	9%	5%
230 001 – 300 000	0%	1%	3%	7%	4%
> 300 000	3%	1%	4%	12%	6%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations

Table 39: Education group – Taxable income

Tax year	2006 MS model				
Taxable income groups	**No Education**	**Grade R-11**	**Grade 12**	**Other qualification**	**Total**
35 000 – 60 000	2 437	43 817	25 667	13 630	85 551
60 001 – 80 000	895	17 747	17 107	15 009	50 758
80 001 – 130 000	1 311	23 667	45 718	60 235	130 931
130 001 – 180 000	211	7 511	27 920	62 865	98 507
180 001 – 230 000	120	5 225	14 469	37 624	57 438
230 001 – 300 000	105	3 562	13 011	37 995	54 673
> 300 000	1 063	10 124	36 868	145 824	193 879
	6 142	111 653	180 760	373 182	671 737
Percentage of total					
35 000 – 60 000	40%	39%	14%	4%	13%
60 001 – 80 000	15%	16%	9%	4%	8%
80 001 – 130 000	21%	21%	25%	16%	19%
130 001 – 180 000	3%	7%	15%	17%	15%
180 001 – 230 000	2%	5%	8%	10%	9%
230 001 – 300 000	2%	3%	7%	10%	8%
> 300 000	17%	9%	20%	39%	29%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations

Table 40: Education group – Tax liability

Tax year	**2006 MS model**				
Taxable income groups	**No Education**	**Grade R-11**	**Grade 12**	**Other qualification**	**Total**
35 000 – 60 000	84	1 759	1 108	595	3 546
60 001 – 80 000	78	1 540	1 529	1 295	4 442
80 001 – 130 000	170	2 990	5 945	8 160	17 265
130 001 – 180 000	36	1 293	4 904	11 182	17 415
180 001 – 230 000	25	1 107	3 071	7 986	12 189
230 001 – 300 000	27	884	3 273	9 547	13 731
> 300 000	307	3 257	12 180	48 500	64 244
	727	12 830	32 010	87 265	132 832
Percentage of total					
35 000 – 60 000	12%	14%	3%	1%	3%
60 001 – 80 000	11%	12%	5%	1%	3%
80 001 – 130 000	23%	23%	19%	9%	13%
130 001 – 180 000	5%	10%	15%	13%	13%
180 001 – 230 000	3%	9%	10%	9%	9%
230 001 – 300 000	4%	7%	10%	11%	10%
> 300 000	42%	25%	38%	56%	48%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations

Table 41 contains the number of taxpayers, taxable income, and tax liability based on settlement area. Two areas are identified; rural and urban. About 87 per cent of taxpayers stay in an urban area, and pay 92 per cent of total taxes.

Table 41: Number of taxpayers, taxable income, and tax assessed by settlement

Tax year	2006 MS model		
Settlement	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**
Urban	4 659 065	606 230	122 016
Rural	676 405	65 508	10 816
Total	**5 335 470**	**671 738**	**132 832**
Percentage of total			
Urban	87%	90%	92%
Rural	13%	10%	8%
Total	**100%**	**100%**	**100%**

Source: Own calculations

5.6.10 Ageing the base year to 2010/2011 for policy simulations

5.6.10.1 *Re-weighting the base year to 2010/2011*

Household composition and employment status are characteristics of the population that would have changed between 2005/2006 and 2010/2011. However, these changes have not been included in the analysis that follows. Comparing the changes in the variables (gender, age groups) in Tax Statistics from 2003 to 2010, the distribution of these variables between taxable income groups stayed more or less the same.

Static re-weighting involves changing the weight attached to each individual record in the micro database to reflect the economic and social changes since the base year adjustments. The CALMAR re-weighting programme is used to age the database from 2005/2006 to the 2010/2011 fiscal year by adjusting the weights in the MS model. The mid-year population estimates for 2010 and 2011 by Stats SA are reworked to the fiscal year 2010/2011, with a population total of 50.59 million.

5.6.10.2 *Up-rating income*

Up-rating involves adjusting the monetary values within the original micro data to account for estimated movement since the base year. The total gross income is benchmarked against the 2010/2011 fiscal year household primary income of R1 627 billion as published in the national accounts of the SARB. Primary income includes households and non-profit organisations, and is adjusted to account only for household income, which comprises 93[16] per cent of the total income.

5.6.10.3 *Tax allowances, deductions, and fringe benefit ratios*

Following the same methodology as in Table 27, Table 42 shows the allowance ratios for the fiscal year 2010/2011, using allowances and deduction data in the publication Tax Statistics 2012. These ratios differ from the 2005/2006 ratios: they are higher in the lower income groups, and decline slightly in the highest income group, indicating more tax relief for lower income individuals.

Table 42: Allowance factor for 2010/2011

Taxable income group	Allowance factor
R0 – R140 000	0.21
R140 001 – R221 000	0.21
R221 001 – R305 000	0.20
R305 001 – R431 000	0.20
R431 001 – R552 000	0.20
R552 000 and above	0.17

Source: Own calculation

5.6.10.4 *Calculating tax liability – fiscal year 2010/2011*

In order to calculate the tax liability for 2010/2011, the tax rates in Table 43 have been used.

[16] R1 627 billion*93 per cent = R1 513 billion

Table 43: Tax rates 2010/2011

Taxable income brackets	Marginal rates of Tax	
R0 – R140 000		18% of each R1
R140 000 – R221 000	R25 200 +	25% of the amount above R140 000
R221 000 – R305 000	R45 450 +	30% of the amount above R221 000
R305 000 – R431 000	R70 650 +	35% of the amount above R305 000
R431 000 – R552 000	R114 750 +	38% of the amount above R431 000
R552 000 and above	R160 730 +	40% of the amount above R552 000
Primary rebate: R10 260		
Secondary rebate: R15 935		
Tax thresholds for below 65 years: R57 000		
Tax thresholds for 65 years and older: R88 528		

Source: National Treasury (2011)

5.6.10.5 *Up-rated model results*

Table 44 shows the up-rated data for 2010/2011 estimated by the MS model. The total number of taxpayers liable to submit returns increases to 5.3 million, which is more than the 4.5 million taxpayers recorded in Tax Statistics (2012) for 2010/2011 (only 94 per cent of individuals assessed). The model estimates a total taxable income and tax liability of R1 069 billion and R204 billion, respectively for the fiscal year 2010/2011. The published filer data for 2010/2011 total taxable income and tax assessed are R908 billion and R182 billion, respectively.

Table 44: MS model 2010/2011

Tax year	2011 SARS (94.1% assessed)			Tax year	2011 MS model		
Taxable income bands	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**	**Taxable income bands**	**Number of taxpayers**	**Taxable income (R million)**	**Tax assessed (R million)**
threshold – 140 000	2 250 574	161 395	10 172	57 000 – 140 000	2 892 972	258 734	16 626
140 001 – 221 000	985 078	175 899	24 133	140 000 – 221 000	1 204 443	213 079	28 905
221 001 – 305 000	547 758	132 146	22 559	221 000 – 305 000	575 359	148 642	26 574
305 001 – 431 000	345 390	123 726	27 201	305 000 – 431 000	320 434	116 350	25 818
431 001 – 552 000	141 479	68 109	17 476	431 000 – 552 000	150 311	73 232	18 908
> 552 000	252 413	246 647	80 620	> 552 000	242 862	259 868	86 841
	4 522 692	**907 922**	**182 161**		**5 386 380**	**1 069 906**	**203 672**
Percentage of total				**Percentage of total**			
threshold – 140 000	50%	18%	6%	threshold – 140 000	54%	24%	8%
140 001 – 221 000	22%	19%	13%	140 000 - 221 000	22%	20%	14%
221 001 – 305 000	12%	15%	12%	221 000 - 305 000	11%	14%	13%
305 001 – 431 000	8%	14%	15%	305 000 - 431 000	6%	11%	13%
431 001 – 552 000	3%	8%	10%	431 000 - 552 000	3%	7%	9%
> 552 000	6%	27%	44%	> 552 000	5%	24%	43%
Total	**100%**	**100%**	**100%**	**Total**	**100%**	**100%**	**100%**

Source: Own calculations

5.6.11 Main findings and insight

The individual tax revenue base is disseminated by using an MS model based on individual and household data from the IES published by Stats SA. After substantial imputation, the data has been aggregated to tax data and compared to data published by SARS. For the missing categorical variables in the IES survey, a frequency table for each variable was obtained to determine the distribution of the missing values. The RANUNI statistical method was used to impute the missing values. A problem encountered is that data on tax liability has not been accurately recorded in the survey data.

Furthermore, the IES and SARS databases differ in terms of base years (calendar versus fiscal years); and to be able to compare them, the IES data had to be adjusted to the fiscal year 2005/2006 data using the CALMAR re-weighting programme. An analysis of the demographics of the data shows that income (and therefore tax liability) is slightly more skewly distributed according to the IES data. Both datasets indicate that the richest 10 per cent of individuals pay almost 40 per cent of total revenue collected. The CALMAR re-weighting programme is then used to age the database to the 2010/2011 tax year for tax policy analysis.

The base model also allows for comparisons between different gender groups, indicating that males contribute 73 per cent of total tax liability. Different race groups are also compared. It is interesting to note that the African/Black racial group (which comprises more than 78 per cent of the total population) only pays 22 per cent of total tax liability, compared to the 68 per cent of the White population group (reflecting the skewness in income distribution).

The model also indicates that tax liability increases substantially with higher levels of education. More than 90 per cent of taxpayers possess a Grade 12 or higher qualification. The age distribution analysis shows that most income is earned by individuals in the age group 35 to 44 years of age (more than 28 per cent), followed by those in the age group 45 to 54 years. However, as far as tax liability is concerned, the share of the two groups is reversed: they are 29 and 27 per cent, respectively.

5.7 CONCLUSION

This chapter provides an overview of literature on the MS models, the differences and limitations between MS and CGE models, and their linking or layering. The importance of the MS modelling lies in the fact that it includes household characteristics such as age, household size, and settlement variables, which are important demographic characteristics of the taxpaying population. Diversified information of this nature is not available at the macro level, and macro-models can therefore not be used for analysis of this kind. The model used in this analysis provides for analysis of income, distributional and incentive effects of cost, and benefits over the full range of individuals and families included in the data base.

The MS model devised in this study contains information on individuals, and offers the user of the model various simulation options that reflect fiscal policy changes and their impact on the disposable income of individuals in South Africa. Comparing the simulated and actual taxes collected by SARS, a portion of the tax gap can be quantified. The quality and reliability of the model can be tested by comparing the taxable income, tax liability, and number of taxpayers of the model with similar results published by SARS in their filer data. Thus the model is unique, and it adds value by integrating the Stats SA survey database and the published Tax Statistics data.

In the next chapter, the MS model simulates some of the identified tax reforms namely changes in marginal rates, thresholds, income bands, and tax expenditures. The impact of progressivity, tax efficiency, revenue, and growth-maximising tax ratios of each scenario is outlined.

CHAPTER 6

TESTING DIFFERENT TAX POLICY OPTIONS

6.1 INTRODUCTION

In this chapter, the MS model is used to analyse the impact of three tax reform options discussed in Chapter 2, and further verified in Chapter 3 that could improve revenue and the efficiency of PIT in South Africa. The analysis includes estimates of the impact of the tax reforms on progressivity and therefore the "fairness" of the tax structures. Three alternative scenarios are assessed under each policy reform option.

The first tax reform option simulates changes in the PIT structure by means of changes in marginal rates. More progressive marginal rates are tested, using as one extreme the relatively high marginal income tax rates from the 1998/1999 fiscal year, followed by a less progressive scenario based on the findings on best practice tax structures (as explained in Chapter 2) with the marginal rate of the lowest taxable income group on 12 per cent and that of the highest income group on 30 per cent.

The second tax reform option simulates changes in income tax bands and non-taxable thresholds. As explained previously, tax reform in other upper-middle income countries mainly features the adjustment of tax brackets and thresholds to account for inflation (avoiding bracket creep). This practice is also followed in South Africa, where taxable income bands and threshold levels are indexed for inflation every fiscal year. Thus, the scenario testing accounts for the adjustment of thresholds and margins of taxable income bands, initially based on inflation adjustments only, but then also based on best practices in other upper-middle income countries.

The third tax reform option analyses the impact of tax expenditures on the progressivity (equity/fairness) and the efficiency of PIT. In this case, the tax expenditure considered is limited to medical deductions. The reason for this is the fact that the South African Government has recently announced a change in policy by switching from a system of tax free deductions to medical credits. Factors that affected the proposed change in policy included limited membership of medical schemes in this country and the relatively low quality – or lack – of public medical services. Thus, the scenario tested in this study is the impact of such a switch from a system where member contributions to medical schemes are deducted from taxable income, to a scheme where such contributions are regarded as credits against the contributor's tax liability. This tax reform has already been implemented by the National Treasury in fiscal year 2012/2013 (National Treasury, 2012:51). Therefore, this study merely attempts to analyse the merit for such a reform and also to quantify the implications thereof both in terms of the requirements for a "good" tax but also its impact on the revenue base.

It should be noted that medical deductions are one of the largest leakages from the revenue base. As indicated earlier, tax expenditures include allowances as determined by the tax law that reduce the amount of revenue that would otherwise have been collected. In this analysis, the revenue foregone method is used in the MS tax model to estimate the impact of such tax expenditures. It does so by calculating the amount of tax revenue that would have been collected in the absence of such expenditures. Given the static nature of the model, it is assumed that the behavioural response of taxpayers remains unchanged.

The MS model reflects how each income category is affected by tax reform changes, by identifying winners and losers. It also estimates the impact on the level of equity (distribution of wealth) by testing for changes in the progressivity of the tax structure before and after a tax reform. The efficiency of tax reform is measured by using the deadweight loss methodology as outlined in Chapter 4.

6.2 TAX REFORM 1: CHANGING THE MARGINAL TAX RATE STRUCTURE

As mentioned at the beginning of this chapter, the main objective of this analysis is to determine the impact of changes in marginal tax rates on the revenue base, and its impact on tax efficiency. The marginal tax rates of the 2005/2006 fiscal year are used as a base from which changes are implemented. Besides the base scenario, two other scenarios are simulated: one where marginal rates are increased, and one where marginal rates are decreased. The different marginal tax rate structures are reported in Table 45. The scenarios are defined as follows:

Scenario A: The base year is 2005/2006, and the marginal tax rates are between 18 and 40 per cent. These rates have remained constant since the 2002/2003 fiscal year.

Scenario B: From Chapter 2 it is evident that the PIT/GDP ratios of higher income countries are lower than South Africa's. This is because, in most upper-middle income countries, PIT is not as important a source of tax revenue as it is in South Africa and in high income countries. High income countries' marginal tax rates are also higher than those of upper-middle income countries. In order to choose a realistic scenario with higher marginal rates, the rates were chosen that applied in the financial year 1998/1999 (during those years the rates were higher than the current rates in Scenario A and useful for the purpose of comparison since at the time the number of income tax bands were also reduced to only 6 from the previous 10 which is equal to the number in Scenario A). Marginal rates in this scenario range between 19 and 45 per cent for the lowest and highest income groups, respectively. These rates are also more progressive than those in the base scenario.

Scenario C: This scenario includes lower marginal tax rates. According to the literature discussed in Chapter 2, best practice shows that the marginal tax rate for the lower income band should be between 10 and 20 per cent, and the highest marginal tax rate between 30 and 50 per cent, with the number of income tax bands between 4 and 6. Therefore, the scenario reflects a tax regime comparable to those of South Africa's peers, with marginal tax rates starting at 12 per cent and increasing to a maximum of 30 per cent for the highest income group.

6.2.1 <u>Model results with a marginal tax rate reform</u>

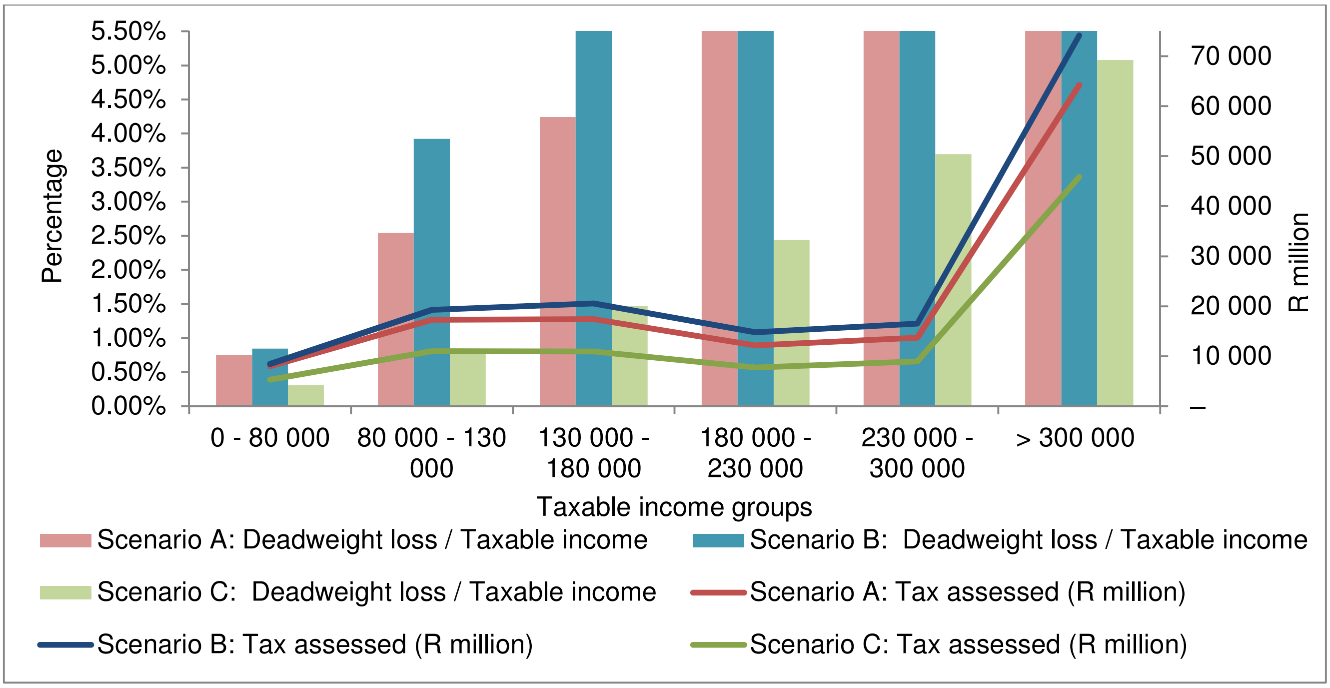
6.2.1.1 *Impact on the revenue base, tax efficiency and optimal revenue levels*

The results for Scenario A are given in Table 46, which reflects the number of taxpayers, taxable income, tax assessed, and the deadweight loss per population group for the different income groups. The total deadweight loss amounts to R37.5 billion, with total tax liability at R132.8 billion in Scenario A. It should be noted that the deadweight loss increases substantially with an increase in taxable income levels – of which 54.5 per cent comes from the highest income group.

Table 46 also reflects the results of both more and less progressive marginal tax rate regimes, compared to the base model. In Scenario B the marginal tax rate per income group increases from 18 to 19 per cent, 25 to 30 per cent, 35 to 43 per cent, 38 to 44 per cent, and 40 to 45 per cent, respectively. These changes result in an increase in total revenue, from the previous R132.8 billion to R153.7 billion (an increase of 16 per cent), but with deadweight loss increasing from R37.5 billion to R56.2 billion (an increase of 50 per cent).

The decreased marginal tax rates in Scenario C (from 18 to 12 per cent, 25 to 15 per cent, 30 to 19 per cent, 35 to 23 per cent, 38 to 27 per cent, and 40 to 30 per cent, respectively) imply a loss of about R43 billion (tax liability decreases from R132.8 to R89.9 billion), but also a reduction in the deadweight loss (increase in efficiency) of R21.3 billion. The changes in both revenue and deadweight loss per income group demonstrate that income groups are affected differently by such changes in marginal taxes. Although those in the highest income group are mostly affected in both Scenarios B and C as far as tax liability is concerned, the percentage change is different from that of some of the other income groups. In the case of Scenario B the tax liability of the above R300 000 group increases by 15 per cent, while tax efficiency decreases by 38 per cent. In Scenario C this group's tax liability deceases by 29 per cent and tax efficiency increases by 52 per cent.

Figure 19: Tax assessed and tax efficiency



Source: Own calculations

However, a similar analysis of the income group R130 000 to R180 000 demonstrates that, in the case of Scenario B, their tax liability increases by 18 per cent; but tax efficiency as measured by the inverse of the deadweight loss of tax in this income group decreases by 94 per cent. In Scenario C, with the lower rates, their tax liability decreases by 37 per cent and deadweight loss by 65 per cent (increase in tax efficiency). The changes in all income groups as a result of the changes in the marginal rates are also reflected in Figure 19. With higher marginal tax rates (Scenario B), revenue increases, but tax efficiency decreases. Lower marginal tax rates (Scenario C) show a decrease in tax revenue in all income groups, but an increase in efficiency as could be anticipated.

The revenue-maximising rate (Chapter 4) provides an upper bound on the range of optimal tax rates at which PIT is maximised. This estimated revenue-maximising tax rate between the taxable income groups hovers around 40.5 to 43 per cent in Table 20. In Scenario A (Table 45) the marginal tax rates range between 18 and 40 per cent and the tax rates are below the revenue-maximising tax rates. In Scenario B, for income groups in excess of R230 000, the marginal tax rate is 44 and 45 per cent, respectively, and higher than the optimum tax rates. Tax rates above the revenue-maximising level are irrelevant to consider because the excess burden of collecting an additional rand approach infinity. Less progressive marginal tax rates in Scenario C (Table 45) range between 12 to 30 per cent and result in a tax/GDP ratio lower than the revenue-maximising tax rate.

6.2.1.2 *Impact of reforms in marginal rates on progressivity and optimal growth levels*

The impact of tax reform on progressivity can be analysed by means of the elasticities in Table 47, as discussed in Chapter 4. The first approach is to apply the tax elasticity coefficients to changes in taxable income (equation 15) for the different scenarios. As mentioned before, a coefficient exceeding unity indicates the progressiveness of the tax regime. In the case of the base scenario, elasticity is 1.35 and it increases to 1.37 with more progressive tax rates, but decreases to 1.34 with less progressive tax rates.

In Table 47 the tax elasticity (marginal tax rate divided by the average tax rate in equation 7) for the lower income group (below R80 000) is much higher (3.07) than that of the upper income groups (1.21). The reason is that for this group, government allows more tax relief by means of increased deductions and allowances, thereby decreasing progressivity. The analysis in Table 47 reflects that, with more progressive marginal tax rates (Scenario B), the total average tax rate increases from 20 to 23 per cent while it declines to 13 per cent with less progressive tax rates (Scenario C).

More progressive marginal rates (Scenario B) take the growth maximising PIT/GDP ratio to 9.6 per cent (Table 47), thus beyond the optimal level of 6.7 per cent. Since tax rates beyond the optimum level may have a negative effect on economic growth and tax payer behaviour, the longer term effect (although not measured in this model) could be negative to the revenue base. Such a change in tax payer behaviour is often caused by a double tax effect since firstly, tax payers have to pay their taxes, but secondly they also experience a decrease in their standard of living because of the lower economic growth. Less progressive marginal rates (Scenario C) reduces the growth maximising PIT/GDP ratio to 5.6 per cent and below but closer to the optimal level and, although revenue decreases in the short term, such a policy change may positively affect revenue in the longer term.

6.2.1.3 *Demographic impact of such a tax reform*

Population

Table 46 shows the skewed income distribution per population group which is due to the fact that the African/Black racial group (which comprises 47 per cent of total taxpayers) only contributes 22 per cent of the total tax liability, compared to the 68 per cent paid by the White population group. About 30 per cent of those classified as African/Black fall within the income grouping below the level of R80 000, and contribute only 4 per cent to total revenue from PIT. With more progressive tax rates, tax liability increases by 6 per cent and efficiency decreases by 13 per cent. With a less progressive tax, liability decreases by 33 per cent and efficiency improves by 59 per cent.

Age

Table 48 also reflects that in Scenario A, on average, most tax is paid by individuals in the age group 35 to 44 years of age (28 per cent), followed by those in the age group 45 to 54 years (29 per cent). The deadweight loss of income tax contributed by these two age groups is 57 per cent of the total deadweight loss. This highlights the importance of the age group 35 to 54 years of age to the tax revenue base.

6.2.2 Main insight and concluding remarks

As a general guideline, the literature overview suggests that top maximum marginal rates vary between 30 and 50 per cent, with minimum rates between 10 and 20 per cent. The rates in upper-middle income countries are 12 per cent for the lowest income category and 30 per cent for the highest income band. In South Africa the current minimum and maximum marginal rates are 18 and 40 per cent, respectively, which are clearly higher than those of its peers. The result is that, in order to align the marginal tax regime in this country with that of its peers, the future trend in marginal rates will have to be downward. From an efficiency point of view, the model clearly shows that increases in marginal rates from the current levels (especially in the higher income groups) will be detrimental to the economy. A voluminous literature outlines the problems of unaligned tax rates from a tax competition perspective.

The inclusion of deadweight loss as an indication of tax efficiency brings some additional perspective to the choice of marginal rates. The results in this study clearly indicate that increased marginal taxes negatively impact on tax efficiency, thus possibly neutralising the potential advantage of increased revenue. It is also important from an efficiency point of view that such changes in marginal rates impact more heavily on those in the middle income groups (for example, the R130 000 to R180 000 income group); yet this group is responsible for a major portion of the individual income tax collected.

The less progressive marginal tax rates cause revenue to be lower than the optimal revenue-maximising tax rate of 43 per cent. Although the lower marginal rates impact negatively on the progressiveness (fairness) of the tax structure, the PIT/GDP ratio decreases to 5.6 per cent which is less than the optimal ratio from an economic growth perspective, and tax efficiency accordingly improves.

6.3 TAX REFORM 2: CHANGES IN THE NON-TAXABLE THRESHOLD AND INCOME BANDS

The main objective with this analysis is to determine the impact of adjustments to the thresholds and taxable income bands on the revenue base, tax efficiency, progressivity, and optimal growth. The tax bands and thresholds for the 2005/2006 fiscal year are used as a base from which changes are implemented. Besides the base scenario, two other scenarios are simulated: one where the income tax bands and thresholds are only adjusted with inflation from the 1998/1999 levels, and a second where income tax bands and thresholds are adjusted to the optimal GDP/capita levels as discussed in Chapter 2 and which are based on that of South Africa's peers[17] (lower levels). The different scenarios for the adjustment in tax bands and the thresholds per taxable income group can be seen in Table 49. The scenarios are as follows:

Scenario A: The base year is 2005/2006, and the marginal tax rates are between 18 and 40 per cent. The lowest and highest income bands are R80 000 and R300 000, respectively.

Scenario B: The impact of tax reform on individual tax liability over the period 1998/1999 to 2005/2006 is measured by changing the parameters underlying the tax structure (rebates and threshold levels). Again, the 1998/1999 figures have been used due to the fact that the tax bands in that year had been reduced from 10 to 6. It is assumed that between the 1999 and 2006 fiscal years, fiscal policy has remained unchanged other than adjustments for bracket creep. In order to do this, the 6 income bands and the thresholds in the 1998/1999 tax structure have been adjusted only by the inflation rate. Thus, this scenario shows what the rebates and threshold would have been in 2005/2006 had they only been adjusted for inflation based on the 1998/1999 levels.

Scenario C: This scenario is selected by changing the rebates and threshold to reflect a tax regime that is similar to that of South Africa's peers. The threshold for taxpayers below the age of 65 years is set to equal the GDP/capita (R33 787) in 2005/2006[18]. The lowest income band is double the GDP/capita, and the highest income band is 18 times the GDP/capita.

[17] For example: Brazil, Chile, Botswana, Uruguay, Mexico, Turkey, Malaysia
[18] 2005: R33 176*10/12+2006: R36 844*2/12.

The rest of the income bands are evenly distributed, with the marginal tax rates equal to those of the 2005/2006 tax regime.

6.3.1 Model results of changes in the income tax bands and threshold levels

6.3.1.1 *Impact on the revenue base and tax efficiency*

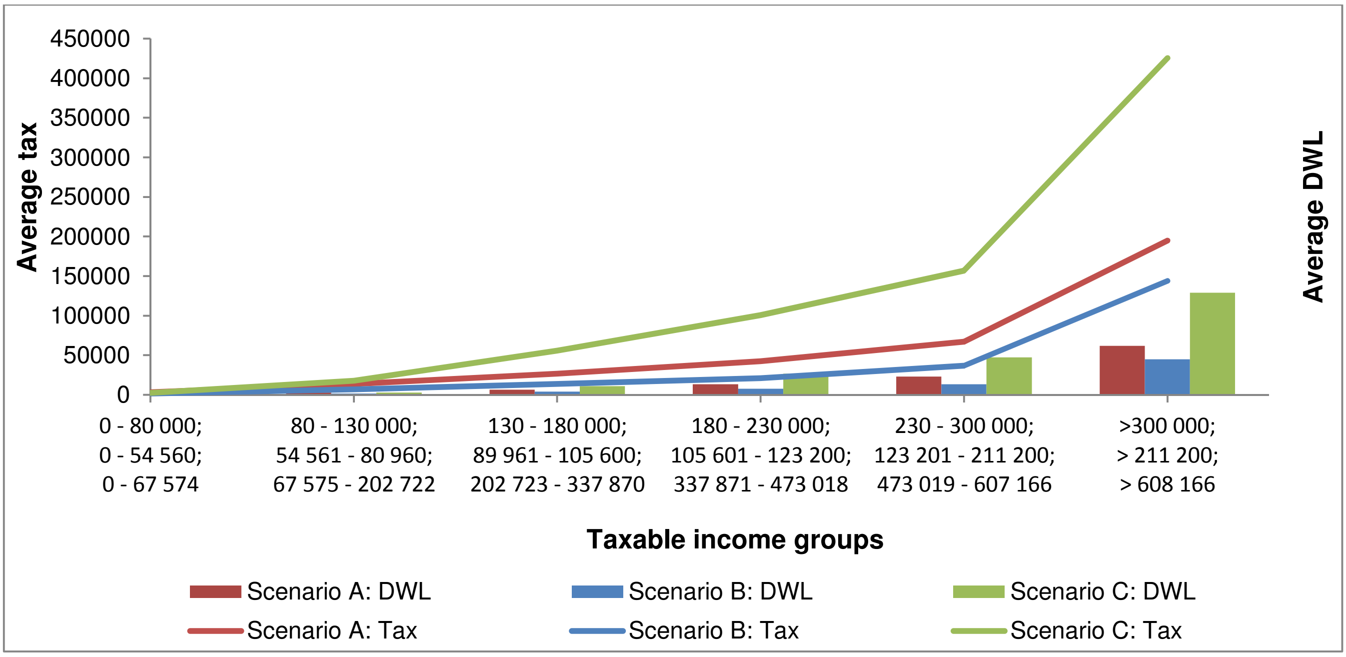
Table 50 reflects the results of changes in the income tax bands and threshold levels, compared to the base model. In Scenario A the total deadweight loss amounts to R38.8 billion, with total tax liability at R132.8 billion. Scenario B, applying the inflation-adjusted tax codes for 1998/1999 to the taxable income of 2005/2006, shows an estimated tax liability of R152 billion, which is 15 per cent more than in Scenario A. The deadweight loss increases to R48.6 billion (25 per cent more than in Scenario A), thus lowering the efficiency of the tax system as a result of the lowering of the levels of the tax bands in Scenario B. More individuals are included (363 057) because of the lower threshold; and more individuals fall within the higher income groups, where tax elasticity measuring the deadweight loss is higher.

The impact of this reform becomes more evident when comparing the figures on a per capita base. Both per capita tax liability and the deadweight loss decline when compared to the base scenario because of the increased number of taxpayers in the higher income groups (with lower taxable income bands).

In Scenario C, tax liability decreases to R128 billion, and the deadweight loss amounts to R28.5 billion, which is, respectively, 4 per cent and 24 per cent less than in the base scenario in Table 50. In this scenario, the tax bands in the higher income groups (above R202 722) are higher than the 2005/2006 tax bands, and more individuals fall into the lower income groups. When comparing the per capita tax liability and the deadweight loss per taxable income group to that in Scenario A, both tax assessed and deadweight loss for taxable income groups above R67 575 increase because of the smaller number of individuals in the higher income groups.

Figure 20 illustrates the average tax liability and deadweight loss per income group. Scenario B, with only inflation-adjusted tax bands, shows that on average, the tax liability is much lower, with a resulting increase in tax efficiency compared to the base scenario. In Scenario C, tax bands are higher than in the base scenario; therefore the average tax liability and deadweight loss are higher – especially in the highest income group, where it is almost double that of the average tax liability and deadweight loss in the base scenario.

Figure 20: Average tax assessed and deadweight loss



Source: Own calculations

6.3.1.2 *Impact of changes in income tax bands and non-taxable threshold levels on progressivity and the optimal PIT/GDP ratio*

Table 47 contains the elasticities, average tax ratios, and PIT/GDP ratios for the different tax reform scenarios. Tax elasticity for the base scenario is 1.35, and increases to 1.38 with inflation-adjusted tax bands, but then decreases again to 1.36 when income tax bands are adjusted to those of South Africa's peers. Thus, both Scenarios B and C are slightly more progressive than the base scenario.

Progressivity is also measured by looking at the GDP/capita multiple of the highest income band (Chapter 2). In Scenario A the highest taxable income band is 8.9 times the

GDP/capita, and it decreases to 3.6 in Scenario B with inflation-adjusted income bands. In Scenario C the highest taxable income band is adjusted to that of South Africa's peers which is 18 times the GDP/capita. Therefore, progressivity increases from Scenario A to B, but decreases with Scenario C mainly because of smaller differences between the higher and lower income bands and many more taxpayers falling within the lower income bands.

For Scenarios A and B the PIT/GDP ratios are 8.2 and 9.5 per cent, respectively, which are higher than the optimal PIT/GDP ratio of 6.7 per cent. With threshold and income bands adjusted to levels equal to those of South Africa's peers (Scenario C), the PIT/GDP ratio is 8 per cent – the lowest in all three scenarios and closer to the optimal ratio.

6.3.1.3 *Demographic impact of such a tax reform*

Age

The results for each age group identified by the number of taxpayers, tax paid, and deadweight loss in the three scenarios, are contained in Table 51. In Scenarios B and C the age groups below 24 years and above 65 years show the highest increase in the number of taxpayers. This is because the adjusted income bands are much lower than in the base scenario, thus including an increased number of lower income individuals.

For the age group below 24 years in Scenario B, the tax liability increases by R723 million (20 per cent), with an increased deadweight loss of R471 million (50 per cent). The above 65-year-old tax liability increases by R643 million (27 per cent), and efficiency decreases by 45 per cent, with a deadweight loss increase of R367 million. By adjusting tax bands and thresholds to levels similar to that of South Africa's peers (Scenario C) for the age group below 24 years, tax liability decreases marginally by R10 million (0.28 per cent). However, such a decrease in revenue is accompanied by an efficiency increase of 28 per cent, the monetary value of which is estimated at R263 million.

Education

In Scenario A, Table 52 reflects that 1.57 million (29 per cent) of the total number of taxpayers have a Grade R to Grade 11 education, and contribute R13 billion (10 per cent) of the total tax liability. Furthermore, 1.62 million (30 per cent) of the total number of taxpayers have a matric qualification, and contribute R32 billion (27 per cent) to total tax liability, whereas more than 2 million (39 per cent) of the total number of taxpayers have a post-school degree or diploma and contribute R87 billion (66 per cent) to total tax liability. It is therefore evident that 98 per cent of the total number of taxpayers possess of a school or post-school qualification. This indicates that taxpayers with an educational background, especially a post-school qualification, are more inclined to fill positions with proportionally higher income. The higher the qualification a person has, the higher his/her income which then expands the revenue base accordingly. This highlights the importance of education to the revenue base.

In Scenario B, the band margins and the non-taxable thresholds are adjusted by the rate of inflation. It is evident that the number of taxpayers now increases because the tax bands are lower than in the base scenario. The number of taxpayers increases by 14 per cent in both the no-schooling and Grade R to Grade 11 groups. The tax liability of taxpayers with no schooling, a Grade R to Grade 11, a Grade 12, and a degree/diploma increases by 18, 19, 16 and 14 per cent, respectively. This seems to be controversial from an equity perspective but it simply reflects the increase in number of taxpayers because of the lower tax bands with fewer potential taxpayers outside the tax net.

Scenario C reflects the non-taxable thresholds and taxable income bands adjusted to those of South Africa's peers. Again the number of taxpayers increases because of the lower non-taxable thresholds compared to the base scenario which reduces the number of potential taxpayers outside the tax net. The groupings "no schooling" and "Grade R to Grade 11" show the highest increase in number of taxpayers: 11 and 10 per cent, respectively. This is obviously because these groups are found primarily within the lower band margins. Tax liability increases by 2 per cent for the Grade R to Grade 11 group while in in the other groups, tax decreases because of the broader band margins compared to the base scenario. The tax liability of taxpayers with no schooling and those with a Grade 12 and/or a degree/diploma decreases by 2, 1, and 5 per cent, respectively.

6.3.2 Main insight and concluding remarks

From the scenarios it can be concluded that the reform of income tax bands and threshold levels do in fact affect tax liability and thus revenue as well as tax efficiency. During the period under review, adjustments to threshold levels and income bands more than compensated for bracket creep adjustments, with the result that the total tax liability of individuals in 2005/2006 was lower than what it would have been under the inflation only adjusted 1998/1999 tax regime. With lower non-taxable thresholds and adjusted taxable income bands for inflation (Scenario B), and with taxable income bands similar to those of South Africa's peers (Scenario C), respectively, 7 and 5 per cent more taxpayers are allowed into the tax system. In Scenario C the adjustment of income bands and thresholds shows greater changes in tax liability and efficiency than in the case of only inflation-adjusted tax bands. This is because of the broader tax bands and more individuals falling into a lower taxable income group than in the base scenario. The margin of the highest income band is also much higher than in the base scenario; so fewer individuals are taxed at the highest marginal tax rate. This scenario shows that tax liability decreases (3.4 per cent) but efficiency improves (24 per cent) with more realistic adjustments in tax bands and threshold levels.

With tax elasticity at 1.36 in Scenario C (taxable income bands with higher multiples of GDP/capita than in the other scenarios) the tax structure becomes less progressive which could be interpreted as negative from a "tax fairness" perspective. However, the PIT/GDP ratio in this case amounts to 8 per cent, which is lower than in the other scenarios albeit still higher than the optimal ratio of 6.7 per cent. Accordingly, economic growth is expected to be higher in Scenario C with a potential expansion of the revenue base which could compensate for the loss in progressivity.

6.4 TAX REFORM 3: REFORM MEDICAL TAX EXPENDITURE DEDUCTION

As indicated earlier on, the only form of tax expenditures investigated is the switch from medical allowances to medical credits. As in the case of the previous tax reforms analysed the objectives here also include a comparison of the impact of medical deductions and medical credits as a tax expenditure on the revenue base, efficiency, progressivity (equity) as well as the optimal levels of revenue and growth. Specifically, the scenario tested is the switch from a system where member contributions to medical schemes can be deducted from taxable income, to a scheme where such contributions are regarded as credits against the contributor's tax liability. The notion is that medical tax credits provide more relief to low income individuals by enabling them to have some form of medical insurance. The three different scenarios (A, B and C) are presented per taxable income group in Table 53.

Scenario A: This scenario includes all allowances, fringe benefits, and deductions for 2005/2006. As indicated earlier (Chapter 5), these deductions have been obtained from the Tax Statistics filer data. The average allowance ratio per taxable income group is equal to total allowances and deductions divided by total income before deductions. A taxpayer's medical deduction is subtracted from taxable income, and the revenue loss to government is the loss in taxable income times the marginal tax rate. Therefore, higher income taxpayers benefit more from a medical deduction, given the steeper proportional decline in their taxable income after such a deduction. The scenario reflects the current system of medical contributions being deducted from taxable income, with a capped limit on such deductions based on a percentage of taxable income.

Scenario B: This scenario serves as the benchmark and excludes medical deductions and the medical credit. It therefore estimates the total cost of medical deductions to the fiscus. The revenue forgone method is used to calculate the amount of revenue that would have been collected in the absence of medical deductions, assuming that the behavioural response of taxpayers remains unchanged. The difference in tax liability before and after the deduction reflects the revenue loss due to the deductions allowed. Table 47 shows the PIT/GDP ratios when medical deductions are excluded and as can be expected the ratios are lower than in Scenario A.

Scenario C: In this scenario medical tax credits are being implemented which may vary between fiscal years. Data was obtained from the publication Tax Statistics 2012 (SARS) which is used as a proxy to calculate medical credit ratios as a percentage of taxable income. Under the medical expenditure credit scheme the tax credit will be 25 per cent of medical expenditures and 33.3 per cent for taxpayers under 65 years and over 65 years, respectively. The credits are then divided by taxable income to give the credit ratios per taxable income group. The medical tax credits used in the simulation are those suggested in the 2012

National Budget. According to the literature (Chapter 2), medical tax credits seem to be a more equitable form of relief than medical deductions, because the relative value of the relief does not increase with higher income levels, and it has the same value for all taxpayers, irrespective of the marginal tax rate within each tax band.

6.4.1 <u>Model results of converting the medical tax expenditure deduction to a medical tax credit</u>

6.4.1.1 *Impact on the revenue base and tax efficiency*

Table 54 compares the different income and age groups by number of taxpayers, taxable income, tax paid, and deadweight loss. Scenario A reflects the pre-tax credit era which includes medical deductions in the total allowance ratio. Total tax liability and the deadweight loss amount to R132.8 billion and R37.5 billion, respectively.

Scenario B is the benchmark scenario and excludes medical deductions from the total allowance ratio in order to estimate tax liability without the revenue loss as a result of the allowances for medical expenses. Due to the lower allowance ratio, taxpayers' taxable income is higher and their tax liability increases accordingly. The number of taxpayers increases by 343 842 (6.4 per cent). Comparing this scenario to Scenario A shows that revenue foregone as a result of medical expense allowances amounts to R3.68 billion (2.8 per cent of total revenue). However, with the increased tax liability the deadweight loss also increases and tax efficiency decreases accordingly by R913 million (2.4 per cent).

In Scenario C, the allowance ratios are also excluded as in Scenario B but medical credit ratios are implemented instead. Taxable income and the number of taxpayers are similar to that in Scenario B and in order to estimate tax liability medical credits are then deducted from tax liability. The results show that with a medical tax credit, total tax liability decreases by R3.74 billion (2.82 per cent) when comparing this scenario to Scenario B. Total tax liability with a medical tax credit is slightly less than in the case of medical tax expenditure deduction. This decline could be expected due to the fact that with a medical tax credit, more taxpayers fall within the lower income groups in which case their tax liability decreases with a higher medical credit ratio compared to allowances.

For individual income groups the comparison between Scenario C and A shows that with a tax credit (Scenario C), the tax liability of the income group R0 up to R80 000 decreases by R1.79 billion (20.6 per cent), and for the income group R80 000 to R130 000 by R894 million (4.5 per cent). However, the tax liability of all other income groups decreases less than the lower income groups. Also, as far as age is concerned with a medical credit (Scenario C), the total tax liability of the age groups 45 to 54 years and 55 to 64 years decreases by R1.3 billion (2 per cent) compared to Scenario B. The results show that with a medical deduction (Scenario A) the total tax liability decreases with R1.46 billion (2.3 per cent) compared to Scenario B. Thus, these age groups' tax liability increases marginally with a medical credit. However all the other age groups' tax liability decreases with a medical tax credit. Most of the individuals in these age groups fall within the higher income groups.

These results are plausible since the main goal of a medical tax credit is to provide more tax relief to lower income taxpayers.

6.4.1.2 *Impact of a switch from medical tax expenditure deduction to medical tax credits on progressivity and the PIT/GDP ratio*

Table 47 contains the elasticities, average tax ratios, and PIT/GDP ratios for the different tax reforms. The tax elasticity for medical deductions and medical tax credits is 1.35 and 1.38, respectively. Thus, a medical deduction is slightly less progressive than a medical tax credit and as a result the implementation of the latter could also improve the fairness of the tax system.

For Scenarios A, B, and C, the PIT/GDP ratios are 8.3, 8.5, and 8.3 per cent, respectively, each higher than the optimal growth PIT/GDP ratio of 6.7 per cent as stated earlier. Thus, with a medical deduction and a medical credit, the ratio 8.3 is marginally closer to the optimal growth ratio.

6.4.2 Main insight and concluding remarks

With a medical tax credit, the number of taxpayers will increase because of their higher taxable income (medical credits exceed deductions - especially at the lower income levels which are dominant in terms of numbers). The analysis shows that individuals older than 65 years and those between 18 and 24 years of age mostly fall within the lowest income group, and will benefit most from the implementation of the tax credit scheme. Comparing a medical deduction (Scenario A) and a medical credit (Scenario C) to the benchmark Scenario B, tax liability decreases by R3.68 billion (2.77 per cent) and R3.74 billion (2.82 per cent), respectively. Thus, a medical credit which increases disposable income at the lower end of the scale and discriminates against higher income groups also improves progressiveness of the tax regime and accordingly the fairness thereof. It should be noted though that the impact of the switch between deductions and credits is relatively small as far as total taxable income is concerned and has therefore virtually no effect on the tax/GDP ratio. Thus, it cannot be argued that such a change would enhance economic growth except that more people share in the fiscal benefits of the credit scheme (lower tax liability with higher disposable income) and should therefore enjoy marginally higher standards of living. With more workers exposed to health services this could of course impact positively on productivity and growth. However, this has not been tested in this model.

6.5 CONCLUSION

The MS model demonstrates how the number of taxpayers, taxable income, tax liability, and efficiency are affected by tax reform changes, and it identifies winners and losers from the suggested tax reforms. It also estimates the impact of the progressivity of the tax structure before and after a tax reform indicating compliance of the norms for a “good” tax system. The model furthermore calculates tax/GDP ratios before and after tax reforms which can then be compared to “optimal” levels for economic growth as outlined in the literature overview.

The adjustment in marginal tax rates shows that the most favourable scenario is a reduction in such rates (Scenario C). It improves efficiency and decreases tax liability– mostly in the higher income groups. The marginal tax rates used are also lower than the Laffer bound curve, thus the efficiency gain exceeds the loss in revenue. In fact, by implementing such a scenario the PIT/GDP ratio is less than the optimal growth rate. It obviously results in a corresponding loss in government revenue which will have to be compensated for by other means. Although not tested due to the stationary nature of the model, it is expected though that such a loss could be covered by an increase in productivity and capital flows that would increase the economic growth rate and thereby expands the revenue base.

Adjusting the taxable income bands to those of peer economies (Scenario C) improves efficiency, with a marginally lower tax liability. Adjustments to threshold levels and income bands allow more taxpayers into the tax system and therefore more individuals are liable to pay taxes. The tax structure still portrays the required levels of progressiveness with higher income tax payers paying more tax than lower income tax payers but more potential tax payers are included into the tax net albeit with only a marginal tax liability. The PIT/GDP ratio is also closer to the optimal growth ratio, therefore economic growth should be higher in Scenario C.

With the tax expenditure reforms, the results show that the difference in revenue loss between a medical deduction and medical tax credit scheme is relatively small and as a result the efficiency of the tax remains virtually unchanged. However, more taxpayers at the lower end of the income scale will benefit from the tax credit scheme which contributes towards improving the fairness of the tax structure. As already indicated the suggested tax reform is in the process of being implemented and the results merely validate the implementation thereof.

Table 45: Marginal tax rates

Marginal tax rate	A[19]: Base	B: More progressive	C: Less progressive
0 – 80 000	18%	19%	12%
80 001- 130 000	25%	30%	15%
130 001- 180 000	30%	39%	19%
180 001- 230 000	35%	43%	23%
230 001- 300 000	38%	44%	27%
> 300 000	40%	45%	30%

Source: Own calculation

[19] A – Scenario A; B – Scenario B; C – Scenario C

Table 46: Taxable income, tax assessed, and deadweight loss (DWL) by population and taxable income group

Taxable income group	Population group	Number of taxpayers	Taxable income (R million)	A: Tax paid (R million)	A: DWL (R million)	B: Tax paid (R million)	B: DWL (R million)	C: Tax paid (R million)	C: DWL (R million)	Change Tax B	Change Tax C	Change DWL B	Change DWL C
0 – 80 000	*African/Black*	1 586 848	82 198	4 723	617	4 985	696	3 149	256				
	Coloured	326 333	16 934	973	127	1 027	143	649	53				
	Indian/Asian	147 816	8 071	518	61	546	68	345	25				
	White	518 520	29 108	1 774	219	1 873	246	1 183	90				
		2 579 517	136 310	7 988	1 023	8 432	1 154	5 325	424	6%	-33%	13%	-59%
				6.01%	2.73%	5.49%	2.05%	5.93%	2.62%				
80 001 - 130 000	*African/Black*	564 234	57 008	7 515	1 449	8 362	2 236	4 812	460				
	Coloured	131 971	13 615	1 828	346	2 040	534	1 168	110				
	Indian/Asian	53 360	5 612	752	143	843	220	479	45				
	White	529 886	54 697	7 170	1 390	8 012	2 145	4 575	442				
		1 279 451	130 930	17 265	3 328	19 256	5 134	11 034	1 057	12%	-36%	54%	-68%
				13.00%	8.87%	12.53%	9.14%	12.28%	6.53%				
130 001 - 180 000	*African/Black*	214 569	32 155	5 682	1 364	6 698	2 646	3 567	473				
	Coloured	66 869	10 011	1 772	425	2 088	824	1 113	147				
	Indian/Asian	26 238	3 868	678	164	796	318	425	57				
	White	347 436	52 473	9 283	2 226	10 962	4 318	5 826	772				
		655 113	98 507	17 415	4 180	20 544	8 106	10 931	1 449	18%	-37%	94%	-65%
				13.11%	11.14%	13.37%	14.42%	12.16%	8.94%				
180 001 - 230 000	*African/Black*	57 007	11 358	2 413	760	2 926	1 308	1 529	277				
	Coloured	18 280	3 645	775	244	939	420	491	89				
	Indian/Asian	26 251	5 368	1 157	359	1 404	618	734	131				
	White	185 342	37 067	7 843	2 480	9 518	4 268	4 969	904				
		286 880	57 438	12 188	3 843	14 787	6 614	7 724	1 401	21%	-37%	72%	-64%
				9.18%	10.25%	9.62%	11.77%	8.59%	8.65%				
230 001 - 300 000	*African/Black*	22 998	5 873	1 441	506	1 739	751	936	217				
	Coloured	12 379	3 221	791	278	955	412	515	119				
	Indian/Asian	14 822	3 939	989	339	1 190	504	646	146				
	White	154 766	41 640	10 510	3 588	12 645	5 326	6 875	1 539				
		204 966	54 673	13 731	4 711	16 529	6 993	8 972	2 020	20%	-35%	48%	-57%

Taxable income group	Population group	Number of taxpayers	Taxable income (R million)	A: Tax paid (R million)	A: DWL (R million)	B: Tax paid (R million)	B: DWL (R million)	C: Tax paid (R million)	C: DWL (R million)	Change Tax B	Change Tax C	Change DWL B	Change DWL C
				10.34%	12.56%	10.75%	12.44%	9.98%	12.47%				
> 300 000	*African/Black*	40 588	22 076	7 193	2 325	8 323	3 211	5 112	1 121				
	Coloured	9 877	5 213	1 687	549	1 954	758	1 196	265				
	Indian/Asian	14 725	7 155	2 268	754	2 636	1 041	1 599	363				
	White	264 353	159 435	53 096	16 794	61 238	23 187	37 980	8 097				
		329 544	193 879	64 244	20 422	74 151	28 196	45 887	9 846	15%	-29%	38%	-52%
				48.37%	54.45%	48.24%	50.17%	51.06%	60.79%				
		5 335 470	671 738	132 832	37 507	153 698	56 198	89 873	16 197	16%	-32%	50%	-57%
Total													
	African/Black	2 486 244	210 668	28 968	7 022	33 033	10 847	19 105	2 804	14%	-34%	54%	-60%
	Coloured	565 709	52 638	7 827	1 968	9 004	3 091	5 132	782	15%	-34%	57%	-60%
	Indian/Asian	283 213	34 013	6 361	1 820	7 415	2 769	4 228	767	17%	-34%	52%	-58%
	White	2 000 304	374 419	89 676	26 697	104 247	39 491	61 408	11 843	16%	-32%	48%	-56%
		5 335 470	671 738	132 832	37 507	153 698	56 198	89 873	16 197	16%	-32%	50%	-57%
	African/Black	47%	31%	22%	19%	21%	19%	21%	17%				
	Coloured	11%	8%	6%	5%	6%	5%	6%	5%				
	Indian/Asian	5%	5%	5%	5%	5%	5%	5%	5%				
	White	37%	56%	68%	71%	68%	70%	68%	73%				
		100%	100%	100%	100%	100%	100%	100%	100%				

Source: Own calculation

Table 47: Elasticties

Base Scenario A	**Tax elasticity**		
Taxable income group	**Marginal rate (%)**	**Average rate (%)**	**Marginal rate/Average rate**
0 – 80 000	18	6	3.07
80 001–130 000	25	13	1.9
130 001–180 000	30	18	1.7
180 001–230 000	35	21	1.65
230 001–300 000	38	25	1.51
>300 000	40	33	1.21
Panel A: Option 1	**Scenario A**	**Scenario B**	**Scenario C**
Elasticity of tax liability to taxable income	1.35	1.37	1.34
Average tax ratio (Tax/Taxable income)	20%	23%	13%
PIT/GDP ratio [2]	8.2%	9.6%	5.6%
Panel B: Option 2	**Scenario A**	**Scenario B**	**Scenario C**
Elasticity of tax liability to taxable income	1.35	1.38	1.36
GDP/per capita ratio for the top income band [1]	8.9	3.6	18
Average tax ratio (Tax/Taxable income)	20%	22%	19%
PIT/GDP ratio [2]	8.2%	9.5%	8.0%
Panel C: Option 3	**Scenario A**	**Scenario B**	**Scenario C**
Elasticity of tax liability to taxable income	1.35	1.43	1.38
Average tax ratio (Tax/Taxable income)	19.80%	19.50%	19%
PIT/GDP ratio [2]	8.30%	8.50%	8.30%

[1] A: 300000/33 787; B: 120 000/33 787; C: 608166/33 787

[2] GDP 2005/2006: R1 603 805 million.

Source: Own calculation

Table 48: Number of taxpayers, taxable income, tax assessed, and deadweight loss (DWL) by age group

Age group	Number of taxpayers	Taxable income (R million)	A: Tax paid (R million)	A: DWL (R million)	B: Tax paid (R million)	B: DWL (R million)	C: Tax paid (R million)	C: DWL (R million)	Change Tax B	Change Tax C	Change DWL B	Change DWL C
<18	37 212	2 628	277	58	312	93	179	21	13%	-35%	61%	-64%
18 - 24	62 914	23 034	3 316	883	3 841	1 346	2 160	359	16%	-35%	52%	-59%
25 - 34	1 562 945	164 058	27 771	7 434	32 048	11 365	18 455	3 080	15%	-34%	53%	-59%
35 - 44	471 006	87 336	36 489	10 224	42 337	15 572	24 433	4 338	16%	-33%	52%	-58%
45 - 54	170 390	74 441	38 781	11 140	44 859	16 454	26 566	4 929	16%	-31%	48%	-56%
55 - 64	620 985	100 265	23 841	6 957	27 510	10 107	16 540	3 145	15%	-31%	45%	-55%
>65	210 018	19 977	2 356	811	2 791	1 260	1 540	326	18%	-35%	55%	-60%
	5 335 470	**671 738**	**132 832**	**37 507**	**153 698**	**56 198**	**89 873**	**16 197**	16%	-32%	50%	-57%

Source: Own calculation

Table 49: Income bands and thresholds of different scenarios

Scenario A: 2005/2006				Scenario B: 1998/1999				Scenario C: Tax reform lessons			
Income bands		**Threshold**		**Income bands**		**Threshold**		**Income bands**		**Threshold**	
0 -	80 000	< 65 years	35 000	0 -	31 000	< 65 years	18 500	0 -	67 574	< 65 years	33 787
80 001	130 000	> 65 years	60 000	31 001	46 000	> 65 years	31 950	67 575	202 722	> 65 years	58 787
130 001	180 000			46 001	60 000			202 723	337 870		
180 001	230 000			60 001	70 000			337 871	473 018		
230 001	300 000			70 001	120 000			473 019	608 166		
>300 000				>120 000				>608 166			
				1998/1999 to 2005/2006 adjusted for inflation (76 %)							
				Income bands		**Threshold**					
				0 -	54 560	< 65 years	32 560				
				54 561	80 960	> 65 years	52 560				
				80 961	105 600						
				105 601	123 200						
				123 201	211 200						
				>211 200							

Source: Own calculations

Table 50: Income bands, number of taxpayers, tax, and deadweight loss (DWL)

Scenario A

Tax bands		Marginal rate	Number of taxpayers	Taxable income (R million)	Tax assessed (R million)	Deadweight loss (R million)	Taxable income per capita	Tax assessed per capita	Deadweight loss per capita
0 -	80 000	18%	2 579 517	136 310	7 988	1 023	52 843	3 097	397
80 001	130 000	25%	1 279 451	130 930	17 265	3 328	102 333	13 494	2 601
130 001	180 000	30%	655 113	98 507	17 415	4 180	150 367	26 584	6 380
180 001	230 000	35%	286 880	57 438	12 188	3 843	200 216	42 486	13 395
230 001	300 000	38%	204 966	54 673	13 731	4 711	266 743	66 992	22 986
>300 000		40%	329 544	193 879	64 244	20 422	588 326	194 950	61 970
			5 335 470	**671 738**	**132 832**	**37 507**			

Scenario B

Tax bands		Marginal rate	Number of taxpayers	Taxable income (R million)	Tax assessed (R million)	Deadweight loss (R million)	Taxable income per capita	Tax assessed per capita	Deadweight loss per capita
0 -	54 560	18%	1 858 402	78 270	3 040	588	42 117	1 636	316
54 561	80 960	25%	1 158 325	76 414	7 718	1 942	65 969	6 663	1 677
80 961	105 600	30%	837 569	76 756	11 389	3 257	91 641	13 598	3 888
105 601	123 200	35%	339 926	38 739	7 061	2 592	113 963	20 772	7 625
123 201	211 200	38%	870 366	136 011	31 832	11 721	156 269	36 573	13 466
>211 200		40%	633 939	270 792	91 194	28 523	427 157	143 852	44 994
			5 698 527	**676 981**	**152 233**	**48 622**			
Change from Scenario A			7%	1%	15%	25%			

Scenario C										
Tax bands		Marginal rate	Number of taxpayers	Taxable income (R million)	Tax assessed (R million)	Deadweight loss (R million)	Taxable income per capita	Tax assessed per capita	Deadweight loss per capita
0 -	67 574	18%	2 386 888	112 235	5 410	843	47 021	2 267	353
67 575	202 722	25%	2 481 983	285 312	44 107	7 252	114 953	17 771	2 922
202 723	337 870	30%	474 029	121 045	26 331	5 136	255 354	55 548	10 834
337 871	473 018	35%	135 161	53 460	13 575	3 577	395 526	100 436	26 462
473 019	608 166	38%	51 706	28 455	8 118	2 452	550 318	157 008	47 423
>608 166		40%	71 963	88 083	30 613	9 278	1224 001	425 405	128 928
			5 601 731	**688 590**	**128 155**	**28 537**			
Change from Scenario A			5%	3%	-4%	-24%			

Source: Own calculations

Table 51: Number of taxpayers, tax paid, deadweight loss (DWL) per age group

Age group	A: Number of taxpayers	Taxable income (R million)	A: Tax paid (R million)	A: DWL (R million)	B: Number of taxpayers	B: Tax paid (R million)	B: DWL (R million)	C: Number of taxpayers	C: Tax paid (R million)	C: DWL (R million)
Below 18	37 212	2 628	277	58	44 206	340	105	43 913	295	51
18 - 24	262 914	23 034	3 316	883	293 905	3 976	1 307	283 540	3 288	627
25 - 34	1 562 945	164 058	27 771	7 434	1 678 969	32 505	10 401	1 651 398	27 498	5 507
35 - 44	1 471 006	187 336	36 489	10 224	1 564 371	42 198	13 682	1 533 726	35 245	7 579
45 - 54	1 170 390	174 441	38 781	11 140	1 227 200	43 748	13 795	1 214 097	36 955	8 664
55 - 64	620 985	100 265	23 841	6 957	658 615	26 467	8 155	646 496	22 561	5 523
65 and older	210 018	19 977	2 356	811	231 259	2 999	1 178	228 561	2 310	586
	5 335 470	**671 738**	**132 832**	**37 507**	**5 698 527**	**152 233**	**48 622**	**5 601 731**	**128 155**	**28 537**

	Change Number B	Change Number C	Change Tax B	Change Tax C	Change DWL B	Change DWL C
Below 18	19%	18%	23%	7%	82%	-12%
18 - 24	12%	8%	20%	-1%	48%	-29%
25 - 34	7%	6%	17%	-1%	40%	-26%
35 - 44	6%	4%	16%	-3%	34%	-26%
45 - 54	5%	4%	13%	-5%	24%	-22%
55 - 64	6%	4%	11%	-5%	17%	-21%
65 and older	10%	9%	27%	-2%	45%	-28%
	7%	5%	15%	-4%	30%	-24%

Source: Own calculations

Table 52: Number of taxpayers, tax paid, deadweight loss (DWL) per education group

Education group	A: Number of taxpayers	Taxable income (R million)	A: Tax paid (R million)	A: DWL (R million)	B: Number of taxpayers	B: Tax paid (R million)	B: DWL (R million)	C: Number of taxpayers	C: Tax paid (R million)	C: DWL (R million)
No schooling	85 531	6 143	728	196	97 416	858	265	94 720	713	145
Grade R - 11	1 568 404	111 653	12 830	3 105	1 782 241	15 218	4 630	1 722 693	13 057	2 681
Grade 12	1 617 364	180 760	32 010	8 640	1 720 000	37 079	11 871	1 692 110	31 551	6 652
Degree/Diploma	2 064 170	373 182	87 263	25 565	2 098 871	99 078	31 857	2 092 208	82 833	9 060
	5 335 470	**671 738**	**132 832**	**37 507**	**5 698 527**	**152 233**	**48 622**	**5 601 731**	**128 155**	**28 537**

Changes to the base scenario	Change Number B	Change Number C	Change Tax B	Change Tax C	Change DWL B	Change DWL C
No schooling	14%	11%	18%	-2%	35%	-26%
Grade R - 11	14%	10%	19%	2%	49%	-14%
Grade 12	6%	5%	16%	-1%	37%	-23%
Degree/Diploma	2%	1%	14%	-5%	25%	-25%
	7%	5%	15%	-4%	30%	-24%

Source: Own calculations

Table 53: Tax allowances and medical credits

	Scenario A	Scenario B	Scenario C	
Taxable income group	**All**	**All**	**< 65 years**	**> 65 years**
	Allowance ratio	**Allowance ratio**	**Medical credit ratio**	
0 – 80 000	0.15	0.10	0.016	0.024
80 001–130 000	0.14	0.12	0.007	0.009
130 001– 180 000	0.16	0.15	0.005	0.006
180 001–230 000	0.19	0.18	0.004	0.005
230 001–300 000	0.20	0.19	0.003	0.004
>300 000	0.18	0.17	0.001	0.002

Source: Own calculations

Table 54: Number of taxpayers, taxable income, tax assessed, and deadweight loss (DWL) per income and age group

Taxable income group	Age group	A: Number of taxpayers	A: Taxable income (R million)	A: Tax paid (R million)	A: DWL (R million)	B: Number of taxpayers	B: Taxable income (R million)	B: Tax paid (R million)	B: DWL (R million)	C: Number of taxpayers	C: Taxable income (R million)	C: Tax paid (R million)	C: DWL (R million)
0 – 80 000	*<18*	26 435	1 358	78	10	32 677	1 626	87	12	32 677	1 626	69	12
	18 – 24	174 212	8 974	518	67	198 942	10 154	574	76	198 942	10 154	455	76
	25 – 34	831 250	44 279	2 733	332	918 821	48 758	2 988	366	918 821	48 758	2 411	366
	35 – 44	635 550	33 644	2 052	253	707 152	37 144	2 231	279	707 152	37 144	1 785	279
	45 – 54	512 825	27 417	1 704	206	547 740	29 237	1 812	219	547 740	29 237	1 429	219
	55 – 64	282 619	14 723	870	111	313 999	16 381	970	123	313 999	16 381	760	123
	>65	116 626	5 916	33	44	136 303	6 908	41	52	136 303	6 908	2	52
		2 579 517	**136 310**	**7 988**	**1 023**	**2 855 632**	**150 207**	**8 704**	**1 128**	**2 855 632**	**150 207**	**6 910**	**1 128**
						5.38%	3.10%	-1.50%	3.10%	-0.18%	-0.88%	-2.22%	-0.88%
80 001-130 000	*<18*	7 091	638	75	16	7 844	714	85	18	7 844	714	82	18
	18 – 24	46 040	4 681	622	119	49 794	5 067	674	129	49 794	5 067	641	129
	25 – 34	398 973	40 225	5 309	1 022	412 386	41 697	5 517	1 060	412 386	41 697	5 260	1 060
	35 – 44	371 631	38 577	5 222	981	380 289	39 505	5 351	1 004	380 289	39 505	5 093	1 004
	45 – 54	267 570	27 807	3 768	707	269 476	27 622	3 699	702	269 476	27 622	3 516	702
	55 – 64	134 371	13 637	1 810	347	138 606	14 184	1 897	361	138 606	14 184	1 804	361
	>65	53 776	5 365	459	136	54 472	5 507	483	140	54 472	5 507	436	140
		1 279 451	**130 930**	**17 265**	**3 328**	**1 312 867**	**134 295**	**17 706**	**3 413**	**1 312 867**	**134 295**	**16 832**	**3 413**
						3.55%	4.38%	5.12%	4.38%	0.29%	-0.50%	-1.12%	-0.50%
130 001-180 000	*<18*	3 281	525	97	22	3 281	532	99	23	3 281	532	97	23
	18 – 24	18 184	2 743	488	116	16 983	2 558	455	109	16 983	2 558	443	109
	25 – 34	154 093	23 215	4 129	985	159 165	24 050	4 287	1 020	159 165	24 050	4 168	1 020
	35 – 44	224 527	33 634	5 959	1 427	227 267	34 079	6 042	1 446	227 267	34 079	5 881	1 446
	45 – 54	163 215	24 587	4 373	1 043	178 273	26 787	4 756	1 137	178 273	26 787	4 627	1 137
	55 – 64	73 396	11 017	1 954	467	74 404	11 280	2 015	479	74 404	11 280	1 962	479
	>65	18 417	2 786	414	118	18 746	2 863	430	121	18 746	2 863	413	121
		655 113	**98 507**	**17 415**	**4 180**	**678 118**	**102 149**	**18 083**	**4 334**	**678 118**	**102 149**	**17 591**	**4 334**
						5.69%	7.12%	8.11%	7.12%	-3.01%	-3.55%	-4.00%	-3.55%

Taxable income group	Age group	A: Number of taxpayers	A: Taxable income (R million)	A: Tax paid (R million)	A: DWL (R million)	B: Number of taxpayers	B: Taxable income (R million)	B: Tax paid (R million)	B: DWL (R million)	C: Number of taxpayers	C: Taxable income (R million)	C: Tax paid (R million)	C: DWL (R million)
180 001– 230 000	*<18*	3 890	834	185	56	5 092	1 062	232	71	5 092	1 062	228	71
	18 – 24	79 299	15 909	3 395	1 064	78 236	15 751	3 369	1 054	78 236	15 751	3 314	1 054
	25 – 34	92 058	18 344	3 898	1 227	95 419	19 029	4 046	1 273	95 419	19 029	3 975	1 273
	35 – 44	64 021	12 812	2 730	857	63 589	12 796	2 736	856	63 589	12 796	2 687	856
	45 – 54	35 540	7 098	1 510	475	35 024	7 064	1 513	473	35 024	7 064	1 486	473
	55 – 64	12 072	2 442	470	163	12 072	2 472	480	165	12 072	2 472	468	165
		286 880	**57 438**	**12 188**	**3 843**	**289 432**	**58 176**	**12 377**	**3 892**	**289 432**	**58 176**	**12 158**	**3 892**
						3.88%	5.17%	6.07%	5.17%	-4.54%	-5.03%	-5.26%	-5.03%
230 001 – 300 000	*<18*	404	107	27	9	404	108	27	9	404	108	27	9
	18 – 24	16 908	4 504	1 132	388	16 908	4 559	1 152	393	16 908	4 559	1 140	393
	25 – 34	45 721	11 941	2 969	1 029	45 784	11 875	2 942	1 023	45 784	11 875	2 909	1 023
	35 – 44	60 966	16 401	4 141	1 413	61 331	16 496	4 165	1 422	61 331	16 496	4 118	1 422
	45 – 54	57 092	15 208	3 821	1 311	58 645	15 730	3 966	1 356	58 645	15 730	3 924	1 356
	55 – 64	20 657	5 642	1 436	486	21 215	5 841	1 492	503	21 215	5 841	1 476	503
	>65	3 217	870	206	75	2 836	765	181	66	2 836	765	178	66
		204 966	**54 673**	**13 731**	**4 711**	**207 122**	**55 374**	**13 925**	**4 772**	**207 122**	**55 374**	**13 771**	**4 772**
						-0.84%	-0.90%	-0.99%	-0.90%	-2.97%	-3.74%	-4.14%	-3.74%
> 300 000	*<18*					-	-	-	-	-	-	-	-
	18 – 24	3 681	1 299	371	137	3 681	1 315	378	138	3 681	1 315	376	138
	25 – 34	53 609	28 489	9 235	3 001	56 781	29 798	9 631	3 139	56 781	29 798	9 599	3 139
	35 – 44	86 275	46 736	15 217	4 923	88 964	48 117	15 662	5 068	88 964	48 117	15 611	5 068
	45 – 54	105 667	66 610	22 386	7 016	106 021	67 530	22 739	7 113	106 021	67 530	22 673	7 113
	55 – 64	74 402	48 148	16 261	5 072	74 402	48 735	16 496	5 133	74 402	48 735	16 444	5 133
	>65	5 910	2 597	774	274	6 292	2 745	816	289	6 292	2 745	810	289
		329 544	**193 879**	**64 244**	**20 422**	**336 141**	**198 241**	**65 721**	**20 881**	**336 141**	**198 241**	**65 513**	**20 881**
						6.58%	5.82%	5.66%	5.82%	-1.72%	-2.94%	-3.20%	-2.94%
Total	*<18*	37 212	2 628	277	58	44 206	2 980	298	62	44 206	2 980	274	62
	18 – 24	262 914	23 034	3 316	883	291 398	24 714	3 466	916	291 398	24 714	3 283	916
	25 – 34	1 562 945	164 058	27 771	7 434	1 671 173	171 930	28 734	7 662	1 671 173	171 930	27 660	7 662
	35 – 44	1 471 006	187 336	36 489	10 224	1 560 422	194 370	37 496	10 492	1 560 422	194 370	36 462	10 492
	45 – 54	1 170 390	174 441	38 781	11 140	1 223 744	179 702	39 708	11 383	1 223 744	179 702	38 856	11 383
	55 – 64	620 985	100 265	23 841	6 957	657 649	103 485	24 382	7 071	657 649	103 485	23 932	7 071
	>65	210 018	19 977	2 356	811	230 720	21 260	2 432	834	230 720	21 260	2 307	834
		5 335 470	**671 738**	**132 832**	**37 507**	**5 679 312**	**698 442**	**136 515**	**38 420**	**5 679 312**	**698 442**	**132 774**	**38 420**

Source: Own calculations

CHAPTER 7

SUMMARY, CONCLUSIONS, AND POLICY RECOMMENDATIONS

7.1 INTRODUCTION

This chapter presents a summary of the structure of this study, the major conclusions, and important policy recommendations.

The purpose of this study was to analyse tax reform measures to secure the tax revenue base, in particular the PIT structure of South Africa. More specific objectives included, first, the identification of PIT reform interventions that are necessary to align the PIT tax structure in South Africa with international best practices. The second objective was to determine how such tax reforms would impact revenue collection, given optimal economic growth levels. The third objective was to experiment with tax reforms that would minimise the individual tax burden and maximise its efficiency. The fourth and final objective was to determine the impact of the suggested tax reforms on fairness as a principle of a good tax.

The methodology used was to simulate the tax reforms using a static MS tax model. The different suggested tax reforms were selected from a study of international tax reform trends and from an analysis of the South African PIT tax structure. The impact of the suggested tax reforms is quantified in monetary terms in order to provide answers that would prove whether the objectives set have been achieved.

7.2 SUMMARY AND MAIN FINDINGS

The study has six main chapters. Chapter 1 presents the introduction and the specific objectives of the study, as indicated in the introduction. This is followed by an overview of relevant literature on tax reform. It is found that tax reform in the field of PIT is mainly directed towards addressing issues such as plugging leakages from the revenue base in the form of allowances and deductions, and changes in thresholds and marginal rates, in order to address fairness and efficiency as well as optimal revenue and growth. It is also found that such reforms are necessary to prevent the brain drain of highly skilled taxpayers. Another very important fact is that PIT taxes should be simplified to eliminate tax evasion and tax avoidance, and thus to develop a fair and efficient tax system. Another specific drive in tax reform is the attempt to devise tax structures that address deficiencies in health care provision and pensions. In this study, only the medical issue is analysed.

The literature provides clear margins for the structuring of tax bands and threshold margins. A rule of thumb for determining the non-taxable thresholds in upper-middle income countries seems to be a number equal to the GDP/capita; for the highest income band the number should be 18 times the GDP/capita. It is also recommended that the income tax bands range in number between 4 and 6. The top marginal rate should be between 30 and 50 per cent, and the lowest marginal rate between 10 and 20 per cent. Evidence from other countries shows a significant shift towards simpler income tax structures and lower tax burdens, especially at the top of the income distribution. To give more tax relief to lower income taxpayers, a medical tax credit is preferred to a medical deduction.

Chapter 3 analyses tax structure and tax reform in South Africa. It shows that the South African tax system has gone through several tax reforms. Over the years income tax bands decreased in number from 10 to 6. In the 1960s the top marginal tax rate was 66 per cent. In 1998/1999 the minimum and maximum tax rates declined to 19 and 45 per cent, respectively. In 2002/2003 the minimum and maximum marginal tax rates declined further to 18 and 40 per cent, respectively. Since 2003 the PIT/GDP ratio of South Africa has been hovering around 8 per cent, which indicates the importance of PIT revenue as a major source of income. For other upper-middle income countries this ratio is, on average, below 4 per cent. Since 1999/2000 this ratio has shown a declining trend, with top marginal tax rates in particular decreasing.

As in the case of other upper-middle income countries, tax reforms mainly make adjustments for inflation to avoid bracket creep. Medical deductions are one of the largest leakages from the revenue base. In South Africa, medical deductions are in the process of being converted to medical tax credits, which seems to be the preferred way to help low income individuals to afford medical insurance. The chapter concludes with a summary of the main tax reforms and possible tax reforms suggested for use in the simulations in the next chapter. These reforms include the following:

- Marginal tax rates applicable to the 2006 fiscal year are used as a base from which changes are implemented. Apart from the base scenario, two other scenarios are simulated: one where marginal rates are increased, and one where marginal rates are decreased.
- The non-taxable thresholds and top taxable income band are adjusted to GDP/capita levels similar to those of South Africa's peers.
- Taxable income bands and thresholds only are inflated by the CPI from the 1998/1999 levels.
- Changing medical deductions to medical tax credits is simulated and compared.

In order to explain the methodology for determining the impact of tax reforms, Chapter 4 discusses tax elasticities, which are then used in the model explained in Chapter 5. These elasticities include the elasticities for determining the progressiveness of the PIT structure, the deadweight loss (tax efficiency), and optimal levels of taxes and economic growth and revenue maximisation. In the case of progressivity, a relatively large elasticity coefficient confirms the progressivity of the PIT system in South Africa. It is also indicated that tax efficiency can be measured in the form of deadweight loss using the consumer surplus approach. In this case elasticity is measured as the change in revenue, due to a similar percentage change in net tax income. The elasticity coefficient therefore varies between different income levels – another reflection of the progressivity of the tax structure and the efficiency of a tax reform as measured by deadweight loss. By increasing taxable income or marginal tax rates, tax liability increases, and so the deadweight loss increases as well. The literature overview explains that it is common practice to estimate taxable income elasticity by using the difference-in-differences approach with data before and after a major tax policy change. Due to the lack of such tax data series in South Africa, this approach could not be used in this study. Instead tax elasticity is derived from an analysis of optimum tax performance and the thickness of the income distribution (inverted Pareto), as explained in Chapter 4. The results show that the revenue-maximising tax rate/Laffer bound curve, hovers around 40.5 and 43 per cent between the taxable income groups.

Given this optimum level of taxable income, elasticity amounts to 0.38 for the lowest income group and increases to 0.79 for the highest income group. The elasticities are within the range of other empirical studies. The analysis shows that the optimum PIT/GDP ratio to maximise growth is 6.7[20] per cent. Thus the finding indicates that the current South African average PIT/GDP ratio (8.5 per cent) might be on the downward-sloping portion of the Laffer curve. The tax burden thus has a negative impact on economic growth. As part of tax reform, policy makers should consider adjusting tax rates in order to align revenue to the optimal ratios defined.

Chapter 5 provides an exposition of the literature on MS tax models, the differences and limitations of these models, and the linking or layering of MS and CGE models. It shows that MS models are mainly based on individual and household data, as is the case with the model structured in this study (mostly data from the IES of Stats SA). After substantial imputation, the data is calibrated with aggregated tax data published by SARS. For the missing categorical variables in the IES survey, a frequency table for each variable is obtained to determine the distribution of the missing values. A problem encountered is that data on tax liability is not accurately recorded in the survey data. Furthermore, the IES and SARS databases differ in terms of base years (calendar versus fiscal years); and to be able to compare, the IES data had to be adjusted to fiscal year 2005/2006 data using the CALMAR re-weighting program. An analysis of the demographics of the data shows that income (and therefore tax liability) is slightly more skewly distributed according to the IES data. Both datasets indicate that the richest 10 per cent of individuals pay almost half of the total revenue collected. The CALMAR re-weighting program is then used to age the database to the 2010/2011 tax year. The base model also allows for comparisons between different gender groups, race groups, levels of education, and age groups.

In Chapter 6 tax reform scenarios are simulated, and the progressivity, efficiency, growth, and revenue optimising ratios of each scenario are discussed. The analysis shows that Scenario C is the most favourable scenario, with lower marginal tax rates that improve efficiency by 57 per cent and decrease tax liability by 32 per cent – mostly in the middle

[20] The optimum tax revenue/GDP ratio for South Africa is 20.5 per cent. The actual level of total tax revenue as a share of GDP for 2011/2012 is 24.6 per cent. Thus, the tax ratio that maximises growth is substantially lower than the 2011/2012 realised rate. The growth-maximising tax ratio of 20.5 per cent might appear to be on the low side if measured against the revenue required to finance the government's budget.

income groups. The PIT/GDP ratio also declines to 5.6 per cent, which is below the optimal rate of 6.7 per cent, compared to the other scenarios. Although this could result in lower revenue from PIT, the literature provides sufficient proof that such a lowering in marginal taxes will also increase productivity and improve revenue flows. With the proposed tax reform using marginal rates equal to those of South Africa's peers (12 to 30 per cent) the rates will also be lower than what is proposed in the Laffer bound curve; and the analysis also shows that efficiency will improve. However, the revenue elasticity at lower marginal tax rates (1.34) indicates that progressivity declines from the levels in the base scenario, which could be interpreted as a less fair tax structure. The marginal tax reform impacts positively on tax efficiency, given the lower total tax burden on individuals.

The result is that, in order to align the marginal tax regime in South Africa to that of its peers, the future trend in marginal rates will have to be downward. Although the model has no connection with the macro-economy, and tax changes are therefore not reflected in macro-behaviour, there is sufficient literature that outlines the problems of unaligned tax rates from a tax competition perspective. However, the inclusion of deadweight loss as an indication of tax efficiency, progressivity, growth, and revenue-maximising tax rates provide some additional perspective to the choice of marginal rates. The results in this study clearly indicate that increased marginal taxes impact negatively on tax efficiency, which could neutralise the potential advantage of increased revenue. It is also important that, from an efficiency point of view, such changes in marginal rates impact more heavily on those in the middle income groups. Behavioural changes show the vulnerability of the lowest income group, and of individuals older than 65 years who also fall within this income group.

From adjusting the non-taxable thresholds and taxable income bands, it can be concluded that such tax reforms also affect tax liability and therefore revenue collected. Adjustment to threshold levels and income bands similar to those of South Africa's peers allows 5 per cent more taxpayers into the tax system. This is because the broadening of tax bands allows fewer potential taxpayers outside the tax net. The results also show that if the threshold and tax bands are only adjusted for inflation instead of using the current levels, tax liability increases with a corresponding decrease in tax efficiency. This effect is somewhat softened if the threshold and tax bands are adjusted according to the algorithms provided in the literature overview with especially the lower income groups benefitting from such a reform. Furthermore, an adjustment of threshold and tax bands as suggested also increases the progressivity of the tax structure thereby improving its level of “fairness”. Although total tax liability is reduced which would result in revenue loss, the PIT/GDP ratio after such a reform gets closer to the optimal ratio for economic growth as indicated. This in turn could stimulate productivity with a resultant increase in economic growth and an expansion of the revenue base that could compensate for the loss in current revenue.

With a medical tax credit, taxpayers with a marginal tax rate below 25 per cent will pay less tax, since it allows for a deduction in excess of the monetary value of deductions at the applicable marginal tax rate. However, the tax liability of taxpayers with marginal tax rates above 25 per cent will increase. From the analysis it is clear those individuals older than 65 years, along with those between 18 and 24 years, mostly fall within the lowest income group, and will therefore benefit more from a tax credit. Comparing a medical deduction scheme to a medical credit scheme shows that total tax liability in the case of the latter also decreases which is expected since, as explained above, more taxpayers fall within the lowest income group, and their tax liability decreases more with a medical credit.

Tax elasticity also increases in the case of a medical tax credit which enhances the progressiveness of the tax structure and therefore also the fairness of the system. Given the small difference in revenue collected, the impact of this tax reform on the PIT/GDP ratio shows little variance from the medical deduction scenario and in both cases the ratio remains in excess of the optimal ratio. However, although not enhancing economic growth directly, more taxpayers are exposed to medical services which should enhance productivity and therefore, indirectly contribute towards increased growth and an expansion of the revenue base.

7.3 CONCLUSION AND POLICY RECOMMENDATIONS

The results of the suggested tax reform scenarios indicate that they will not only affect revenue collected but also the levels of tax efficiency and fairness (as measured in terms of progressivity). In the process, the different scenarios take the economy closer to or further away from optimum growth and optimum revenue. However, the researcher should warn that the tax policy recommendations have to be dealt with carefully since in many instances this study does not allow for an elaborate discussion of the full impact of the policies recommended. For example, the upgrading of educational skills would be better explained if accompanied by an analysis of its impact on job creation. This in turn might later on need, among others, tax incentives to entice the private sector to invest more in South Africa. As explained earlier on, the model used in this research does not allow for such an analysis but in further research this is definitely an aspect that will have to be explored by for example, linking the current model to a Computable General Equilibrium (CGE) model as will be outlined later on.

Furthermore, recommendations that rely heavily on best practices in peer countries also need qualification. South Africa has its own unique history and structural features that warrant mention and caution before the policy maker blindly follows what peers are doing. One obvious issue is the skewness in income distribution and the resultant skewness in the tax burden. This phenomenon could pose the question why the income tax burden of the rich simply cannot be increased to narrow the income gap between the rich and the poor which relates to the concept of fairness? Thus, policymakers have to discount these caveats when considering the policies recommended in the rest of this Chapter.

From the model results the following tax policy reforms for individual taxes have been identified that would improve on optimum levels and also maximise tax efficiency and fairness:

- Adjustment in marginal tax rates

Due to globalisation and the resultant international tax competition, studies show that many countries have embarked on a declining trend in marginal tax rates on personal income. From an efficiency point of view, the model clearly shows that increases in marginal rates from the current levels (especially for the higher income groups) will be detrimental to the economy. Thus policymakers will have to weigh carefully the trade-off between lower levels of PIT and the benefits of increased tax efficiency (lower deadweight loss). It is therefore recommended that marginal tax rates be adjusted downwards – especially the rates of middle income groups, where efficiency is relatively more sensitive to tax changes.

However, it is also acknowledged that marginal rates that are too low erode the revenue base, with the result that alternative sources of revenue would have to be implemented, or the revenue from existing sources other than income tax be increased. Thus, as a benchmark, it is recommended that marginal tax rates be adjusted to levels close to those of South Africa's peers (12 to 30 per cent).

- Adjustment of the income bands and the non-taxable thresholds

Adjustment of income bands and the non-taxable thresholds to the GDP/capita benchmark used by South Africa's peers shows greater improvement in tax liability and efficiency than just with inflation-adjusted taxable income bands.

A policy recommendation should therefore be to adjust these levels accordingly. The threshold for those below the age of 65 years is set to equal the GDP/capita (R33 787) in 2005/2006. The lowest income band should be double the GDP/capita, and the highest income band 18 times GDP/capita. The rest of the income bands are evenly distributed in between.

- Adjustment in tax expenditures

With the tax expenditure reforms, the analysis has shown that a medical tax credit provides a more equitable form of relief than medical deductions. The reform, which has already been implemented by government with effect from 1 March 2012 and which is to be phased in over the next few years, can therefore be substantiated from the results in this study. Its impact on the tax/GDP ratio is limited and efficiency is also largely unaffected.

- Upgrading educational skills and limiting vulnerability

The demographic impact of the suggested reforms in the MS model also shows some important trends that should feature in policy recommendations. For example, improving educational skills contributes not only to finding jobs, but also increases the proportional share of individuals in the revenue base. So tax policy adjustments that enhance the quality of education would be a positive investment in future revenue collection.

As far as age is concerned, the analysis shows that a substantial number of taxpayers in the categories below the age of 24 and above 65 falls into the lower taxable income groups. Those are the most vulnerable groups from a subsistence point of view, and will benefit most from the suggested tax reforms.

7.4 RECOMMENDATIONS FOR FUTURE RESEARCH

Future research in this field of study should expand the MS model to become a dynamic model that can also capture features such as population ageing and other demographic changes. The model should then be even more useful in simulating the impact of important policy changes such as health care and retirement incentives.

This study is limited to individual income tax, using income data from the Stats SA IES. However, the same database also contains rich data on household expenditures, and so the model should be expanded to include an analysis of the impact of taxes not only on disposable income but also on expenditure patterns. Given the structure of an MS tax model, such changes in expenditure patterns as a result of changes in tax policy could be very helpful in determining not only the efficiency but also the fairness of such tax initiatives, given the skewness of income and the resultant tax liability.

Another shortcoming of the static MS model used in this analysis is that it is not linked to a macro model that could also estimate the impact of changes in disposable income and tax liability on consumption and saving, and eventually on the full circle throughout the economy, with changes in the income base. For example, linking this model to a CGE model allows for a better calibration between the parameters of both models, and thus for a more accurate measurement of the effects of fiscal policy reforms.

Finally, the MS model used in this research is based on 2005/2006 IES data. However, data for the 2010/2011 fiscal year has just been released and another more recent benchmark would be helpful in judging the quality of the research outcomes. This means that the model would have to be re-calculated to accommodate structural changes since the 2005/2006 base year.

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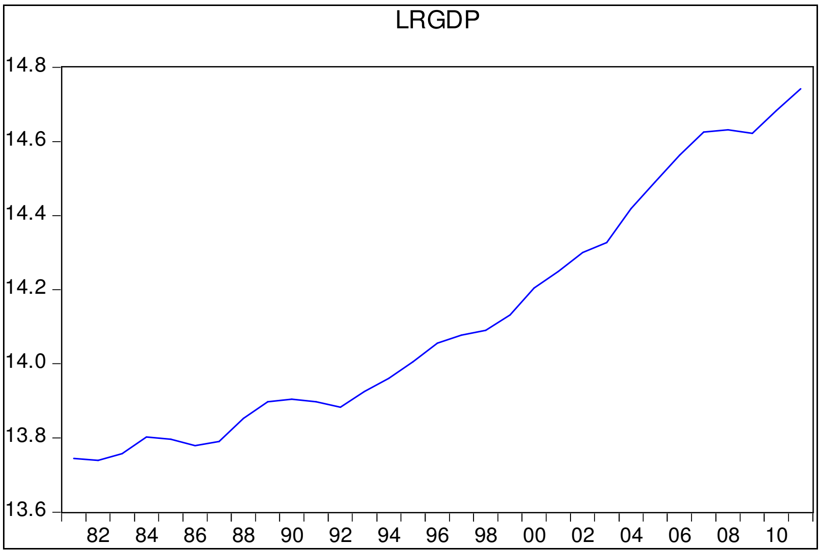
APPENDIX 1

REAL GROSS DOMESTIC PRODUCT (RGDP)

Figure 21 which graphs real government expenditure in natural logarithm levels indicates that the series does not have a constant mean and variance. The autocorrelations of the correlogram[21] takesome time to taper off, thus perhaps indicating non-stationarity. The Augmented Dickey-Fuller unit root test[22] proves the non-stationarity of the series.

Figure 21: Natural logarithm levels of real gross domestic product (LRGDP)



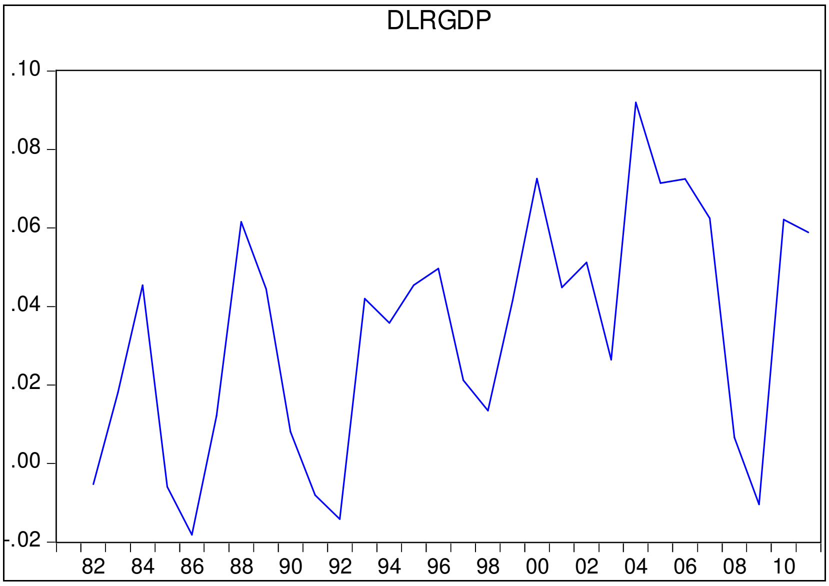
Source: Own calculations

Figure 22 real GDP in natural logarithm levels is differenced once, indicating that the series have a constant mean and variance about the trend – thus possibly stationary. The Augmented Dickey-Fuller unit root[20] confirmed stationarity. Therefore RGDP~I(1).

---

[21] See Appendix 2
[22] See Appendix 3

Figure 22: Difference of the natural logarithm levels of real gross domestic product (DLRGDP)

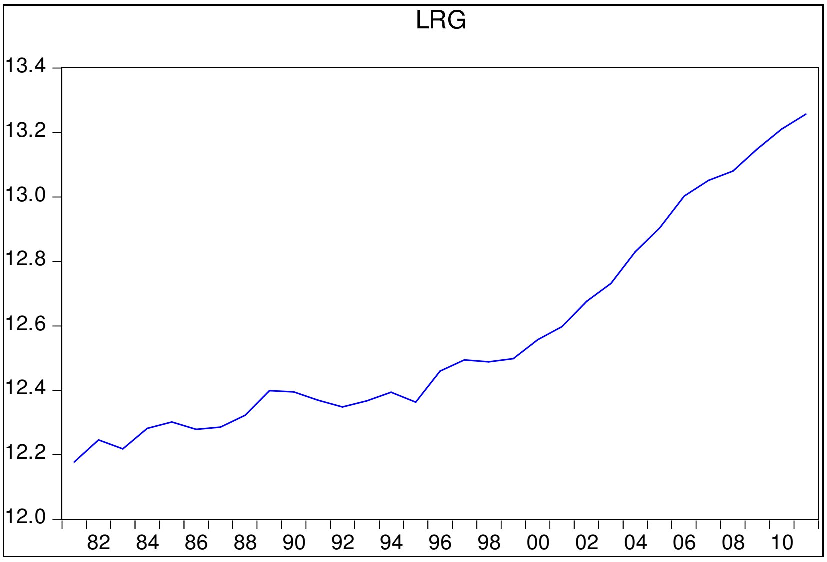


Source: Own calculations

REAL GOVERNMENT EXPENDITURE (RG)

Figure 23 which graphs real government expenditure in natural logarithm levels, indicates that the series does not have a constant mean and variance. The autocorrelations of the correlogram[19] take some time to taper off, thus perhaps indicating non-stationarity. The Augmented Dickey-Fuller unit root test[20] proves the non-stationarity of the series.

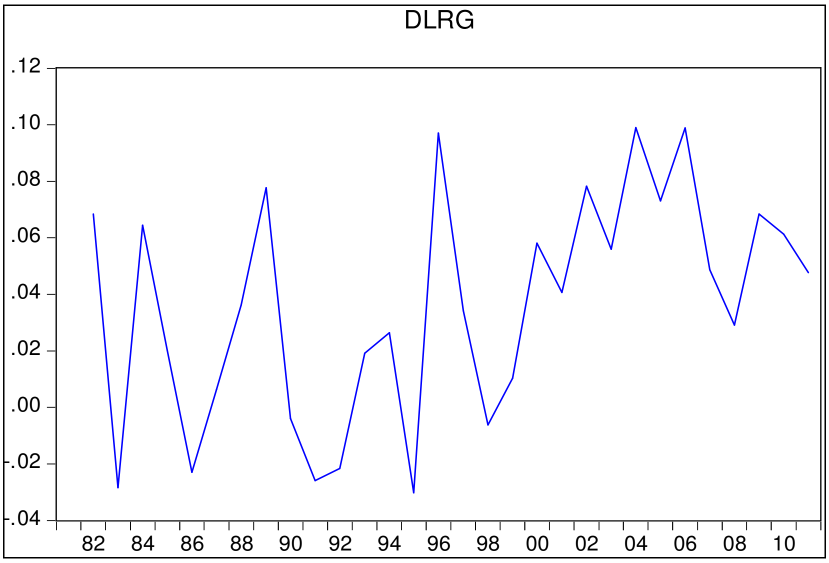
Figure 23: Natural logarithm levels of real government expenditure (LRG)



Source: Own calculations

In Figure 24 real government expenditure in natural logarithm levels is differenced once, indicating that the series have a constant mean and variance about the trend – thus possibly stationary. The Augmented Dickey-Fuller unit root[20] confirmed stationarity. Therefore RG~I(1).

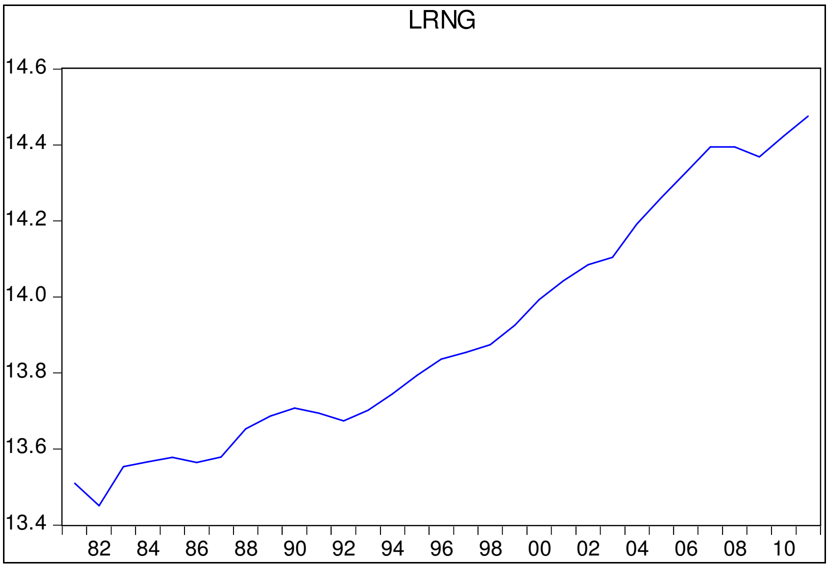
Figure 24: Difference of the natural logarithm levels of real government expenditure (DLRG)



Source: Own calculations

REAL NON GOVERNMENT (RNG)

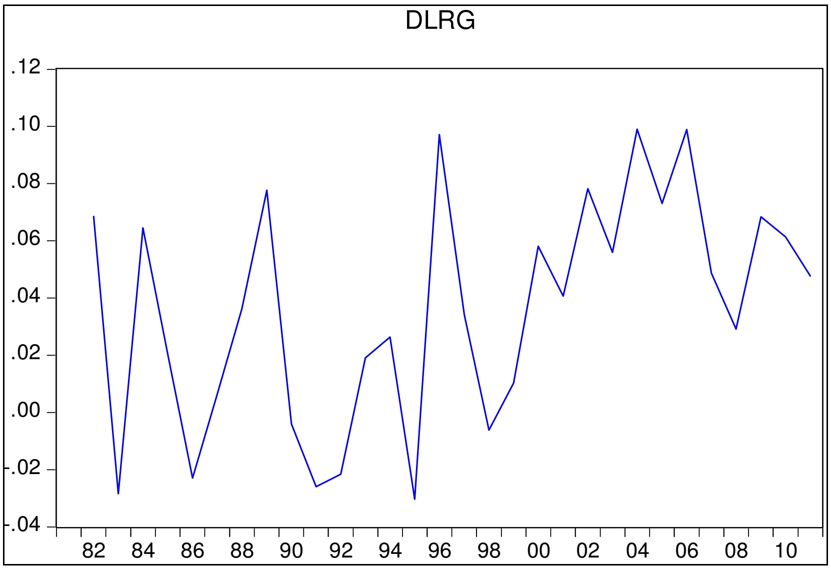
Figure 25: Natural logarithm levels of real non-government expenditure (LRNG)



Source: Own calculations

Figure 25 shows the real non-government expenditure over time exhibiting the characteristics of a stationary time series. The autocorrelations of the correlogram[19] take some time to taper off, thus perhaps indicating non-stationary. The Augmented Dickey-Fuller unit root test[20] proves the non-stationarity of the series.

Figure 26: Difference of the natural logarithm levels of real non-government expenditure (DLRNG)



Source: Own calculations

In Figure 26 real non-government expenditure is differenced once, indicates a constant mean and variance around the trend – indicating stationarity. The Augmented Dickey-Fuller unit root test[20] confirms stationary. Therefore RNG~I(1)

Dummy variable (Dum)

A dummy variable was incorporated to account for the structural break caused by the economic and other sanctions on South Africa (1982-1992) which distorted the available time series.

APPENDIX 2

Figure 27: Correlogram of lrgdp

```
Sample: 1981 2011
Included observations: 31

Autocorrelation     Partial Correlation        AC      PAC    Q-Stat   Prob

   .  |*******          .  |*******        1   0.909   0.909   28.152  0.000
   .  |******|          .  |  .  |         2   0.814  -0.064   51.553  0.000
   .  |*****  |         .  |  .  |         3   0.726  -0.022   70.784  0.000
   .  |*****  |         . *|  .  |         4   0.631  -0.084   85.872  0.000
   .  |****   |         . *|  .  |         5   0.526  -0.118   96.756  0.000
   .  |***    |         . *|  .  |         6   0.418  -0.084   103.92  0.000
   .  |**.    |         .  |  .  |         7   0.315  -0.057   108.14  0.000
   .  |**.    |         .  |  .  |         8   0.223  -0.007   110.34  0.000
   .  |* .    |         .  |  .  |         9   0.147   0.026   111.35  0.000
   .  |  .    |         . *|  .  |        10   0.071  -0.067   111.60  0.000
   .  |  .    |         .  |  .  |        11  -0.003  -0.063   111.60  0.000
   . *|  .    |         . *|  .  |        12  -0.079  -0.101   111.93  0.000
   . *|  .    |         .  |  .  |        13  -0.142  -0.022   113.08  0.000
   . *|  .    |         .  |  .  |        14  -0.197  -0.034   115.40  0.000
   .**|  .    |         .  |  .  |        15  -0.246  -0.039   119.28  0.000
   .**|  .    |         .  |  .  |        16  -0.290  -0.030   125.01  0.000
```

Source: Own calculations

Autocorrelation do not seem to converge very quickly therefore the series appears to be non-stationary.

Figure 28: Correlogram of dlrgdp

```
Sample: 1981 2011
Included observations: 30

Autocorrelation     Partial Correlation        AC      PAC    Q-Stat   Prob

   .  |***    |         .  |***   |        1   0.391   0.391   5.0628  0.024
   . *|  .    |         .**|  .   |        2  -0.087  -0.283   5.3201  0.070
   . *|  .    |         .  |* .   |        3  -0.087   0.087   5.5868  0.134
   .  |* .    |         .  |* .   |        4   0.140   0.160   6.3128  0.177
   .  |**.    |         .  |* .   |        5   0.287   0.171   9.4693  0.092
   .  |**.    |         .  |* .   |        6   0.292   0.184   12.874  0.045
   .  |* .    |         .  |  .   |        7   0.104  -0.008   13.326  0.065
   . *|  .    |         . *|  .   |        8  -0.086  -0.073   13.646  0.091
   . *|  .    |         .  |  .   |        9  -0.087  -0.053   13.991  0.123
   .  |  .    |         . *|  .   |       10   0.012  -0.071   13.998  0.173
   .  |* .    |         .  |* .   |       11   0.155   0.078   15.217  0.173
   .  |  .    |         . *|  .   |       12   0.002  -0.197   15.218  0.230
   .**|  .    |         . *|  .   |       13  -0.239  -0.172   18.448  0.141
   .**|  .    |         . *|  .   |       14  -0.299  -0.149   23.810  0.048
   . *|  .    |         . *|  .   |       15  -0.178  -0.123   25.838  0.040
   .  |  .    |         .  |* .   |       16   0.039   0.093   25.944  0.055
```

Source: Own calculations

Autocorrelations do seem to converge very quickly; therefore the series appears to be stationary.

Figure 29: Correlogram of lrg

```
Sample: 1981 2011
Included observations: 30

Autocorrelation    Partial Correlation      AC     PAC    Q-Stat  Prob

   . |***  |          . |***  |         1  0.391   0.391  5.0628  0.024
   . *|  .  |         .**|  .  |        2 -0.087  -0.283  5.3201  0.070
   . *|  .  |         .  |* .  |        3 -0.087   0.087  5.5868  0.134
   .  |* .  |         .  |* .  |        4  0.140   0.160  6.3128  0.177
   .  |**.  |         .  |* .  |        5  0.287   0.171  9.4693  0.092
   .  |**.  |         .  |* .  |        6  0.292   0.184  12.874  0.045
   .  |* .  |         .  |  .  |        7  0.104  -0.008  13.326  0.065
   . *|  .  |         . *|  .  |        8 -0.086  -0.073  13.646  0.091
   . *|  .  |         .  |  .  |        9 -0.087  -0.053  13.991  0.123
   .  |  .  |         . *|  .  |       10  0.012  -0.071  13.998  0.173
   .  |* .  |         .  |* .  |       11  0.155   0.078  15.217  0.173
   .  |  .  |         . *|  .  |       12  0.002  -0.197  15.218  0.230
   .**|  .  |         . *|  .  |       13 -0.239  -0.172  18.448  0.141
   .**|  .  |         . *|  .  |       14 -0.299  -0.149  23.810  0.048
   . *|  .  |         . *|  .  |       15 -0.178  -0.123  25.838  0.040
   .  |  .  |         .  |* .  |       16  0.039   0.093  25.944  0.055
```

Source: Own calculations

Autocorrelation do not seem to converge very quickly therefore the series appears to be non-stationary.

Figure 30: Correlogram of dlrg

```
Sample: 1981 2011
Included observations: 31

Autocorrelation    Partial Correlation      AC     PAC    Q-Stat  Prob

   .  |******|        .  |******|       1  0.888   0.888  26.888  0.000
   .  |******|        .  |  .  |        2  0.780  -0.038  48.374  0.000
   .  |*****|         . *|  .  |        3  0.669  -0.078  64.727  0.000
   .  |****  |        .  |  .  |        4  0.567  -0.022  76.920  0.000
   .  |***  |         . *|  .  |        5  0.460  -0.088  85.260  0.000
   .  |**.  |         . *|  .  |        6  0.349  -0.099  90.234  0.000
   .  |**.  |         .  |  .  |        7  0.249  -0.021  92.883  0.000
   .  |* .  |         .  |  .  |        8  0.159  -0.036  94.006  0.000
   .  |* .  |         .  |  .  |        9  0.090   0.026  94.386  0.000
   .  |  .  |         .  |  .  |       10  0.027  -0.036  94.422  0.000
   .  |  .  |         .  |  .  |       11 -0.027  -0.024  94.459  0.000
   . *|  .  |         .  |  .  |       12 -0.078  -0.049  94.785  0.000
   . *|  .  |         .  |  .  |       13 -0.120  -0.028  95.605  0.000
   . *|  .  |         .  |  .  |       14 -0.160  -0.055  97.153  0.000
   .**|  .  |         . *|  .  |       15 -0.210  -0.108  99.981  0.000
   .**|  .  |         .  |  .  |       16 -0.245  -0.000  104.09  0.000
```

Source: Own calculations

Autocorrelations do seem to converge very quickly; therefore the series appears to be stationary.

Figure 31: Correlogram of lrng

```
Sample: 1981 2011
Included observations: 30

Autocorrelation      Partial Correlation        AC      PAC     Q-Stat   Prob

   . |* .  |            . |* .  |          1   0.208   0.208   1.4303   0.232
   . |* .  |            . |* .  |          2   0.150   0.112   2.2015   0.333
   . |* .  |            . |* .  |          3   0.198   0.155   3.5926   0.309
   . |**.  |            . |* .  |          4   0.259   0.197   6.0778   0.193
   . |* .  |            . | .   |          5   0.157   0.055   7.0247   0.219
   . | .   |            . *| .  |          6   0.023  -0.085   7.0464   0.317
   . |* .  |            . |* .  |          7   0.187   0.123   8.5114   0.290
   . |* .  |            . | .   |          8   0.132   0.023   9.2746   0.320
   . | .   |            . *| .  |          9  -0.019  -0.112   9.2903   0.411
   . *| .  |            .**| .  |         10  -0.168  -0.227   10.648   0.386
   .**| .  |            .**| .  |         11  -0.239  -0.308   13.544   0.259
   . | .   |            . | .   |         12  -0.028   0.004   13.587   0.328
   . *| .  |            . *| .  |         13  -0.195  -0.107   15.728   0.264
   . *| .  |            . | .   |         14  -0.184  -0.026   17.770   0.217
   . *| .  |            . |* .  |         15  -0.099   0.081   18.403   0.242
   . *| .  |            . | .   |         16  -0.112   0.017   19.262   0.255
```

<u>Source:</u> Own calculations

Autocorrelation do not seem to converge very quickly therefore the series appears to be non-stationary.

Figure 32: Correlogram of dlrng

```
Sample: 1981 2011
Included observations: 31

  Autocorrelation    Partial Correlation        AC      PAC     Q-Stat   Prob

   . |*******           . |*******         1   0.909   0.909   28.201   0.000
   . |******|           . *| .  |          2   0.810  -0.100   51.328   0.000
   . |***** |           . | .   |          3   0.725   0.035   70.530   0.000
   . |***** |           . *| .  |          4   0.630  -0.121   85.546   0.000
   . |****  |           . *| .  |          5   0.526  -0.094   96.421   0.000
   . |***   |           . *| .  |          6   0.419  -0.090   103.61   0.000
   . |**.   |           . | .   |          7   0.316  -0.059   107.86   0.000
   . |**.   |           . | .   |          8   0.226   0.005   110.14   0.000
   . |* .   |           . | .   |          9   0.152   0.019   111.22   0.000
   . |* .   |           . | .   |         10   0.080  -0.054   111.53   0.000
   . | .    |           . *| .  |         11   0.005  -0.077   111.53   0.000
   . *| .   |           . *| .  |         12  -0.072  -0.107   111.81   0.000
   . *| .   |           . | .   |         13  -0.139  -0.038   112.90   0.000
   . *| .   |           . | .   |         14  -0.194  -0.023   115.18   0.000
   .**| .   |           . | .   |         15  -0.242  -0.018   118.92   0.000
   .**| .   |           . | .   |         16  -0.284  -0.028   124.44   0.000
```

<u>Source:</u> Own calculations

Autocorrelations do seem to converge very quickly; therefore the series appears to be stationary.

APPENDIX 3

Augmented Dickey Fuller unit root test on variables

H_0 : ρ*= 0 (non-stationarity)
H_1 : ρ*< 0 (stationarity)

Table 55: Summary of ADF Results

	Model	**Lags**	$\tau_\tau, \tau_\mu, \tau$ [23]	ϕ_3, ϕ_1	**Conclusion**
LRG	Trend & Intercept	0	-0.287	3.353*	Non-stationary
	Intercept	0	2.284	5.214	
	None	0	5.043		
LRNG	Trend & Intercept	0	-1.941	3.389	Non-stationary
	Intercept	0	1.179	1.392	
	None	0	4.137		
LRGDP	Trend & Intercept	0	-1.54	5.258	Non-stationary
	Intercept	0	2.240	5.017	
	None	0	2.874		
ΔLRG	Trend & Intercept	0	-5.567***	15.583***	Stationary
	Intercept	0	-4.252***	18.083***	
	None	0	-2.907***		
ΔLRNG	Trend & Intercept	0	-5.540***	15.598***	Stationary
	Intercept	0	-5.539***	30.683***	
	None	0	-3.003***		
ΔLRGDP	Trend & Intercept	0	-3.888**	7.571***	Stationary
	Intercept	0	-3.461**	11.976***	
	None	0	-1.816*		

Source: Own calculations

The results of the formal unit root tests ADF clearly show that RG, RNG, RGDP test stationary (null hypothesis is not rejected) after first differencing. The assertion that these series are integrations of order one I(1) is credible.

[23] *(**)[***] Statistically significant at a 10(5)[1] % level

APPENDIX 4

Use the MacKinnon response surface calculation to determine the critical value for cointegration test.

$C(p) = \phi_\infty + \phi_1 * T^{-1} + \phi_2 T^{-2}$

10%: $C(10) = -3.4518 + (-6.241)(31^{-1}) + (-2.79)(31^{-2})$
$= -3.6560$
5%: $C(5) = -3.7429 + (-8.352)(31^{-1}) + (-13.41)(31^{-2})$
$= -4.0263$
1%: $C(1) = -4.2981 + (-13.79)(31^{-1}) + (-46.37)(31^{-2})$
$= -4.7912$
n=3