AN ECONOMIC ANALYSIS OF MATERNAL HEALTH CARE IN ZAMBIA

by

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Declaration

This thesis is entirely my own work and acknowledgments have been made where other sources are used. I declare that this thesis has not been previously submitted for the award of another degree at any University.

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Date:……………………………………………………………...…………….

Abstract

This thesis investigates the utilisation of maternal health care in Zambia, where despite being a signatory to the Safe Motherhood Initiative and Millennium Development Goals, which are aimed at improving maternal health, indicators of maternal health continue to perform poorly. The need to understand crucial factors in improving maternal health motivated the current research, especially since there is a dearth of literature in this area in Zambia. The thesis focuses on two aspects of maternal health care: antenatal care (ANC) and facility-based deliveries, to answer two broad questions. Firstly, what factors determine the use of ANC in Zambia? Secondly, to what extent has the abolition of user fees affected facility-based deliveries?

An assessment of the factors, which explain the utilisation of ANC in Zambia, using three sets of comparable datasets reveals that, while there are differences in the factors explaining the decision to use ANC and the frequency of visits over time, the decision to seek ANC and the frequency of use is low among the poor and less educated, and there are marked regional differences in utilisation. The most appropriate econometric specification for antenatal visits, according to different performance indicators, was the two-part model, which differs from recent research favouring more complex methodologies.

The analysis is further extended through the inclusion of supply-side factors and the examination of individual and community level factors associated with inadequate and non-use of ANC, following the adoption of the focused ANC approach in Zambia. To incorporate the supply side factors, the 2007 Zambia Demographic and Health Survey was linked to administrative and health facility census data using geo-referenced data. To assess the factors associated with (1) the inadequate use of ANC (defined as three or less visits), and (2) the non-use of ANC in the first trimester of pregnancy, we specify two multilevel logistic models. At the individual level, the woman's employment status, quality of ANC received and the husband's educational attainment are negatively associated, while parity, the household childcare burden and wealth are positively associated with inadequate utilisation of ANC. Both individual and community level characteristics influence inadequate use and non-use of ANC in the first trimester; however, community level factors are relatively stronger in rural areas.

Although ANC is an important facet of maternal care, it occurs before delivery, but does not necessarily provide much information with respect to delivery decisions. Therefore, the thesis investigates delivery decisions, as well, in particular, the effect of user fee removal in rural areas of Zambia on facility-based deliveries. To account for regional differences, we employ a Seemingly Unrelated Regression model incorporating an Interrupted Time Series design. The analysis uses quarterly longitudinal data covering 2003q1-2008q4. When unobserved heterogeneity, spatial dependence and quantitative supply-side factors are controlled for, user fee removal is found to immediately increase aggregate facility-based deliveries, although the national trend was unaffected. Drug availability and the presence of traditional birth attendants also influence facility-based deliveries at the national level, such that, in the short-term, strengthening and improving community-based interventions could increase facility-based deliveries. However, there is significant variation and spatial dependence masked in the aggregate analysis. The results highlight the importance of service quality in promoting facility-based deliveries, and also suggest that social and cultural factors, especially in rural areas, influence the use of health facilities for delivery. These factors are not easily addressed, through an adjustment to the cost of delivery in health facilities.

Additionally, we analyse the effect of user fee abolition on the location of childbirth, focussing on deliveries that occur in public health facilities using household survey data. To elicit the causal relationship, we exploit the relative change in fees across health districts within a difference-in-differences framework. Surprisingly, although reductions in home deliveries were observed, as expected, reductions in public health facility-based deliveries were also uncovered, along with increases in deliveries at private health facilities. However, these findings were statistically insignificant; suggesting that the abolition of user fees had little, if any, impact on the choice of location for childbirth. The statistically insignificant, but unexpected, causal effects further suggest that the removal of user fees have unintended consequences, possibly the transference of facility costs to the client, which would deter the utilisation of delivery services. Therefore, abolishing user fees, alone, may not be sufficient to affect changes in outcomes; instead, other efforts, such as improving service quality, could have a greater impact.

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Above all, I thank the Almighty God for seeing me through, yet, another memorable journey in my quest for knowledge!

Dedication

To the memory of my brothers, Musonda and Gift, I am sure you would have been so proud of me! Till we meet again.

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CHAPTER 1

1 Introduction

1.1 Overview

For over a decade, Zambia has been a signatory to the Safe Motherhood Initiative and Millennium Development Goals (MDG), which are aimed at improving maternal health, yet, maternal health indicators remain poor. Although the maternal mortality rate (MMR) declined from 729 to 591 per 100,000 live births between 2001/2 and 2007, it is still relatively high compared to other developing countries. As such, Zambia is unlikely to achieve the MDG 5 target of 185 per 100,000 live births by 2015. In order to improve MMR trajectories, uncovering information related to the utilisation of maternal health care is crucial. To design, adopt and implement targeted evidence-based interventions, policymakers need to know what is most likely to improve maternal health behaviours, based on robust empirical evidence. Given the dearth of empirical literature in Zambia, it is important to develop further evidence shedding light on the interaction between the utilisation of maternal health care and the underlying, proximal and intermediate determinants.

Therefore, this thesis investigates the utilisation of maternal health care in Zambia. It focuses on the influence of individual and community level factors, as well as recent policy changes. Specifically, the thesis examines two aspects of maternal health care, antenatal care (ANC) and facility-based deliveries, to answer two broad questions. Firstly, what factors determine the use of ANC in Zambia? Secondly, to what extent has the abolition of user fees affected facility-based deliveries? Undoubtedly, ANC and delivery care are important for both maternal and neonatal health. The timing and frequency of ANC have been shown to affect maternal and neonatal health outcomes, due to preventative measures, such as the early detection of disease, and timely care (Abou-Zahr and Wardlaw, 2003). Moreover, ANC can be more effective in avoiding adverse pregnancy outcomes, if it is sought early in pregnancy and continues up to delivery. Appropriate care at delivery, often only available in a health facility, is the assistance of a skilled health worker; if complications arise during delivery, a skilled health worker can manage the complications and/or refer the woman to the next level of care. Thus, increasing facility-based deliveries is an important factor in reducing deaths arising from the complications of pregnancy.

The thesis is focussed on this area in the hope that it can contribute positively to the agenda to improve maternal health in Zambia. It attempts to provide robust evidence by using multiple datasets and empirical strategies to assess the utilisation of maternal health care. Policymakers in Zambia need sound empirical evidence, and the main contribution of the thesis is to present such evidence.

1.2 Background on the health system and maternal health care in Zambia

1.2.1 Zambia's health system

The overarching goal of the health sector in Zambia is "equitable access to cost effective, quality health services as close to the family as possible" (MoH, 2005). Since 1992, Zambia has implemented a wide range of health sector reforms aimed at achieving this objective. These reforms were necessitated by poor quality health care delivery and inadequate capacity, due to an increased population and declining economic conditions, further compounded by the HIV/AIDS pandemic. The main attributes of the reforms were to: decentralise health service planning to the district level; increase community participation in the management of health services; focus on preventative care, rather than curative care; and coordinate donor support, by pooling resources, and jointly financing approved health sector plans, through a sector wide framework.

One of the early reforms, the introduction of healthcare user fees in 1993, had three main objectives: increasing income to improve service quality; developing a sense of ownership over the health system within the community; and improving staff motivation and accountability, through performance bonuses (Central Board of Health *et al.*, 2002). However, concerns over the low level of resources generated, minimal contribution to service quality and negative impact on access could not be ignored. Similar concerns were raised in other African countries that had introduced user fees. Although not immediately, most countries in sub-Saharan Africa reversed course, abolishing or reducing user fees for health services, including maternity and delivery services (De Allegri *et al.*, 2011; Masiye *et al.*, 2008; Nabyonga *et al.*, 2005; Wilkinson *et al.*, 2001). In many instances, only certain groups were exempted from payment (Penfold *et al.*, 2007; Witter *et al.,* 2007). In April 2006, user fees for health services were removed in public health facilities in 54 rural districts in Zambia. The policy reform was aimed at improving access to health services, particularly for the poor, who mostly reside in rural areas. Free health services included all aspects of preventative and curative services at Health Posts (HP) and Health Centres (HC), including Hospital Affiliated Health Centres (HAHC). Patients referred to first level hospitals were to be treated free of charge for all services at such facilities. Patients referred from Level 1 hospitals and further upwards were to be exempt from charges. Services for which user fees were removed include consultation, treatment, admission and diagnostic services (MoH, 2007).

Prior to the policy change, preventative services, such as ANC, family planning and counselling, were exempt from payment. However, delivery services were not previously exempt from payment, and, therefore, it is possible to exploit this policy differential to assess policy effects, potentially improve policy formulation, and, hopefully, improve maternal health care in Zambia.

1.2.2 Health care delivery in Zambia

Health care in Zambia is operated as a tiered system with tertiary, secondary and primary health facilities that specialise in service delivery. Health services are predominately provided by public health institutions. Other formal private sector institutions include mission hospitals, which fall under the Churches Health Association of Zambia (CHAZ). Primary health services, which include both preventative and curative services, are offered at health posts, health centres and district hospitals. These primary health facilities are located in each district; there is at least one district hospital per district. At the provincial level, 26 secondary health facilities are located in the provincial headquarters, although a few are owned and operated by non-governmental organisations. At the national level, five tertiary hospitals provide referral services, in addition to serving as training centres for medical staff (World Bank, 2012).

Table 1.1: Health facilities by Province and Level of Care, 2010

Description	Central	Copperbelt	Eastern	Luapula	Lusaka	Northern	North-Western	Southern	Western	Zambia
a) By level of care										
Level 3 Hospitals	0	3	0	0	3	0	0	0	0	6
Level 2 Hospitals	2	9	2	1	0	2	2	2	1	21
Level 1 Hospitals	6	8	8	5	15	6	10	14	12	84
Urban Health Centres	32	137	8	1	182	14	18	34	10	436
Rural Health Centres	113	53	156	125	47	145	120	174	127	1,060
Health Posts	35	25	53	10	32	49	17	30	24	275
Total	**188**	**235**	**227**	**142**	**279**	**216**	**167**	**254**	**174**	**1,882**

Source: Health institutions in Zambia, Ministry of Health, 2010.

Health service delivery in Zambia is constrained by a number of factors. As is evident from Table 1.1, which shows the number of public health facilities in each province in Zambia by the level of care provided, the existing, but inadequate, health infrastructure is skewed in favour of urban areas. Provinces that are predominately urban (such as Copperbelt and Lusaka provinces), or lie closer to the 'line of the rail', have better access to health facilities. In rural areas, 46% of households live outside a radius of 5 km from a health facility, while 99% of households in urban areas (MoH, 2009) live inside the 5 km radius. Whereas 70% of the Zambian population live in rural areas, only 24% of the doctors are based there.[1] As is the case in most developing countries, there is a shortage of skilled health workers in Zambia. In 2008, there were approximately 0.6 physicians per 10,000 persons, while the vacancy rate was, on average, 66% (World Bank, 2011). The health worker to population ratio, 0.93 health workers per 1000, is far below the World Health Organisation recommended level of 2.5 per 1000 (WHO, 2011). Other challenges affecting health service delivery include the unavailability of drugs and the inadequacy of medical supplies, due to inadequate funding and weak logistics links. These health care delivery challenges have a direct bearing on health indicators, including maternal health. Thus, omitting health system or supply-side variables in the analysis may present the researcher or policymaker with an incomplete picture, or worse, lead to erroneous conclusions and inappropriate policy formulation.

1.2.3 Maternal health care in Zambia

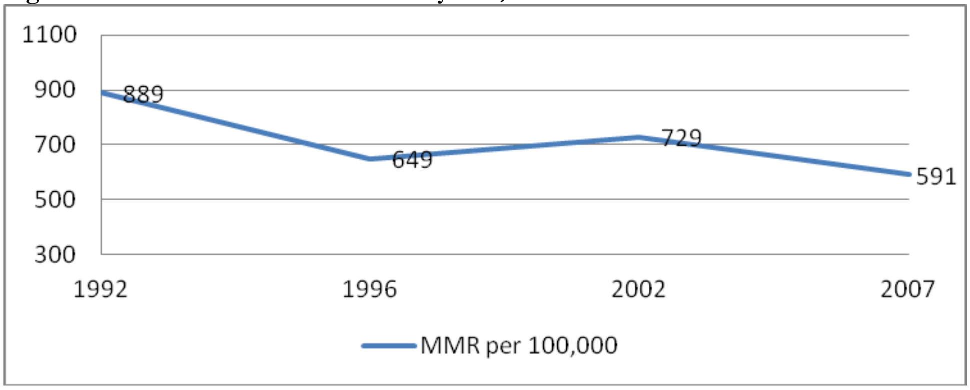
Over time, Zambia has not been able to achieve consistent reductions in maternal mortality. The trend in the MMR from 1992 to 2007 is illustrated in Figure 1.1. The MMR declined from 1992 to 1996 followed by a notable increase from 1996 to 2002. While remarkable progress has been made in reducing the (MMR) from 889 to 591 per 100,000 live births, the MMR is still high, and, therefore, Zambia is unlikely to meet the MDG target of reducing maternal mortality by 75% by 2015. The Ministry of Health (2009) indicates that about 75% of maternal deaths in Zambia are directly attributable to haemorrhage, sepsis, obstructed labour, abortion and eclampsia. Most of these deaths can be mitigated through the provision of ANC and skilled delivery care (World Bank, 2010).

In an attempt to address the high MMR, the Safe Motherhood Initiative (SMI) was introduced in Zambia in 1996 (MoH, 2007). Four main interventions were identified by the SMI: family planning, ANC and essential obstetric care, along with clean and safe delivery (WHO, 1994). These interventions recognize that the provision of antenatal services, skilled attendance at birth, emergency obstetric care and postnatal care can mitigate maternal deaths. After a

[1] The main constraints affecting the availability of human resources in the health sector have been identified as: high staff attrition rates, partly attributable to poor working conditions; poor distribution of health staff; low training output; inadequate funding for recruitment and retention; and a long bureaucratic employment processes (MoH, 2009).

number of years, due to the ineffectiveness of the traditional ANC model, a new approach to antenatal health care delivery, referred to as focussed antenatal care (FANC), advocated by the WHO, was adopted (MoH, 2005). This new ANC approach emphasises the importance of the quality of care provided during the antenatal visit, rather than the frequency of visits. Under the traditional approach to ANC provision in Zambia, 12 antenatal visits were recommended. The traditional approach relied on the frequency of ANC visits to provide better care for pregnant women. However, under the FANC approach, fewer visits are recommended, unless there are complications. The recommendation for uncomplicated pregnancies is four ANC visits, since empirical evidence suggests that is sufficient, while women with complications should visit more often (WHO, 1994; Villar *et al.,* 2001).

Figure 1.1: Trends in maternal mortality rate, 1992-2007



Source: Constructed using data from ZDHS 1992, 1996, 2002 and 2007.

However, in Zambia, high ANC coverage rates continue to co-exist with high MMR. According to the Central Statistical Office (2009), 94% of women had at least one antenatal visit in 2007, yet the maternal mortality rate was 591 deaths per 100,000 live births. Possibly, mortality rates remain so high, due to low first trimester ANC usage or incomplete ANC follow-through; only 19% of ANC visits occur in the first trimester, while only 60% complete the recommended minimum four antenatal visits during pregnancy. Notably, about 52% of births take place at home. Forty-seven per cent of all births are assisted by a skilled health provider, and this coverage is unevenly distributed; there is higher coverage for wealthier, more educated urban women; see Table 1.2. The concentration indices capture the direction and degree of inequality.[2] The larger the index in absolute value, the higher the degree of inequality in utilisation. In each of the survey years, for both indicators, utilisation was higher amongst the better off. Such

[2] A negative value is an indicator with a higher value amongst the poor, while a postive index shows that the indicator takes higher values among the wealthy.

disparities are a concern, as the provision of delivery services and ANC are key strategies in the reduction of maternal and neonatal mortality. Moreover, the continued co-existence of high ANC coverage rates with high MMR raises the need to understand the determinants of the observed disparities in the utilisation of maternal health services, as well as the factors that have an impact on utilisation of ANC after the introduction of FANC.

Table 1.2: Inequalities in utilisation of maternal health care in Zambia

	Q1	Q2	Q3	Q4	Q5	Total	CI
1996							
Skilled antenatal care (4+ visits)	63.6%	66.0%	71.3%	78.5%	88.4%	73.0%	0.038***
Skilled birth attendance	19.9%	24.8%	38.0%	68.5%	90.6%	47.2%	0.046***
2001/2							
Skilled antenatal care (4+ visits)	60.5%	66.5%	68.6%	81.8%	87.4%	72.4%	0.082***
Skilled birth attendance	19.5%	23.5%	34.2%	69.4%	91.5%	44.0%	0.337***
2007							
Skilled antenatal care (4+ visits)	55.9%	58.0%	59.5%	57.8%	63.9%	58.7%	0.028***
Skilled birth attendance	27.5%	27.9%	36.3%	73.0%	91.6%	46.4%	0.275***

Source: World Bank. 2012. Health Equity and Financial report.
CI=concentration index: ranges between -1 and 1: negative sign indicates that the health outcome takes higher values among the poor. Q= quintile (where quintile 1 is the poorest). ***, **, * shows significance at 1%, 5% and 10% respectively.

Evidently, good access to maternal health care is critical in the reduction of the maternal deaths. Indeed, the removal of financial barriers has been proposed as a key strategy to increase the utilisation of health services. However, it is possible that the quality of health care can be compromised, due to an increase in the use of services, thus, yielding little or no increase in utilisation rates after the removal of the price barriers. It is, therefore, crucial to provide empirical evidence on the effect of user fee abolition on the use of health facilities for delivery. It is clear that access to maternal care in Zambia may be impeded by factors related to the health system and culture, and not just user fees. In fact, user fees could affect the status of the health system. However, those possibilities are often ignored, since examining those possibilities, simultaneously, requires information from both the health system and health system clients. Unfortunately, health system information is not available in existing household surveys; thus, the availability of geo-referenced household datasets along with routine data, in Zambia, provides an opportunity to merge different data sources and overcome this problem.

1.3 Research questions and methods used

Besides the domestic demand-side and supply-side constraints highlighted in the above summary, one of the major challenges in tackling adverse maternal outcomes in Zambia is the lack of sound empirical research to facilitate effective policy formulation. Additionally, there are region-based disparities within Zambia in maternal health care delivery, which are not being adequately captured in existing research, such that the potential for policies directed towards improved health outcomes to succeed is not well understood. Therefore, this thesis attempts to address these shortcomings. The thesis focuses on a number of objectives to further understand the determinants of ANC use and the impact of one specific policy reform on the utilisation of facility-based deliveries in Zambia.

The analysis in Chapter 2 considers factors capable of explaining the utilisation of ANC in Zambia over the past decade, using three comparable and nationally representative Demographic and Health Survey (DHS) datasets, and an appropriate micro-econometric framework. Thus, the following specific questions are addressed in the chapter. (1) What is the appropriate framework for analysing the utilisation of ANC in Zambia? (2) What characteristics explain and predict the probability of using antenatal health care services? (3) What characteristics explain the frequency of use of antenatal health services? The findings suggest that the utilisation of ANC involves two distinct decision processes, and can be adequately represented by a two-part model in each of the three survey years. The performance of the two-part model was found to be superior to other models that have been used more recently in cross-sectional studies of health care utilisation. While there are differences in the factors explaining the decision to use ANC and the frequency of visits, the results suggest that the decision to seek ANC and the frequency of use is low among the poor and less educated, and that there are marked regional differences in utilisation.

Chapter 3 extends the analysis by incorporating supply-side factors and providing an empirical analysis of the factors associated with poor utilisation of ANC following the adoption of focussed ANC in Zambia, using the 2007 Demographic and Health Survey (DHS). A major limitation of cross-sectional surveys is that they do not contain information on health system or supply-side factors known to influence utilisation. To overcome this limitation, data from the 2007 Zambia DHS is linked to administrative data collected by the Ministry of Health. The key results indicate that at the individual level, the woman's employment status, quality of ANC received and the husband's educational attainment are negatively associated, while parity, the household childcare burden and wealth are positively associated with inadequate utilisation of ANC. Both individual and community level characteristics influence inadequate use and non-use of ANC in the first trimester; however, community level factors are relatively stronger in rural areas.

In a recent systematic review of the literature, Dzakpasu *et al.* (2013) highlight the scarcity of robust evidence of the effects of removing user fees on the utilisation of maternal health services. Moreover, few studies address potential sources of bias, such as secular trends over time and changes in supply-side factors; thus, the effect size remains uncertain. In the light of this paucity of empirical evidence, Chapters 4 and 5 assess the impact of the removal of user fees in public health facilities in 54 rural districts in Zambia on the utilisation of facility-based deliveries in Zambia, using national household data and longitudinal data, respectively.

Chapter 4 exploits the information carried in a panel, rather than a single cross-section, and considers potential dynamic effects. Not accounting for the panel structure of the data could lead to erroneous conclusions and inappropriate policy formulation if, for example, potential time invariant confounders are ignored. Since estimates obtained from an aggregate analysis often mask important heterogeneities, regional level estimates from Seemingly Unrelated Regressions (SUR) are also obtained, addressing spatial dependence within an error component framework. When unobserved heterogeneity, spatial dependence and quantitative supply-side factors are incorporated in the Interrupted Time Series (ITS) design, user fee removal is found to immediately increase aggregate institutional deliveries, although the national trend was unaffected. Drug availability and the presence of traditional birth attendants also influence institutional deliveries at the national level, such that, in the short-term, strengthening and improving community-based interventions could increase institutional deliveries. However, there is significant variation and spatial dependence masked in the aggregate analysis. The results highlight the importance of service quality in promoting institutional deliveries, and also suggest that social and cultural factors, especially in rural areas, influence the use of health facilities for delivery. These factors are not easily addressed, through an adjustment to the cost of delivery in health facilities.

In Chapter 5, the impact of the policy reform on utilisation of facility-based deliveries is assessed using difference-in-differences methods. The analysis incorporates supply-side factors, including quantitative measures of service quality, in assessing the effect of the policy reform on facility-based deliveries. By complementing the Zambia DHS with administrative data, we are able to control for both demand-side and supply-side factors that influence the use of facility-based deliveries. The findings suggest that the abolition of user fees had little, if any, impact on the place of delivery. Although not significantly, the abolition of user fees leads to a reduction in home deliveries, as well as deliveries in public health facilities, but increases deliveries in private health facilities. Our finding of minimal causal effects from the abolition of user fees to delivery in public health facilities may seem at odds with the existing literature, but it does suggest that the removal of user fees could have other, unintended, consequences. For example, it may lead to a transfer of costs, or cost-shifting from the service provider to the client, which may further deter the utilisation of delivery services.

Chapter 6 summarises the key findings of the thesis and discusses key policy implications emanating from the findings.

CHAPTER 2

2 The utilisation of antenatal care in Zambia: a micro-econometric approach

2.1 Introduction

Antenatal care (ANC) services in the public health system in Zambia are provided free-of-charge (MoH, 2005). Ideally, universal access to ANC should encourage the use of the service, ultimately fostering the improvement of maternal and neonatal health outcomes, as evidence suggests that there is a direct relationship between the utilisation of antenatal health services and low neonatal and maternal mortality (Ivanov and Flynn, 1999, Celik and Hotchkiss, 2000; Campbell and Graham, 2006; Sepehri *et al.*, 2008). The antenatal period presents an opportunity to reach expectant women with interventions, including communicating risks associated with labour and delivery, as a way to encourage women to seek skilled assistance during delivery (Campbell and Graham, 2006; Gage, 2007; WHO, 2003). In contrast, inadequate use of ANC has been associated with both perverse pregnancy outcomes and contributing to high maternal death rates in developing countries (Raguhupathy, 1996; Raatikainen *et al.,* 2007).

Despite the provision of free ANC services and the implementation of measures to improve access to and use of maternal health services, maternal health service indicators in Zambia continue to perform poorly; these indicators are amongst the lowest for countries in East and Southern Africa (Picazo and Zhao, 2008). More importantly, the maternal mortality rate (MMR) is relatively high, 591 deaths per 100,000 live births, and indications are that Zambia is unlikely to attain the Millennium Development Goal (MDG) of reducing the MMR by 75% between 1990 and 2015 (CSO, 2009; WHO, 2010). While the antenatal coverage rate is impressively high, with 90% of women having at least one antenatal visit, only 19% of women have a visit in the first trimester of pregnancy, although about 60% have at least four antenatal visits during pregnancy (CSO, 2009).

Undoubtedly, the decision to seek ANC, and subsequent visits, thereof, may not necessarily be driven by the cost at the point of service. While there are no direct monetary costs at the point of access to ANC services in Zambia, indirect costs and other non-monetary factors may still play an important role in determining the use of the service, as well as the frequency of visits. Thus, parturient women with similar access to health facilities may exhibit different patterns of utilisation of antenatal health services. Other factors, such as distance to the health facility, quality of services and availability of human resources, play a role in the decision to seek ANC services (Gabrysch and Campbell, 2009; Gage, 2007).

In the light of poor maternal health indicators, despite high antenatal coverage rates, the utilisation of ANC services in Zambia is still an important issue that requires further investigation. Previous studies are few and focus on either the influence of the quality of ANC service provision or the distance to health facilities (Kyei *et al.* 2012a, Kyei *et al.* 2012b). Moreover, these studies examine factors associated with any use of ANC, but not factors associated with the frequency of use, and whether separate processes generate these decisions. It remains to assess whether the patterns for any use of ANC and the frequency of use are similar or different. Therefore, this study intends to explain and predict the use of antenatal services between 1996 and 2007. The goal is to provide policymakers and planners with empirical evidence that is useful for the development of effective antenatal health care services. The following specific questions are addressed: What is the appropriate framework for analysing the utilisation of ANC in Zambia? What characteristics explain and predict the probability of using antenatal health care services? and What characteristics explain the frequency of use of antenatal health services?

2.2 Background and related literature

In Zambia, when an expectant woman makes an initial visit for ANC, subsequent visits are scheduled by the preferred ANC provider. Under the traditional approach to ANC provision, 12 antenatal visits were recommended. These visits were to be made in the first trimester, then monthly until the 28th week, then fortnightly up to the 36th week and, thereafter, every week until delivery (CSO, 2009). The traditional approach relied on the frequency of ANC visits to provide better care for the pregnant woman. Due to the ineffectiveness of the traditional ANC models, a new approach, termed focused ANC (FANC), recommended by the World Health Organisation, was adopted in Zambia (MoH, 2005). The emphasis under FANC is on the quality of ANC service, rather than the frequency of visits; as such, it is recommended that women without complications take a minimum of four ANC visits. This recommendation is based on empirical evidence that four visits are sufficient for women without complications (WHO, 1994; Villar *et al.,* 2001). Under FANC, the first visit should take place in the first trimester (ideally before 12 weeks, but no later than 16 weeks), the second visit between the 24th and 28th weeks; the third visit at 32 weeks and the fourth visit at 36 weeks. Women with complications may have more visits scheduled.

During ANC visits, pregnancy progress is monitored to increase the likelihood of early detection of potential problems. Monitoring includes collecting the woman's medical history, measuring blood pressure, testing the blood and urine, providing prophylaxis for prevention of malaria in pregnancy and providing iron supplements. In addition, routine monitoring provides an opportunity to conduct health promotion activities, such as encouraging delivery at a health facility.

The behavioural model of Anderson and Newman (1973) has been used to analyse the utilisation of health services, and can be adapted to the utilisation of maternal health services. The framework includes three components covering individual determinants, accessibility and perceptions of need. Postulating that predisposing factors or individual characteristics influence underlying behaviours to seek medical care, suggests that these characteristics should be included. Thus, for example, individuals with similar socioeconomic backgrounds will seek antenatal health services equally. The second component, based on enabling factors, covers both demand and supply-side factors related to the accessibility of health services. In other words, an individual's ability to make use of health facilities depends not only on the availability of health services, but also the means to obtain them, including factors such as income and distance to the health facilities. Evidence suggests that access is a major determinant of the use of health services (Hortsberg, 2003; Chakraborty *et al.,* 2003; Gage, 2007). The third component is directly related to health care use. That use may be determined by an individual's perceptions or feelings about the use of modern health services. Individuals may decide whether or not to seek health care, based on cultural understanding and/or experiences related to the seriousness of a health condition. In this case, health care may be sought only if the condition is perceived as serious and the individual believes that the care will provide the expected benefits (Andersen and Newman, 1973).

The empirical literature on the use of maternal health services suggests an important role for demographic, cultural and socioeconomic factors in determining the utilisation of antenatal health services. Factors such as maternal education, place of residence and socioeconomic status have a positive association with the use of antenatal health services (Chakraborty *et al.,* 2003; Pallikadavath *et al.,* 2004; Reynolds *et al.,* 2006). Higher levels of household income are associated with better utilisation of antenatal health services (Addai, 2000; Celik and Hotchkiss, 2000; Chakraborty *et al.,* 2003; Mekonnen and Mekonnen, 2003; Gage, 2007). In addition, household poverty and poor access to health facilities reduces the likelihood of seeking antenatal health care (Gage, 2007; Gage and Calixte, 2006; Habibov and Fan, 2008). It is well established that there is a positive association between a mother's level of education and utilisation of maternal health services (Addai, 2000; Celik and Hotchkiss, 2000; Chakraborty *et al.,* 2003; Mekonnen and Mekonnen, 2003; Gage, 2007), presumably because women with better education have more information about available health care services and use it more effectively to maintain and achieve good health.

In addition, place of residence varies with the utilisation of antenatal health services. In developing countries, urban areas usually have a higher density of health facilities compared to rural areas, and, therefore, urban dwellers may live relatively closer to health facilities compared to the rural dwellers (Navaneetham and Dharmalingam, 2002; Magadi, 2003). As such, women in urban areas are more likely to seek ANC (Addai, 2000; Celik and Hotchkiss, 2000; Mekonnen and Mekonnen, 2003; Gage and Calixte, 2006). Additionally, the geographic region may influence the decision to seek ANC and subsequent use. Provinces may be endowed differently and may have a varying share of national resources, different infrastructure and varying levels of human resources, which may influence the access and use of maternal health services.

Often, studies examining factors associated with the use of maternal health services use binary outcome measures and associated methods, such as logistic regression models (Ragupathy, 1996; Addai, 2000; Celik and Hotchkiss, 2000; Navaneetham and Dharmalingam, 2002; Chakraborty *et al.,* 2003, Mekonnen and Mekonnen, 2003; Pallikadavath, *et al.,* 2004; Reynolds, *et al.,* 2006). Mostly, these studies make use of data from demographic and health surveys, wherein multistage sampling is followed. In this case, respondents from the same area are likely to be similar; samples are not independently drawn. Thus, the use of conventional methods without correcting for dependence leads to a bias (Rabe-Hesketh and Skrondal, 2008). To take into account the hierarchical structure of the data and the clustering at different levels, some studies have used random intercept logistic models and multilevel modelling techniques (Magadi *et al.,* 2000; Babalola and Fatsui, 2009; Gage and Calixte, 2006; Gage, 2007; Magadi *et al.,* 2007; Sepehri *et al.,* 2008; Guliani *et al.,* 2012).

Furthermore, most studies of maternal health care do not consider the separate processes which generate the decision to seek any care *and* the frequency of use (Addai, 2000; Mekonnen and Mekonnen, 2003; Chakraborty *et al.,* 2003; Reynolds *et al.*, 2006; Navaneetham and Dharmalinga, 2002). Vecino-Ortiz (2008), in examining the determinants of demand for ANC in Columbia, used a two-part model, where the first stage, which explains the probability of using antenatal health care services, was specified as a logit model. The second stage, which explains the frequency of visits, was specified as an ordinary least squares (OLS) regression. Other studies, though, have used negative binomial regression in the second stage to predict and explain the frequency of using antenatal health services (Habibov and Fan, 2008; Sepehri *et al.,* 2008). Studies that have employed the two-stage approach find that the effects are not constant across the two decision-making processes. For instance, Habibov and Fan (2008) find that poverty and perceptions of low quality health services matter when seeking care, initially, even though these were not strong predictors in determining the frequency of use.

In examining the factors that influence the decision to seek ANC and subsequent visits, therefore, the empirical specification used in the analysis needs to take into account the underlying behavioural structures that drive the demand for ANC services. Specifications which do not correspond to the underlying behavioural structures could produce misleading results. Consequently, policy recommendations based on such estimations may have undesired effects. It is within this context that this chapter seeks to contribute to the existing literature on the utilisation of ANC in developing countries.

2.3 Econometric methods

Generally, we are interested in modelling the probability that the i^{th} expectant woman makes Z_i visits to a health facility (whether private or public) during a given time interval. Two theoretical approaches for analysing the demand for health care, given count data, are generally available (Jimenez-Martin *et al.*, 2002). In the first approach, health care is analysed in the context of the traditional consumer theory, where the demand for health care is determined by the individual. Empirical models underpinned by this theory are one step count data models, such as the Poisson and Negative Binomial (NB) models. However, empirical results from such models often contradict theory (Grossman, 1972; Wagstaff, 1986). The second approach uses the principal-agent framework, where the physician (agent) determines the intensity of utilisation, once the individual (principal) has made the initial visit. Empirical models that are founded on this premise are referred to as two-part, or hurdle, models. More recently, alternatives to the two-part models (TPM), especially latent class models (LCM), which are also based on standard count data models (Deb and Trivedi, 2002), have been increasingly applied.

2.3.1 The Poisson model

The Poisson regression model is the most common count data model, and, therefore, represents a natural starting point for this analysis. Within the model, the density of our random variable of interest, Z_i, is assumed to be Poisson distributed – thus the name – with intensity parameter (conditional mean) λ_i, which is a function of potential explanatory variables x_i. Following the discussion in Jones *et al.* (2007) and Cameron and Trivedi (1998, 2010), the underlying probability structure, during the period t is described in (2.1).

$$\Pr(Z_i = Z_i^*) = \frac{e^{-\lambda_i t}(\lambda_i t)^{Z_i^*}}{Z_i^*!},\ Z_i^* = 0,1,2,\ldots \tag{2.1}$$

In (2.1), $\lambda_i = E(Z_i \mid X_i) = \exp(X_i\beta)$, X_i is the vector of explanatory variables and β is the vector of parameters to be estimated. The Poisson model is estimated via maximum likelihood, and if the data generating process for Z_i follows a Poisson distribution with conditional mean, λ_i, then the estimates obtained are consistent and asymptotically normally distributed, i.e., $\hat{\beta}_p \overset{a}{\sim} N(\beta, V_{ml}(\hat{\beta}_p))$.

The Poisson regression may be the most common specification for count data models, but it has some undesirable features. The equi-dispersion property, equality between the mean and variance, conditional on the explanatory variables, does not often hold in empirical applications. Although estimates from specifications with the equi-dispersion restriction tend to yield consistent estimates in cases of over- or under-dispersion, small standard errors for $\hat{\beta}$ and incorrect prediction of the number of zeros are also observed (Jones *et al.,* 2007). Another weakness of the Poisson model is that the model assumes events occur independently, which means that the probability of the $(n-1)^{th}$ or $(n+1)^{th}$ antenatal visit to the health facility is independent of the n^{th} visit. In practice, however, antenatal visits should be expected to exhibit some dependence over time, since, for example, a second visit requires a first visit.

Furthermore, the Poisson model does not control for unobserved individual heterogeneity, which may be the cause of the over-dispersion often found in count data models (Cameron and Trivedi, 1998). A preliminary glance at the raw data used in this study suggests that the unconditional mean and variance are different (see Table 2.3) in each of the survey years. Further tests, more appropriate than a casual glance at the data, to ascertain the validity of the equi-dispersion property are also conducted. The likelihood ratio test proposed by Cameron and Trivedi (2010), for example, rejects the null hypothesis of equi-dispersion. However, it is important to note that the likelihood ratio test is more useful in cases where there is more variation than would be expected with the Poisson model. In other words, it is better when the data is over-dispersed, rather than under-dispersed (StataCorp, 2011).

2.3.2 Other count data models

The Negative Binomial (NB) model, which overcomes some Poisson model limitations, incorporates unobserved individual heterogeneity by introducing an unobserved individual effect into the conditional mean function; $\lambda_i = E(Z_i \mid X_i) = \exp(X_i\beta)\varepsilon_i$, where ε_i denotes the individual unobserved heterogeneity, which is assumed to be uncorrelated with the $X's$. The NB is a mixture-model; Poisson and Gamma distributions are used togther, in this case. Specifying λ_i as a Gamma distribution and taking the integral over λ_i, yields the probability density over Z_i in the following equation (Cameron and Trivedi, 1998, 2010).

$$\Pr(Z_i = Z_i^*) = \frac{\Gamma(Z_i^* + \upsilon_i)}{\Gamma(Z_i^* + 1)\Gamma\upsilon_i}\left(\frac{\upsilon_i}{\upsilon_i + \lambda_i}\right)^{\upsilon_i} \times \left(\frac{\lambda_i}{\upsilon_i + \lambda_i}\right)^{Z_i^*}, \quad Z_i^* = 0, 1, 2, \ldots \tag{2.2}$$

where $\Gamma(.)$ is the gamma distribution function, with parameters Z_i^* and υ_i, $\lambda_i = \exp(X_i\beta)$, $\upsilon = \lambda_i / \alpha = \alpha^{-1}(\exp(X_i\beta))$ or $\upsilon = 1/\alpha$, and $\alpha \geq 0$. Since $\lambda_i > 0$, the model allows for over-dispersion. Additionally, υ_i captures cross-sectional heterogeneity. Equation (2.2) reduces to a Poisson, if $\alpha = 0$. As implied in the preceding discussion, NB model variance follows one of two formulations. For the first Negative Binomial (NB1) model, we specify $\upsilon = \lambda_i / \alpha$, such that the variance follows $Var(Z_i \mid X_i) = \lambda_i + \alpha\lambda_i$. On the other hand, for the second Negative Binomial (NB2) model, where $\upsilon = 1/\alpha$, the variance follows $Var(Z_i \mid X_i) = \lambda_i + \alpha\lambda_i^2$. Although the NB models account for over-dispersion, they perform poorly in the presence of excess zeroes and skewed distributions, due to the underlying assumption that all non-negative integers are generated by the same process (Gurmu, 1997).

Excess zeroes can be addressed with the zero inflated Poisson (ZIP) developed by Lambert (1992). The ZIP gives more weight to the probability that the count outcome equals zero, and incorporates a mechanism splitting individuals between users and non-users. The probability function for the ZIP is a mixture of the standard Poisson and a degenerate distribution concentrated at zero. Therefore, the ZIP is characterised by the following representation.

$$\Pr(Z_i \mid x_i) = \begin{cases} p_i + (1 - p_i)e^{-\lambda_i}, & \text{if } Z_i = 0 \\ (1 - p_i)\dfrac{e^{-\lambda_i}\lambda_i^{Z_i}}{Z_i}, & \text{if } Z_i > 0 \end{cases} \tag{2.3}$$

where p_i is the probability that the zero outcome is "extra". Essentially, it is assumed that the population can be split into two unobserved or latent groups. Individuals in the first group have zero outcomes, typically classified as non-users, while those in the second group can have either a zero or positive outcome. Since there are two groups, the probability that an observation is from either one of the groups can be estimated via standard binomial models, while outcomes from the second group can be estimated by either the Poisson or NB specification (below). As a final stage in the estimation of the ZIP, the observed probabilities, as a mixture of the probabilities for the two groups, are estimated (Long and Freese, 2006; Jones *et al.*, 2007).

Whereas the ZIP only allows for excess zeroes, the zero inflated negative binomial (ZINB) allows for both excess zeroes and unobserved heterogeneity (and unequal dispersion). The ZINB reduces to the ZIP, when $\alpha = 0$, in the same fashion that the NB reduces to the Poisson. Its representation is given in (2.4).

$$\Pr\left(Z_i \middle| x_i\right) = \begin{cases} p_i + \left(1 - p_i\right)\left(1 + \alpha\lambda_i\right)^{\alpha^{-1}}, & \text{if } Z_i = 0 \\ \left(1 - p_i\right)\dfrac{\Gamma\left(Z_i + \alpha^{-1}\right)}{Z_i!\,\Gamma\left(\alpha^{-1}\right)}\left(1 + \alpha\lambda_i\right)^{\alpha^{-1}}\left(1 + \dfrac{1}{\alpha\lambda_i}\right)^{Z_i}, & \text{if } Z_i > 0 \end{cases} \tag{2.4}$$

Since the ZIP is nested in the ZINB, a likelihood ratio test comparing the two can be applied; a similar comparison between the Poisson and NB can also be applied. A rejection of the null hypothesis, $H_0 : \alpha = 0$, suggests that the data is not equally dispersed. Within the ZIP/ZINB comparison, rejection of the hypothesis also suggests that introduction of a zero-state, within the data generating process, does not sufficiently account for over-dispersion in the data, and it may be necessary to allow for cross-sectional heterogeneity.

2.3.3 Two-part models

ANC-seeking behaviour can also be modelled as TPM, where the first stage concerns the decision to seek care and the second stage concerns the frequency of use. The underlying assumption in the TPM is that the two stages are, potentially, governed by separate decision processes. Separating antenatal visits into the probability of use and the conditional intensity of use fits within the principal-agent framework. In this framework, the health care provider (agent) determines the level of utilisation, once the expectant woman (principal) has made the initial visit (Mullahy, 1986). The decision to seek ANC is assumed to be initiated by the expectant mother, while the subsequent visits are determined by both the expectant mother and the health care provider. Although the number of ANC visits for an expectant mother can be scheduled by the health care provider, the expectant mother can decide whether to comply or not.

Furthermore, the TPM is more appealing for modelling the utilisation of health care in cases where the number of antenatal visits originates from a single illness (Pohlmeier and Ulrich, 1995). The frequency of use or the number of antenatal visits meets the underlying assumption of a 'single illness spell' (Sepehri *et al.,* 2008). The two parts can be specified with different probability distributions. For example, Mullahy (1986) employed a Poisson specification in both stages, Cameron and Trivedi (1998) specify a probit in the first stage and NB in the second stage, Pohlmeier and Ulrich (1995) specify NB in both stages, taking into account unobserved heterogeneity, while Beeuwkes and Zaslavsky (2004) used OLS in the second stage. Gurmu (1997) suggests that the first part should be modelled as a binary model, when the proportion of zeros is large or when the sample size is small. In this study, the first part specifying the decision to seek ANC is estimated using a logistic regression and the second part, determining the extent of utilisation for women who receive ANC, is specified as a zero truncated Poisson, based on diagnostic tests as detailed in section 2.5.3.

2.3.4 Latent class models or Finite mixture models

Recent empirical literature suggests that the TPM cannot separately identify the parameters driving the two decision processes (Santos-Silva and Windmeijer, 2002). Moreover, Deb and Trivedi (2002) argue that for cross-sectional data, it is more reasonable to distinguish between frequent and infrequent users of health care, since health events in such data are collected over a fixed period of time, such as a month, and not over an *episode of illness*. Thus, a common alternative to TPMs are latent class models (LCMs), which distinguish between groups with high and low average demand, in contrast to the TPM, which distinguishes between users and non-users. The separation between high and low frequency users is done using factors related to lifestyle, attitude towards health risk and health status (Deb and Trivedi, 2002).

Although LCM can be based on standard count data models, they take into account unobserved heterogeneity among individuals by splitting the population into latent classes, based on the individual's health status. The distribution function of the unobservable characteristic is approximated with a finite mixture distribution function (Heckman and Singer, 1984). Within each latent class, the individuals are assumed to be homogenous, but heterogeneous between the latent classes. Since the state of health of the woman is unobservable, proxy variables, such as the self-assessed health status, are widely used. However, these variables may not adequately capture the woman's long term health status (Deb and Trivedi, 2002). In our context, ANC utilization is assumed to differ between birthing women with 'complicated' and 'normal' pregnancies. Complications in pregnancy are more likely to entail a greater number of visits than normal ones.

The log-likelihood function of the LCM is given by the mix of two probability functions, as in (2.5).

$$L_{LCM} = \sum_{k=1}^{K} \pi_k f_k(h_{(i)}) \tag{2.5}$$

In the preceding equation, π_k and $f_k(h_{(i)})$ are, respectively, the mixing probability and the density corresponding to the number of visits by the i^{th} individual for the duration of the pregnancy. The mixing probabilities π_k are unknown parameters, and they are jointly estimated with the rest of the parameters in the model. To identify all the parameters in the model, the restriction $\sum_{k=1}^{K} \pi_k = 1$, $\pi_k \geq 0$ for all k is imposed. In this study, the density $f_k(h_{(i)})$ is specified as a Poisson. The predicted means of the samples can be used to distinguish between the frequent and infrequent users, since the latent classes are unobservable. The model accommodates unobserved heterogeneity, through the density function, and allows unobservables to affect the different types of groups in various ways. Also, since the approach is semi-parametric, it does not require distributional assumptions for the mixing variable. However, Jiménez-Martin *et al.* (2002) note that estimation of the LCM by maximum likelihood can be problematic, when there is over-parameterisation, since the mixing variable is jointly estimated with the other parameters in the model.

To compare models which best suit the data generating process, in-sample statistics, such as the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and the value of the maximised log-likelihood function, are used. Studies have found that latent class models often perform better than parametric count data models for utilisation of health care (Deb and Trivedi, 2002; Sarma and Simpson, 2006). However, Jiménez-Martin *et al.* (2002) and Winkelmann (2004) find that TPMs perform better than LCMs, for certain types of providers and when different distributional assumptions are imposed.

2.4 Data and variable specification

This study uses data from three comparable datasets: the 1996/7, 2001/2 and 2007 Zambia Demographic and Health Survey (ZDHS). The DHS are large-scale household surveys, which use a multistage cluster-sampling design to collect data on, among others: demographics, socioeconomics, maternal health care and the fertility history of reproductive women aged 15-49. During the surveys, women were asked questions related to maternal health utilisation for the last live birth in the past five years, such as the timing and frequency of ANC visits. For the analysis, demographic, socio-economic and other health related information for women, who had received ANC for the last live birth during the five years preceding the survey, was extracted from the datasets. Of the women who were sampled, 4425 women were included from the 1996/7, 3846 in 2001/2 and 3618 in 2007. Since the ZDHS uses a multi-stage stratified cluster sampling method, there is, possibly, inter-cluster correlation. In other words, the expectant woman's decision to seek ANC and the frequency of use could be influenced by unobserved characteristics at the community-level. Therefore, the standard errors of the estimated coefficients are corrected for intra-cluster correlation.

Table 2.1 contains the definitions of the dependent and independent variables used for the analysis. The dependant variables reflect two broad measures of access: (1) the use of ANC services, which takes the value of one if an individual sought ANC during pregnancy and zero otherwise, and (2) the frequency or intensity of use, which is captured by the number of antenatal visits. The study uses three types of explanatory variables to explain the utilisation of antenatal health care: enabling (conditions that make ANC available to the person), predisposing (demographic, household and socioeconomic variables) and pregnancy related variables.

The *enabling variables* capture both the demand-side and supply-side differences in access to ANC. Some differences in the supply of antenatal health services are represented by the geographical locations, while demand-side differences are represented by income, education and employment status. However, other important supply side factors, particularly for developing countries, such as the distance to health facility, availability of health staff, density of health facilities and health providers are not available from the ZDHS; however, we are able to deal with this issue, and do so, in the subsequent chapter. Differences in income are captured by a wealth index. In the DHS, the wealth index is constructed as a weighted sum of the characteristics reflecting household economic status. These include: the household's ownership of durable consumer items, such as television sets, bicycles; household water and sanitation facilities; and others (Filmer and Pritchett, 2001).[3] The wealth index in the DHS was categorised into five wealth quintiles (poorest, poorer, middle, richer and richest). Individuals in the poorest quintile are the reference category in all analyses. In general, there are several pathways through

[3]See Rutstein and Johnson for a detailed discussion on the specific approach used to compute the wealth index in the DHS. Filmer and Prichett (2001) discuss the general approach.

which women's socio-economic status is likely to be positively related to the utilisation of antenatal health services.

Table 2.1: Definition of variables

Variable	Description
Dependant variables	
Sought antenatal care	Dichotomous variable indicating whether the mother attend ANC or not during pregnancy 1= if woman sought ANC, 0 otherwise
Frequency of antenatal visits	A continuous variable indicating the frequency of visits
Explanatory variables	
Household wealth	Index of household wealth
Poorest (reference group)	1=if household wealth quintile is 1, 0 otherwise
Poorer	1=if household wealth quintile is 2, 0 otherwise
Middle	1=if household wealth quintile is 3, 0 otherwise
Richer	1=if household wealth quintile is 4, 0 otherwise
Richest	1=if household wealth quintile is 5, 0 otherwise
Maternal education	Categorical variable indicating the highest level of education for the woman:
No education (reference group)	1=if no education, 0 otherwise
Primary	1=if completed primary education, 0 otherwise
Secondary +	1=if completed secondary education or higher, 0 otherwise
Partners education	Categorical variable indicating the highest level of education for the woman's partner:
No education (reference group)	1=if no education, 0 otherwise
Primary	1=if completed primary education, 0 otherwise
Secondary	1=if completed secondary education or higher, 0 otherwise
Employment status	Dichotomous variable indicating whether the mother is employed or not. 1=if woman is working, 0 otherwise
Urban	Dichotomous variable indicating the area of residence of the woman 1=if household reside in urban area, 0 otherwise
*Household childcare burden**	Continuous variable indicating the number of children under age 5 years in HH
Parity	Categorical variable indicating the number of children ever born by the woman
1 (reference category)	1=if parity is 1, 0 otherwise
2-4	1=if parity is between 2-4, 0 otherwise
5+ (Multi-para)	1=if five and above parity, 0 otherwise
Region	Categorical variable indicating the woman's province Lusaka (reference group) Central Copperbelt Eastern Luapula Northern North-western Southern Western

With greater household wealth, not only is the financial barrier to care reduced, but women tend to be more equipped with more modern and receptive attitudes towards health services (Hotchkiss, *et al.,* 2005; Naveentham and Dharmalingam, 2002). In contrast, it is expected that low utilisation of antenatal health services by women from poor households reflects the high cost of access, perceived poor quality of services and the low perception of the potential benefits of ANC (Hotchkiss *et al.,* 2005). Also, women from poor households tend to have less than the required number of visits and have deficiencies in the content of care (Sepehri *et al.,* 2008). The economic perspective suggests that women with higher income may consume more antenatal services, in order to minimise the time lost, due to complications in pregnancy in future. Additionally, two other income related factors may affect the utilisation of ANC: (1) women with a smaller relative monetary cost – that is, total income less transportation or time cost – are more likely to make more antenatal visits; (2) all else equal, the opportunity cost of the time required to make the antenatal visit may be higher for a high income person, than for a lower income person. The expected result of these two factors is that woman with higher income will make fewer visits, since they have a higher opportunity cost. Thus, income could either increase or decrease usage, such that the direction of the net effect on the number of antenatal visits during a term of pregnancy is ambiguous (McLeod, 2011).

The level of maternal education is treated as a series of binary indicators for those with secondary education and higher, primary education and no education (the last being the reference category). This categorisation provides a useful way to assess the incremental effect of education on the decision to seek care and the intensity of use. Gabrysch and Campbell (2009) outline a number of reasons to include education. It is possible that with higher education, a mother has increased autonomy, decision-making power, and, presumably, greater control over resources. Similarly, a more educated mother may be better able to access and process information or other literature on maternal health. Thus, mothers with more education could seek ANC more often, because they better understand the benefits of ANC. However, Grossman (1972) suggests that schooling may improve the efficiency of household health production, increase allocative efficiency and improve the choice of inputs. Therefore, more educated women are assumed to be more efficient producers of a healthy pregnancy and have less need for antenatal care. As with income, the net effect of education remains an empirical question. In Zambia, however, there is some evidence that education has a positive impact on the probability of seeking health care (Diop, 1998; Hjortsberg, 2003).

In addition to the mother's education, the mother's partner's education is also included. The categorisation of the partner's education status is analogous to the educational variable for the mother. On top of education, employment status is also included. Maternal employment status is captured as a simple binary indicator (employed or not). Employment could enable the mother in accessing better health information, overcoming financial barriers and increasing her mobility. Unemployment, on the other hand, may restrict access to the resources necessary to maintain good maternal health, and is associated with a significant reduction in the demand for health services (Addai, 2000; Gabrysch and Campbell, 2009).

The final set of enabling variables is related primarily to location. Differences in the supply of health services are captured by the place of residence, which is represented by a rural (reference group) indicator, as well as provincial indicators. Mothers residing in urban areas are, potentially, more exposed to a wide range of health care providers and services. In contrast, the prevalence of traditional beliefs and practices, along with limited health infrastructure and services in rural areas, may deter the use of health services (Hjortsberg, 2003; Gabrysch and Campbell, 2009). Provincial differences in terms of service delivery and organisation are captured by a series of provincial dummy variables with Lusaka as the reference category. Unfortunately, the DHS does not contain variables capable of capturing the important heterogeneities in the supply of health services that occur at provincial level; see the following chapter for a solution.

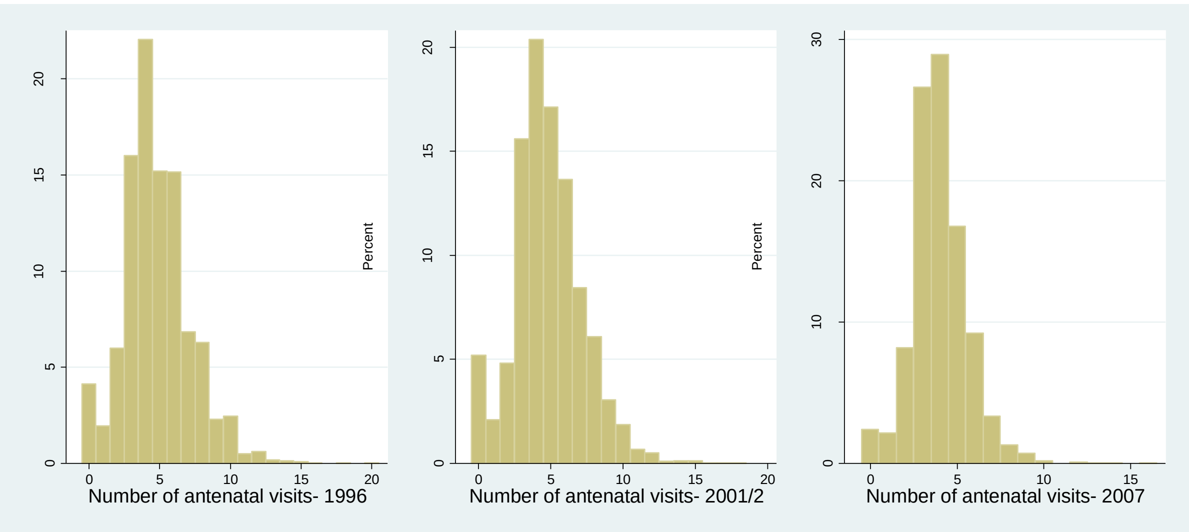
The *predisposing variables* capture differences in characteristics of the individual. These include demographic and attitudinal attributes of the respondents. Religious affiliation is represented by indicators for women who are Catholic (reference category), Protestant or follow other religions. Religion may influence attitudes towards modern health services, and may, therefore, affect the use of maternal health services. Although evidence is limited, Catholics are more likely to use antenatal health services, while those following more traditional practices are less likely (Addai, 2000; Ragupathy, 1996). The last set of variables relate to the woman's pregnancy history. Parity is included to capture potential differences in use across levels of maternal experience with the birthing process. It is categorised into three groups (1, the reference group, 2-4 and 5 or more births). Higher health risks are associated with the first birth, and with the fifth or higher birth, implying a greater need for antenatal services (Bai *et al.,* 2002). In addition, Navaneetham and Dharmalingam (2002) find a negative correlation between parity and early attendance of ANC. However, women of higher parity may seek less antenatal health services, due to the knowledge and experience gained from past births, the lack of available child support, especially if there are younger children that must be left at home and negative comments from the birth attendants at the health facility (Gage and Calixte, 2006; Ragupathy, 1996; Short and Zang, 2004). Due to its high correlation with parity (about 0.8 in each of the three survey years), the age of the woman was omitted from the analysis (Gage, 2007). Given the fact that ANC requires the mother to leave the house, which is harder to do when there are other responsibilities, we also include a count of the number of children under-five, which captures the caretaking burden associated with younger children in the household.

2.5 Results

2.5.1 Descriptive statistics

To assess the effects of the factors detailed in the previous section on the use of ANC and subsequent visits, we use two dependent variables 'attended ANC during the last pregnancy' and 'frequency of ANC visits'. The descriptive statistics of the dependent and control variables for each of the survey years are presented in the Appendices A.1-A.3 and the bivariate analyses of their associated correlations are presented in Table 2.2. The frequency of ANC visits, particularly for the 1996 and 2001/2 survey years, exhibits a significant positive correlation with the woman's and husband's educational attainment. With regard to wealth, there is a positive and significant correlation with women in the poorest and richest quintiles. The place and region of residence are significantly correlated with the frequency of ANC visits and these correlations are marked, particularly for the 1996 and 2001/2 survey years.

Figure 2.1: Graphical depiction of the frequency of antenatal visits by survey year



Source: Authors construction using the ZDHS survey data (1996/7, 2001/2 and 2007)

The frequency of antenatal visits in each survey year is presented in Figure 2.1 and Table 2.3. The proportion of women who did not seek any ANC is much lower in 2007 compared to the previous survey years. However, the average number of visits seems to have decreased in 2007 compared to the previous survey years. This could be attributed to the transition from the traditional ANC approach, where the emphasis was on the frequency of visits, to the new approach, which recommends a minimum of four antenatal visits for women without complications (MoH, 2005).

Table 2.2: Bivariate analysis

	1996		2001/2		2007	
Variables	F-statistics	p-value	F-statistics	p-value	F-statistics	p-value
no education	5.41	0.0000	4.30	0.0000	2.12	0.0114
primary	5.72	0.0000	3.84	0.0000	0.93	0.5214
secondary or higher	11.74	0.0000	10.63	0.0000	3.09	0.0002
partner_no educ	1.25	0.2165	2.38	0.0015	0.72	0.7381
partner_primary	6.37	0.0000	6.01	0.0000	2.66	0.0012
partner_sec or higher	9.75	0.0000	8.58	0.0000	4.05	0.0000
employed	1.17	0.2799	1.37	0.1660	1.54	0.0986
parity 1	0.80	0.6845	0.90	0.5700	1.24	0.2484
parity 2-4	0.69	0.8065	0.83	0.6416	0.92	0.5223
parity 5+	0.81	0.6674	1.10	0.3524	1.52	0.1030
catholic	0.91	0.5565	0.80	0.6890	0.49	0.9226
protestant	0.77	0.7263	0.95	0.5062	0.98	0.4668
other	1.23	0.2373	1.46	0.1179	4.44	0.0000
poorest	7.47	0.0000	4.55	0.0000	1.94	0.0270
poorer	2.63	0.0004	3.61	0.0000	1.15	0.3136
middle	1.38	0.1512	1.70	0.0442	0.85	0.6058
richer	2.72	0.0003	3.14	0.0000	2.11	0.0143
richest	16.46	0.0000	12.95	0.0000	4.06	0.0000
urban	13.41	0.0000	12.16	0.0000	3.98	0.0000
household childcare burden	1.37	0.0395	0.99	0.4758	1.53	0.0134
central	1.96	0.0249	1.46	0.1401	0.94	0.5079
copperbelt	6.48	0.0000	3.70	0.0000	2.01	0.0291
eastern	3.70	0.0000	2.63	0.0008	0.99	0.4535
luapula	1.10	0.3569	1.15	0.3161	1.79	0.0484
lusaka	2.92	0.0002	10.28	0.0000	3.33	0.0003
northern	6.14	0.0000	3.32	0.0001	0.69	0.7472
north-western	1.94	0.0246	3.02	0.0010	1.21	0.2905
southern	0.73	0.7230	1.80	0.0329	1.42	0.1589
western	1.54	0.0946	0.96	0.4821	0.9348	0.4953

Note: The tests of independence are based on the Pearson chi square statistic which is corrected for survey design and converted into an F -statistic (StataCorp, 2011).
Source: Authors computation based on ZDHS (1996, 2001/2 and 2007)

Table 2.3: Tabulation representation of the frequency of antenatal visits, by year

	1996			2001/2			2007		
Number of visits	**No visit**	**Visits**	**Percent (N=4425)**	**No visit**	**Visits**	**Percent (N=3846)**	**No visit**	**Visits**	**Percent (N=3618)**
0	183	-	4.14	200	-	5.2	87	-	2.4
1	-	87	1.97	-	81	2.11	-	78	2.16
2	-	265	5.99	-	186	4.84	-	296	8.18
3	-	708	16	-	601	15.63	-	963	26.62
4	-	973	21.99	-	785	20.41	-	1047	28.94
5	-	673	15.21	-	659	17.13	-	607	16.78
6	-	670	15.14	-	524	13.62	-	333	9.2
7	-	305	6.89	-	323	8.4	-	121	3.34
8	-	280	6.33	-	234	6.08	-	47	1.3
9	-	102	2.31	-	118	3.07	-	26	0.72
10	-	108	2.44	-	72	1.87	-	7	0.19
11	-	22	0.5	-	26	0.68	-	-	0.08
12	-	28	0.63	-	20	0.52	-	3	0.03
13	-	8	0.18	-	4	0.1	-	1	0.03
14+	-	13	0.29	-	13	0.35	-	2	0.09
Total	183	4242	100	200	3646	100	87	3531	100

The frequency distribution and the moments of the raw data for the dependant variable are presented in Table 2.4. It is evident that the data is not normally distributed, but is skewed. Moreover, the 2007 data appears to be less-dispersed compared to the 1996 and 2001/2 survey data and again, this can be attributed to the introduction of the FANC approach in Zambia.

Table 2.4: Moments of the number of antenatal visits

	Mean	Variance	Skewness	Kurtosis	Min	Max
1996 (N=4425)	4.807	5.608	0.623	4.432	0	20
2001(N=3846)	4.816	5.760	0.483	4.158	0	18
2007(N=3618)	3.976	2.609	0.588	5.596	0	16

2.5.2 Empirical results

This section presents the model selection and estimation results. The presentation is organised in two sub-sections as follows: The first discusses the set of tests that are used to select the econometric specification that fits the distribution of antenatal visits in 1996, 2001/2 and 2007; the second presents a summary of the results from the estimation of the preferred model for each survey year.

2.5.3 Model selection

Although the Poisson model is the starting point for count data, it often suffers from over-dispersion, due to the restrictive assumption that the conditional mean of the distribution is equal to the conditional variance. Over-dispersion, which is often caused by either unobserved individual heterogeneity or excess zeros, leads to inefficient estimation (Cameron and Trivedi, 2010). With this data, a likelihood based equi-dispersion test fails to reject the null hypothesis that the Poisson distribution explains the underlying antenatal health care utilisation behaviour for all the three survey years (Table 2.5). Based only on this result, we cannot rule out the Poisson regression (Long and Freese, 2006). However, the likelihood ratio test is more useful in cases, where there is more variation than would be expected with the Poisson model. It is likely that the datasets, particularly the 2007 data, based on visual inspection of the moments in Table 2.4, are exhibiting characteristics of under-dispersion, rather than over-dispersion, which often occurs for events that are not independent of past occurrences (StataCorp, 2011). Importantly, given the nature of antenatal care, under-dispersion is not unexpected. Although, in the presence of under-dispersion, maximum likelihood is consistent, it is inefficient (Jones *et al.,* 2007). We consider this further, below.

Table 2.5: Test for over-dispersion

	$NB1 = H_0 = \alpha_1 = 0$		$NB2 = H_0 = \alpha_2 = 0$	
Model	Estimate 1	Prob>=chibar2	Estimate2	Prob>=chibar2
1996	0.012	0.290	0.002	0.278
2001/2	0.290	0.108	0.004	0.182
2007	0.000	1.000	0.000	1.000

Given that there might, instead, be two data generating processes, we test the Poisson against the ZIP model. We use the ZIP model, as it incorporates an underlying mechanism that splits individuals between users and non-users. Since the data is not over-dispersed, we did not consider the ZINB. The Vuong test of the ZIP against the Poisson model favours the ZIP specification for the 1996 and 2001/2 samples, but not the 2007 sample (Table 2.6). Thus, there is empirical evidence suggesting a spilt between users and non-users for the 1996 and 2001/2 survey years.

Table 2.6: Test between zero inflated Poisson and Poisson

	ZIP vs Poisson	
Model	Vuong test	Pr>Z
1996	5.590	0.000
2001/2	7.190	0.000
2007	0.300	0.382

Two additional competing econometric specifications, previously discussed, in the health economics literature are the TPM and the LCM (Jimenez-Martin *et al.*, 2002; Deb and Trivedi, 2002; Sarma and Simpson, 2006). The LCM specification allows for a different constant term, a different dispersion parameter and a different slope coefficient, and it was specified as a Poisson, as determined by the data. As indicated earlier, the motivation for using the TPM is that it falls within the principal-agent framework and is, thus, a natural extension of economic theory. That is, the TPM reflects a two stage decision making process, each part representing a model for one decision. Therefore, estimating the TPM by maximum likelihood is achieved by separately maximising the two terms in the likelihood, one corresponding to the zeros and the other to the positive values. Essentially, the first part of the TPM uses the full sample, but the second part uses only the positive count observations (Cameron and Trivedi, 2010). In practical applications, Cameron and Trivedi (2010) suggest that any binary outcome model can be used for modelling the first part, which is the zero-versus-positive outcome. The second part uses a truncated parametric count density, either a Poisson or NB. In this chapter, the first stage of the TPM is specified as a logit, to describe the initial contact; in the second stage, describing the intensity or frequency of visits, a zero truncated Poisson model is used, based on earlier diagnostic tests. Both the TPM and LCM are estimated by maximum likelihood.

In-sample statistics namely: the Akaike Information Criterion (AIC); Bayesian Information Criterion (BIC); and the value of the maximised Log-likelihood function for the four specifications are used to compare the performance of the models. The AIC is obtained from AIC=-2lnL+2K and the BIC is given as BIC=-2lnL+ Kln(N) where lnL is the maximised log likelihood, K is the number of parameters and N is the sample size. The preferred models are those with bigger log likelihood values (smaller in absolute terms) and smaller AIC and BIC values. The actual values of the log likelihood, AIC and BIC for the four models are reported in Table 2.7. As can be seen, the log likelihood and AIC criteria clearly favour the TPM for all the three survey years but the BIC favours the ZIP in 1996 and 2001/2 and the Poisson in 2007. Thus on aggregate, the TPM performs better than all the other specified models. This indicates that the individuals' decisions' regarding the utilisation of ANC is adequately represented by the

TPM. The results are consistent with existing empirical literature on utilisation of health services (Jimenez-Martin *et al.,* 2002).

Table 2.7: Testing model specifications

Model	Poisson	NB1	NB2	ZIP	TPM[++]	Latent Class[+]
1996						
Log likelihood	-9731.739	-9731.43	-9731.392	-9644.881	-9550.318[a]	-9599.244
AIC	19511.48	19512.86	19512.78	19339.76	19196.64[b]	19296.49
BIC	19664.96	19672.74	19672.66	19499.64[c]	19503.6	19609.84
2001/2						
Log likelihood	-8532.172	-8531.217	-8531.582	-8373.73	-8306.073[a]	-8319.7
AIC	17112.34	17112.43	17113.16	16797.46	16708.15[b]	16793.4
BIC	17262.46	17268.8	17269.53	16953.83[c]	17008.38	17088.6
2007						
Log likelihood	-6946.398	-6946.398	-6946.398	-6946.194	-6899.791[a]	-6934.469
AIC	13940.8	13940.8	13940.8	13942.39	13895.58[b]	13966.94
BIC	14089.44[c]	14089.44[c]	14089.44[c]	14097.23	14192.88	14270.43

[+]All models were run as Poisson latent class. [++] The Hurdle was run as Logit and ZTP models.
[a] Model with bigger Log likelihood value. [b,c] Models preferred by the AIC and BIC respectively.

2.5.4 Main results and discussion

Table 2.8 presents the detailed estimation results for the preferred model (TPM) for the three surveys showing the effects of the determinants on the probability of seeking ANC and the intensity of use. The directions of the effects of all the independent variables are as predicted in the previous section.

For both models, marginal effects (ME) of the independent variables are also reported. In the case of a continuous variable, calculus can be used to outline the ME, which is, for the j^{th} regressor, $ME_j = \partial E(y \mid x = x^*)/\partial x_j$. For the Poisson model with $E(y \mid X) = \exp(X'\beta)$, the marginal effect is slightly different, $ME_j = \exp(x^* b) b_j$. Note that the marginal effect is not simply the parameter b_j; rather, it also varies with the level of the regressors, x^*. Since calculus methods are not appropriate for indicator variables, finite-difference methods are used to calculate the marginal effect for these indicators. The following expression describes this representation, $ME_j = E(y \mid z = z^*, d = 1) - E(y \mid z = z^*, d = 0)$, where x=(z d), z are regressors other than the j^{th} regressor, which takes on the indicated levels, d. With linear models, the calculus and finite-difference methods give the same result, but for nonlinear models, the results differ (Cameron and Trivedi, 2010). To ensure that the marginal effects for the binary regressors are calculated by the finite difference method, the factor variable i in Stata 12 is used (StataCorp, 2011). The predicted frequency of ANC visits are evaluated at the sample mean of the regressors.

2.5.4.1 First stage: probability of antenatal care utilisation

Results of the binary logit estimation for the probability of ANC utilisation, Table 2.8, show that ANC visits are positively influenced by both maternal and paternal education. Compared to women with no education, women with primary and secondary education or higher, are more likely to seek ANC. This finding is consistent with several studies establishing a positive relationship between the utilisation of antenatal health services and maternal education (Addai, 2000; Chakraborty *et al.,* 2003; Gage, 2007; Habibov and Fan, 2008; Babalola and Fatusi, 2009). The results support the contention that education increases female independence, decision-making power and the ability to use health care inputs to produce better maternal health. The partner's educational status, however, was significant only for women with partners who had secondary education or higher. As expected, and consistent with previous literature, the probability of seeking ANC was higher for women, who are employed, supporting the hypothesis that employment increases a woman's mobility and provides her with better resources, which can enable her to seek ANC (Addai, 2000; Gabrysch and Campbell, 2009). However, employment was not a statistically significant predictor of initiating ANC in the 2001/2 and 2007 survey years.

Higher birth order appears to be a deterrent to ANC initiation. In the 2007 sample, the likelihood of utilising ANC is significantly lower for women with higher parity, compared to women with lower parity. One possible explanation for the low utilisation of ANC by women with higher parity is that such women have gained knowledge and developed confidence from previous pregnancies. The result is consistent with other studies which find that women are less likely to seek ANC for the pregnancies of higher order (Gage and Calixte, 2006; Short and Wang, 2004). Similar to Addai (2000), findings from this study suggest that other religious groups (Muslims and others) are less likely to seek ANC compared to Catholics. In Zambia, as is the case in some developing countries, the Catholic Church plays a critical role in health care delivery and education (Addai, 2000). However, this result was not statistically significant for the 2001/2 sample.

Although wealth is a significant predictor for the decision to use ANC, the result is valid for 2001/2 sample only. In previous literature, household wealth has a positive effect on the use of maternal health services (Chakraborty *et al.*, 2003; Gage and Calixte, 2006; Gage, 2007; Sepehri *et al.*, 2008), probably because wealth is highly correlated with financial resources, and, if more resources are available, there are fewer financial barriers to accessing health care. Although ANC services are provided for free in Zambia, poor households may still experience high access costs, especially related to travel time.

No differential effect regarding location by rural-urban residence was found, but there are notable regional and provincial differences in the decision to seek ANC. These differences were more pronounced in 2007. The results show that, compared to women in Lusaka Province, women in relatively rural regions, such as Luapula and Northern provinces, were less likely to seek ANC. The results are consistent with earlier studies finding differences in utilisation of maternal health services by geographical region (Addai, 2000; Celik and Hotchkiss, 2000). In most developing countries, some provinces have more health infrastructure than others, and, therefore, the region in which a woman is located will influence her decision to seek ANC. Navaneetham and Dharmalinga (2002), for example, find that interstate differences arose from variation in the implementation of maternal health programs and availability and accessibility between states.

2.5.4.2 Second stage: frequency of antenatal care utilisation

Results of the ZTP model for the frequency of ANC utilisation are also presented in Table 2.8. Similar to the findings on the decision to use ANC, maternal education, employment and wealth are found to have a positive effect on the frequency of visits. However, in contrast to the finding for ANC initiation, we find that the frequency of use varies positively for women of higher parity in each of the survey years. Due to higher health risks associated with higher birth order, women with higher parity may need to seek ANC more frequently (Bai *et. al.*, 2001). On the other hand, there is a significant negative relationship between the household childcare burden and the frequency of use of ANC across all the survey years; this result, although consistent with the literature, differs from first stage estimates. In other words, birthing women with a greater childcare burden use ANC less frequently. Regional or provincial variations in the frequency of use are less pronounced in the second stage than in the first stage.

Table 2.8: Determinants of utilisation of antenatal care

	1996				2001				2007			
Variable	Binomial logit	Marginal effects	ZTP	Marginal effects	Binomial logit	Marginal effects	ZTP	Marginal effects	Binomial logit	Marginal effects	ZTP	Marginal effects
Individual characteristics												
Maternal Education (No education)												
Primary	0.912***	0.029***	-0.036*	-0.173*	0.874***	0.043***	0.013	0.061	0.574**	0.011*	0.024	0.094
Secondary or higher	1.599***	0.039***	0.063**	0.325**	1.588***	0.060***	0.093***	0.468***	1.392***	0.019**	0.053**	0.211**
Partners Education (No education)												
Primary	0.220	0.007	0.010	0.050	0.209	0.008	-0.004	-0.020	0.131	0.002	0.014	0.056
Secondary or higher	1.291***	0.027***	0.048**	0.234**	0.579**	0.019**	0.037	0.186	0.984**	0.012**	0.056**	0.225**
Employment status (unemployed)												
Employed	0.304*	0.006*	0.036**	0.178**	0.080	0.003	-0.018	-0.092	0.156	0.002	0.044***	0.174***
Parity at last live birth (1)												
2-4	-0.013	-0.000	0.045***	0.215***	-0.042	-0.001	0.022	0.106	-0.263	-0.003	0.024	0.095
5+	0.091	0.002	0.083***	0.403***	-0.340	-0.011	0.065***	0.322***	-0.686*	-0.008*	0.040*	0.159*
Religion (Catholic)												
Protestant	-0.006	-0.000	-0.004	-0.022	0.262	0.009	-0.015	-0.075	0.050	0.001	0.013	0.051
Other	-0.841**	-0.025*	0.036	0.182	-0.175	-0.007	-0.157***	-0.733***	-1.875***	-0.063**	-0.059	-0.228
Wealth quintile (Poorest)												
Poorer	0.285	0.007	0.006	0.030	0.093	0.004	0.027	0.126	0.163	0.002	0.040*	0.159*
Middle	0.320	0.008	0.028	0.130	0.329	0.013	0.065***	0.307***	0.231	0.003	0.025	0.098
Richer	0.713	0.014	0.100***	0.486***	0.127	0.005	0.134***	0.660***	0.929	0.009	0.013	0.051
Richest	0.767	0.015	0.238***	1.246***	2.162***	0.042***	0.232***	1.203***	-0.608	-0.012	0.091**	0.371**
Location (Rural)												
Urban	0.585	0.011	0.035	0.172	0.088	0.003	-0.005	-0.023	0.006	0.000	-0.027	-0.105
Children in HH under five												
Household childcare burden	0.080	0.002	-0.030***	-0.145***	0.013	0.000	-0.022***	-0.111***	-0.212	-0.003	-0.038***	-0.153***
Region (Lusaka reference category)												
Central	-0.482	-0.016	-0.042	-0.199	-1.029*	-0.040**	-0.215***	-1.101***	-2.311**	-0.018**	0.009	0.035
Copperbelt	1.064	0.017	0.033	0.162	-0.623	-0.020	-0.138***	-0.735***	-2.131**	-0.015**	0.080*	0.318*
Eastern	0.888	0.015	-0.046	-0.220	0.330	0.007	-0.214***	-1.098***	-1.015	-0.004	0.034	0.132
Luapula	-0.232	-0.007	0.038	0.188	-0.264	-0.007	-0.153***	-0.808***	-2.205*	-0.016*	0.048	0.187
Northern	-0.963*	-0.040*	-0.089**	-0.413**	-0.744	-0.025*	-0.240***	-1.215***	-2.107*	-0.015**	0.032	0.125
North-western	0.507	0.010	0.129***	0.669***	-0.548	-0.017	0.044	0.259	-2.838**	-0.032**	0.048	0.189
Southern	0.807	0.014	0.096**	0.490**	0.735	0.012	-0.165***	-0.865***	-1.704	-0.009**	0.024	0.091
Western	0.338	0.007	0.019	0.094	-0.641	-0.020	-0.127***	-0.678***	-2.176**	-0.016**	0.088**	0.352**
Constant	1.196*		1.480***		1.937***		1.654***		5.411***		1.275***	
Log likelihood	-9550				-8306				-6900			
Wald chi2 (Prob>chi2)	230.7***				77.78***				100.1***			

Note: dy/dx for factor levels is the discrete change from the base level. ***, **,* denote significance at 1%, 5% and 10% levels respectively.

2.6 Conclusion

In this chapter, we conduct an econometric analysis of the utilisation of ANC using micro data from the ZDHS for 1996, 2001/2 and 2007. Specifically, using comparable datasets and an appropriate econometric specification, we examine the factors determining both the decision to seek ANC and the frequency of use in Zambia. We find that the utilisation of ANC involves two distinct decision processes, and is adequately represented by a TPM in all the three survey years. The performance of the TPM was superior to other models that have been used more recently in the literature. From a health policy perspective, using a model that best fits the empirical distribution and provides consistent estimates are useful for policymaking. More so, a TPM allows for disaggregated analysis, separating the determinants of ANC initiation from the determinants of the frequency of use.

The findings in this chapter indicate that different sets of explanatory variables are related to the decision to seek ANC and the intensity of use, although there is some overlap. The results suggest that the decision to seek ANC and the frequency of use is low among the poor and less educated, and there are differences in utilisation at the provincial level. The results point to, potentially, the need to develop innovative strategies aimed at encouraging women in these categories (poor and less educated) to seek ANC, as well as reducing regional disparities in the utilisation of antenatal health services.

In terms of improvements, future research should include supply-side factors in the analysis, by making use of geographic information provided in the DHS and linking it to routine data. To fully understand the trends in the utilisation of ANC, both demand and supply factors need to be examined, since changes in the quantity of ANC could result from changes in the demand for ANC, changes in the supply of ANC or both. We turn to that concern in the following chapter.

CHAPTER 3

3 Utilisation of focused antenatal care in Zambia: examining individual and community level factors using a multilevel analysis

3.1 Introduction

Effective utilisation of antenatal care (ANC) is associated with improved maternal and neonatal health outcomes (Darmstadt *et al.,* 2005; Bullough *et al.,* 2005; WHO, 2005). While it is clear that a reduction in maternal mortality ultimately depends on access to adequate obstetric care, evidence suggests that promoting the use of ANC is instrumental in encouraging women to seek skilled assistance at birth (Abou-Zahr and Wardlaw, 2003; Campbell and Graham, 2006; Gage, 2007). The presence of skilled assistance at birth, when most maternal deaths occur, is shown to significantly reduce maternal mortality (Campbell and Graham, 2006). Moreover, timely and appropriate ANC is important for the health of new-borns (Halim *et al.,* 2010). There is international consensus that initiation of care should start in the first trimester of pregnancy, to ensure adequate antenatal follow-up, the early detection and management of complications, and the prevention of mother to child transmission of HIV in pregnancy (Abou-Zahr and Wardlaw, 2003; Kirkham *et al.*. 2005). In developed countries, ANC has long been established, and has brought about considerable achievements in the reduction of maternal and neonatal mortality. Similarly, most developing countries have adopted ANC programmes to improve maternal and neonatal health outcomes (Abou-Zahr and Wardlaw, 2003; Adam *et al.,* 2005). Yet, high rates of ANC coverage continue to co-exist with high maternal and neonatal mortality rates in most developing countries, prompting calls to improve implementation.

Due to the poor implementation of traditional ANC programmes, 'focused ANC' (FANC) has been introduced, and the World Health Organization (WHO) recommends it in developing countries (Villar *et al.,* 2001; Abou-Zahr and Wardlaw, 2003). FANC emphasises the quality of care provided during antenatal visits, rather than the frequency of visits. FANC is intended to reduce waiting times, increase the time spent educating women about pregnancy-related issues and to promote the use of skilled assistance at birth (WHO, 2001; Babalola and Fatsui, 2009; Gabrysch and Campbell, 2009). Additionally, FANC is expected to reduce costs for both the service provider and households in developing countries (Hall, 2001). FANC recommends four visits for women with uncomplicated pregnancies, with the first visit in the first trimester (ideally before 12 weeks, but no later than 16 weeks), at 24-28 weeks, 32 weeks and 36 weeks gestation (Villar *et al.,* 2001; Abou-Zahr and Wardlaw, 2003). Scheduled FANC visits should include: thorough evaluation (history taking and physical examination), intervention (prevention/prophylaxis and treatment), and promotion (health education and counselling).

According to the Central Statistical Office (2009), 94% of women in Zambia had at least one antenatal visit in 2007, yet, the maternal mortality rate was 591 deaths per 100,000 live births. Possibly, mortality rates remain so high, due to low first trimester ANC usage or incomplete ANC follow-through; only 19% of ANC visits occur in the first trimester, while only 60% complete the recommended minimum four antenatal visits during pregnancy. In order to improve the effectiveness of ANC services, ANC provision in Zambia has transitioned to the new model, and key components of FANC were included in the National Health Strategic Plan (Ministry of Health Zambia (MoH), 2005).

While the factors associated with the use of antenatal services in developing countries are well documented, limited evidence exists on individual and community level factors associated with ANC use, after the adoption of FANC. Existing studies examining the factors related to FANC use small samples, which may not be nationally representative (Mathole *et al*., 2004; Chege, 2005; Birungi and Onyango-Ouma, 2006; Nyarko *et al*., 2006; Aniebue and Aniebue, 2011), while little attention is given to community characteristics and supply-side factors that influence FANC utilisation. Understanding both individual and community level factors associated with FANC use is important, since individuals reside in communities and individual decisions can be influenced by the characteristics of their communities (Gage, 2007). Identifying these factors can help in the development of comprehensive policies to improve the effectiveness of ANC in Zambia.

Therefore, this study analyses the individual and community level factors associated with inadequate use of ANC and the non-use of ANC during pregnancy, despite the introduction of FANC in Zambia. In this research, ANC is considered inadequate, if a woman has three or less ANC visits or does not initiate ANC in the first trimester. Moreover, we construct a composite index based on the key components of FANC, using correspondence analysis, to capture the quality of ANC received. It is argued that separate analysis of individual services received may not capture the true content of the care received, as the content varies across women and facilities (Sunil *et al*., 2006). Moreover, the composite index we construct captures the content of ANC received, which underpins the effectiveness of FANC in improving pregnancy outcomes. By complementing the Zambia Demographic and Health Survey with administrative and health facility census data, we are able to control for both demand-side and supply-side factors that influence the use of ANC.

3.2 Methods

3.2.1 Data and variables

The data for the study come from the 2007 Zambia Demographic Health Survey (ZDHS), a nationally representative household survey covering a wide range of topics, but focusing on women aged 15–49. Detailed information about the ZDHS is available at http://www.measuredhs.com and from the report (CSO, 2009). The analysis focuses on responses from the women's individual questionnaire and is restricted to 2925 ever-married women, who had given birth during the three years preceding the survey. We focus on these three years, as they correspond to the introduction of FANC in Zambia (MoH, 2005). The 2007 ZDHS data was complemented with data from the Zambia Health Facility Census (HFC) 2005 and the Health Management and Information System (HMIS) database to, respectively, calculate the distance to the nearest health facility, and capture community level variables. The HFC covered all public and semi-public (i.e. mission and non-governmental health facilities), as well as larger private-for-profit, health facilities (MoH, 2008). The HMIS includes information on supply and use of services at all public health facilities nationwide, aggregated to the district level.

3.2.2 Empirical method

Two indicators of antenatal health service utilisation are used to analyse the factors associated with inadequacy: the receipt of three or less antenatal check-ups, (1, if the woman had three or less antenatal visits, and 0 otherwise); and the non-use of ANC in the first trimester of pregnancy (1, if the woman's first antenatal visit does not occur during the first trimester of pregnancy, and 0 otherwise). Multilevel logistic regression is used to examine the influence of individual and community level characteristics on the utilisation of ANC. Multilevel analysis accounts for the hierarchical structure of the DHS data, enabling the estimation of community level effects on the outcome variables (Gage, 2007). Ignoring observation clustering yields underestimated standard errors, and may result in spurious significant results (Luke, 2004; Gage, 2007; Rabe-Hesketh and Skrondal, 2008). More so, obtaining both individual and community level estimates is often useful for policymaking, since interventions need to be targeted at the level where they will achieve the greatest effect.

The regression model consists of two sub-models, level 1 and 2. Level 1 represents the relationships among the individual level variables, while level 2 examines the influence of community-level factors. Both individual and household characteristics are examined as individual level variables, because the average number of women in any household is small, and, therefore, the household cannot be analysed as its own level. To assess the influence of unobserved community level characteristics on the overall variation in ANC use, we specify a null model (without covariates). Two extended model specifications examining potential determinants of inadequate ANC use are also fitted. Model 1 includes individual characteristics, only, while model 2 includes both individual and community level variables. The model is presented as follows:

$$Logit(\pi_{ij}) = \log(\pi_{ij} / (1 - \pi_{ij})) = \beta_0 + \beta_1 x_{ij} + \beta_2 z_j + \varepsilon_j \quad (3.1)$$

where π_{ij} is the probability that the outcome is 1 (i.e. propensity of antenatal care usage) for a woman i in community j; β_0 is the intercept; the $\beta's$ are the coefficients; x and z represent the individual and community level variables, respectively; and $\varepsilon_j \sim N(0, \sigma^2)$ represents the random effects for the j^{th} community. A description of two-level multilevel models is presented in Appendix B.1. All the statistical analyses are carried out using xtlogit in Stata 12 (StataCorp 2011).

The variables used in the study and expected signs are informed by previous literature on factors associated with the use of ANC (Gage, 2007; Gabrysch and Campbell, 2009; Babalola and Fatusi, 2009, Ndao-Brumblay *et al.*, 2012). The individual level variables include parity, a categorical variable indicating childbirth, captured as: 1, 2–4 and 5 or more (multipara). Multiparity puts women at greater risk of obstetric complications, implying greater need for ANC services (Bai *et al.,* 2002). On the other hand, birthing women with higher parity may seek less ANC services, due to knowledge and experience gained from past births, lack of child support for younger children in the household and past negative comments received from birth attendants at the health facility (Gage and Calixte, 2006). The mother's age was omitted from the regression, due to high correlation (0.8) with parity (Gage, 2007). The woman's and husband's education status are grouped into three categories: no education, primary education and secondary education or higher. Based on previous evidence, more education is associated with a higher propensity for maternal health services (Gage, 2007; Sagna and Sunil, 2012).

Previous literature has demonstrated that household wealth is strongly related to the use of maternal health services (Sagna and Sunil, 2012; Gage, 2007; Fan and Habibov, 2009). Along those lines, even though ANC is provided for free in Zambia, it is expected that wealthier households are better equipped to cope with any other direct and indirect costs of seeking ANC (De Allegri *et al.,* 2011). In this research, household wealth is captured via an index, and is grouped into three categories: poor, middle and rich. To capture the household childcare burden, the number of children in the household under the age of five was included. Without child support, birthing women with more young children in the household needing care may use ANC less frequently. Religion, also included, is categorised as Catholic, Protestant and other. Religion may influence attitudes towards modern health services, and may, therefore, affect the use of maternal health services. Previous research finds a positive correlation between antenatal health service use and Catholicism, but negative associations for women following traditional religions (Addai, 2000).

To capture the actual quality of ANC received, a composite index of FANC components is constructed. The components considered, and demarcated as true/false, include: attendance by skilled health worker, weight and height measured, blood pressure checked, urine and blood sample taken, told about complications, given or bought iron tablets, and took fansidar as prophylaxis for malaria prevention. Correspondence analysis (CA), rather than principle components analysis (PCA), is used to construct the quality index. Although PCA is widely used (Sunil *et al.*, 2006; Gage 2007; Ndao-Brumblay *et al.*, 2012), it was designed to deal with continuous variables (Vyas and Kumaranayake, 2006). CA is employed, instead, because it is designed to manage categorical variables (Blasius and Greenacre 2006). CA was used to calculate the weights using the 'mca' command in Stata 12 (Statacorp, 2011) with adjustment of the principal inertias (eigenvalues), as suggested (Greenacre, 1993). The composite index score for each woman was then calculated, using the generated weights, and is included as a predictor in the model. The computation of the index was based on;

$$MCA_i = Z_{i1}W_1 + Z_{i2}W_2 + ... + Z_{ij}W_j + ... + Z_{iJ}W_J \qquad (3.2)$$

Where MCA_i is the i^{th} woman's composite quality indicator score, Z_{ij} is the response of woman i to category j, and W_j is the CA weight for the first dimension applied to the category. Table 3.1 lists the variables used in the construction of the composite index, with categories and weights for each variable. The weights used are those identified from the first dimension of the CA with iterative adjustment. The first dimension explained about 64% of total inertia. The weights show those components reflecting higher quality of care contributing positively to the FANC index, while the components that reflect lower quality of care contribute negatively to the index.

Table 3.1: Variables included in and weights obtained from correspondence analysis

Variable	Categories	Weights
Skilled assistance	Attended by skilled worker during visit	0.171
	Not attended by skilled worker during visit	-2.897
Weight	Weighed during pregnancy	0.346
	Not Weighed during pregnancy	-3.238
Height	Height measured during pregnancy	1.555
	Height not measured during pregnancy	-0.535
Blood pressure	Blood pressure checked during pregnancy	0.634
	Blood pressure not checked during pregnancy	-2.864
Urine sample	Urine sample taken during pregnancy	2.363
	Urine sample not taken during pregnancy	-0.601
Blood sample	Blood sample taken during pregnancy	1.218
	Blood sample not taken during pregnancy	-1.792
Complications	Told about complications during pregnancy	0.516
	Not told about complications during pregnancy	-1.514
Iron tablets	Given or bought iron tablets during pregnancy	0.079
	Not given or bought iron tablets during pregnancy	-1.105
Prophylaxis	Took fansidar as prophylaxis for malaria prevention in pregnancy	0.209
	Did not take fansidar as prophylaxis for malaria prevention in pregnancy	-1.829

The community level variables often cited in the literature (Gage, 2007; Ndao-Brumblay *et al.*, 2012) capture characteristics, such as accessibility, economic status and other health system factors. A number of these were included in the analysis, such as: community type (urban or rural), drug availability at community health facilities, community average ANC uptake and health facility density. Poverty status in the community, also captured, follows the material deprivation index (MDI). The MDI ranges from -4.65, least deprived, to 1.66, most deprived (Kabaso and Tembo, 2009). Straight-line distances from each DHS cluster to the nearest health facility are calculated via a GIS platform and exported to Stata for further analysis. Previous literature suggests that proximity to a health facility, quality of ANC services provided and antenatal uptake in the community are positively associated with a woman's utilisation of ANC, while poverty concentration in the community is negatively associated with ANC utilisation (Gage and Calixte, 2006; Gage, 2007; Sagna and Sunil, 2012; Kyei *et al.,* 2012a). In this study, the supply-side is proxied by the availability of drugs and the density of health facilities in the community. The distances to the nearest facility and antenatal uptake in the community are, similarly, determinants of the demand for ANC services.

3.3 Results

3.3.1 Descriptive statistics

The descriptive statistics of the selected sample of women (Table 3.2) show 40% with three or less visits, whilst more than 80% of the women do not receive antenatal check-ups in the first trimester. Three or fewer antenatal visits vary by educational attainment and household income. There is also variation in utilisation patterns by region, and these regional differences are more marked for three or less visits than for non-use of ANC in the first trimester.

3.3.2 Individual and community level effects

A two-stage multilevel model was estimated accounting for individual and community levels. Characteristics at each level were incorporated into the two main specifications. Model 2 is the general specification incorporating both individual and community level variables, while Model 1 excludes the community level variables. Analysis was performed on the full sample, and run separately for rural and urban areas. To select the appropriate specification for each outcome, the AIC (Akaike Information Criterion), BIC (Bayesian Information Criterion) and the value of the log likelihood function are considered. The preferred model is one with smaller AIC value, BIC value and absolute log likelihood value. Except for having an initial visit in the first trimester, where Model 2 (including both individual and community level variables) is better, we find that the individual level model fit is better. In other words, the community context has a greater role in explaining individual level variations on insufficient ANC visits in the rural areas.

To establish the extent to which differences in the communities explain individual level variations in inadequate use of ANC, we further estimated a series of random intercept models. From the null model, estimates of the intra-class correlation (ICC), which measures the degree to which community context can explain observed total variation in the utilisation of ANC, are provided in Table 3.3. Similarly, the variance of the random intercept term, which shows the extent to which outcomes between communities differ, after controlling for the covariates, were obtained (Table 3.3). About 6% to 11% of the overall variation in insufficient visits and no visits in the first trimester, respectively, can be attributed to unobserved community level differences.

Table 3.2: Descriptive statistics of women with most recent birth in past 3 years, 2007 Zambia DHS (n=2,925)

	Three or less visits		No visit in first trimester	
Variables	Mean	S.D	Mean	S.D
Total	0.397	0.489	0.822	0.383
Individual-level variables				
Parity				
1	0.198	0.398	0.201	0.401
2-4	0.482	0.500	0.479	0.500
5+	0.320	0.467	0.319	0.466
Religion				
Catholic	0.187	0.390	0.177	0.382
Protestant	0.796	0.403	0.809	0.393
Other	0.017	0.130	0.014	0.118
Children in HH under five				
Household childcare burden	1.888	0.889	1.840	0.894
Woman's employment status				
Employed	0.459	0.498	0.486	0.500
Woman's education				
No education	0.126	0.332	0.124	0.329
Primary	0.610	0.488	0.610	0.488
Secondary or higher	0.264	0.441	0.266	0.442
Husband's education				
No education	0.177	0.382	0.171	0.377
Primary	0.458	0.498	0.448	0.497
Secondary or higher	0.365	0.482	0.381	0.486
Index for actual quality of ANC received	-0.467	4.598	-0.226	4.447
Household wealth index				
Poor	0.405	0.491	0.417	0.493
Middle	0.223	0.417	0.236	0.425
Rich	0.372	0.484	0.347	0.476
Community-level variables				
Urban	0.361	0.480	0.339	0.473
Proportion of drugs available	0.715	0.115	0.709	0.115
Material deprivation index	-0.408	1.889	-0.310	1.869
Distance to nearest facility	7.013	6.027	7.141	6.070
Number of health facilities per 1000	0.136	0.053	0.137	0.052
Antenatal care uptake	0.954	0.132	0.956	0.138

The low ICC suggests that most of the variation in the models is explained by individual level characteristics. Moreover, the inclusion of individual and community level covariates reduces the variation explained by unobserved community characteristics (ICC) for inadequate visits in rural areas. The results reinforce the previous conclusion: the individual level models have more explanatory power, except in the case of inadequate ANC visits in rural areas.

Odds ratios for the various specifications of both outcome variables are presented in Tables 3.4-3.7. At the individual level (Table 3.4), employed women are less likely to have three or less ANC visits compared to the unemployed (OR=0.82, P=0.056), while the odds of having three or less ANC visits are higher, if the actual quality of ANC received during ANC check-ups is low (OR=0.96, P=0.000); the result was statistically significant in both rural and urban areas. Multipara women in urban areas, and the household childcare burden, in both rural and urban areas, are positively associated with three or less visits. Although the woman's education was not significantly associated with three or less visits, the odds of insufficient visits for women, whose husband has at least attained a secondary education qualification, are lower (OR=0.75, P=0.000), compared to women, whose husbands have received no education, at least in urban areas. In the model based on the full sample, household wealth is positively associated with three or less visits at the individual level, although the effect disappears after adjusting for community level variables (Table 3.5). However, the effect of wealth is insignificant in both urban and rural areas. Unexpectedly, the results show that higher quality health care services provided in rural areas, as captured by the structural inputs of quality of health care – namely drug availability and density of health facilities – is positively associated with insufficient ANC visits.

Table 3.3: Intra-class correlation and variances for random intercepts, 2007 Zambia DHS

	Three or less antenatal visits			No visit in first trimester		
	Full	Rural	Urban	Full	Rural	Urban
Intra-class correlation[+]						
Null model	0.060***	0.073***	0.030*	0.105***	0.142***	0.034
Individual level model	0.059***	0.076***	0.018	0.114***	0.150***	0.024
Individual- and community level model	0.054***	0.063***	0.016**	0.110***	0.114***	0.009
Variance of the random intercept						
Null model	0.211***	0.261***	0.101***	0.386***	0.545**	0.117**
Individual level model	0.204***	0.269***	0.062**	0.424***	0.581***	0.080
Individual- and community level model	0.188***	0.222***	0.052**	0.408***	0.544**	0.029

*** p<0.01, ** p<0.05, * p<0.1, [+]The Intra-class correlation is a ratio of the community level variance to the total variance.

Except for the childcare burden (OR=1.24, P=0.000), the woman's employment status (OR=0.716, P=0.058), the husband's educational attainment (OR=0.55, P=0.015 for secondary education or higher) and the actual quality of ANC received (OR=0.88, P=0.000), none of the other individual level variables were statistically significant in explaining initial visits occurring after the first trimester (Table 3.6). The household childcare burden was statistically significant in both rural and urban areas, while the other results were valid only for urban areas. After including community level variables (Table 3.7), only the community's poverty status was found to be negatively associated (OR=0.853, P=0.079) with having a first ANC visit after the first trimester.

3.4 Discussion

Using data from the 2007 Zambia Demographic and Health Survey, complemented with administrative and health facility census data, this paper empirically identifies the individual and community level factors associated with inadequate use and non-use of ANC, following the adoption of focused ANC in Zambia. The findings demonstrate that a considerable proportion of parturient women in Zambia continue to receive less than the minimum number of required visits (four) and/or do not receive antenatal check-ups in the first trimester, even after the adoption of FANC. While all the women in the selected sample have at least one ANC visit, 40% have three or less visits and more than 80% do not have antenatal check-ups in their first trimester. Although both individual and community level characteristics influence the observed inadequacies in ANC use, community level factors have a stronger influence in the rural areas. However, there are still some unobserved factors affecting the adequate use and non-use of ANC in the first trimester of pregnancy.

At the individual level, multipara women in urban areas have statistically significant higher odds of inadequate ANC visits than women of lower parity. These findings are consistent with previous literature in developing countries, suggesting that higher parity is generally a barrier to adequate use of ANC (Magadi *et al.*, 2000; Overbosch *et al.*, 2004; Simkhada *et al.*, 2008; Sagna and Sunil, 2012). The perceived lower risk associated with births of higher order may explain the greater odds of inadequate visits among multiparous women. Moreover, higher parity women may not feel the need to use antenatal services, due to their accumulated pregnancy experiences and knowledge of the birthing process.

Table 3.4: Multilevel modelling of three or less ANC visits with individual covariates only, 2007 Zambia DHS

	Full (n=2,925)		Rural (n=1,925)		Urban (n=1,000)	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Individual level variables						
Parity (ref=1)						
2-4	1.016	(0.806 , 1.280)	0.916	(0.677 , 1.238)	1.263	(0.871 , 1.833)
5+	1.018	(0.788 , 1.314)	0.823	(0.596 , 1.136)	1.692**	(1.084 , 2.643)
Religion (ref=Catholic)						
Protestant	0.891	(0.724 , 1.097)	0.905	(0.690 , 1.187)	0.858	(0.619 , 1.190)
Other	1.528	(0.765 , 3.055)	2.234*	(0.984 , 5.069)	0.561	(0.131 , 2.398)
Household childcare burden						
Number of children under 5 in HH	1.204***	(1.098 , 1.321)	1.226***	(1.091 , 1.377)	1.159*	(0.994 , 1.352)
Woman's employment status (ref=unemployed)						
Employed	0.817**	(0.695 , 0.960)	0.829*	(0.676 , 1.017)	0.772*	(0.591 , 1.009)
Woman's education (ref=no education)						
Primary	1.018	(0.794 , 1.306)	1.036	(0.786 , 1.365)	0.787	(0.420 , 1.476)
Secondary and above	0.953	(0.705 , 1.286)	1.018	(0.700 , 1.480)	0.707	(0.369 , 1.352)
Partner's education (ref=no education)						
Primary	0.923	(0.723 , 1.179)	1.005	(0.754 , 1.339)	0.761	(0.467 , 1.241)
Secondary and above	0.742**	(0.578 , 0.952)	0.863	(0.627 , 1.187)	0.545***	(0.357 , 0.833)
Index for actual quality of ANC received	0.958***	(0.939 , 0.977)	0.950***	(0.928 , 0.973)	0.964*	(0.925 , 1.005)
Household wealth(ref=poor)						
Middle	1.070	(0.865 , 1.324)	0.997	(0.790 , 1.259)	1.097	(0.355 , 3.396)
Rich	1.566***	(1.238 , 1.981)	1.321	(0.912 , 1.914)	1.468	(0.490 , 4.397)
Constant	0.531***	(0.358 , 0.786)	0.496***	(0.307 , 0.802)	0.898	(0.256 , 3.149)
Log likelihood	-1937.0		-1263.0		-663.6	
AIC	3903.2		2555.9		1357.1	
BIC	3993		2639.5		1430.7	

*** p<0.01, ** p<0.05, * p<0.1

Table 3.5: Multilevel modelling of three of less visits with individual and community level covariates

	Full (n=2,925)		Rural (n=1,925)		Urban (n=1,000)	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Individual level variables						
Parity (ref=1)						
2-4	1.028	(0.816 , 1.296)	0.931	(0.688 , 1.259)	1.267	(0.873 , 1.839)
5+	1.031	(0.798 , 1.331)	0.844	(0.612 , 1.165)	1.704**	(1.091 , 2.660)
Religion (ref=Catholic)						
Protestant	0.886	(0.719 , 1.091)	0.884	(0.674 , 1.159)	0.856	(0.617 , 1.188)
Other	1.452	(0.725 , 2.906)	1.986	(0.873 , 4.518)	0.557	(0.130 , 2.381)
Household childcare burden						
Number of children under 5 in HH	1.203***	(1.097 , 1.320)	1.211***	(1.078 , 1.360)	1.163*	(0.997 , 1.358)
Woman's employment status (ref=unemployed)						
Employed	0.802***	(0.682 , 0.944)	0.802**	(0.653 , 0.985)	0.782*	(0.598 , 1.024)
Woman's education (ref=no education)						
Primary	1.016	(0.792 , 1.303)	1.028	(0.780 , 1.354)	0.799	(0.426 , 1.501)
Secondary and above	0.934	(0.692 , 1.262)	1.010	(0.695 , 1.467)	0.721	(0.375 , 1.384)
Partner's education (ref=no education)						
Primary	0.941	(0.737 , 1.202)	1.031	(0.773 , 1.375)	0.760	(0.465 , 1.242)
Secondary and above	0.750**	(0.584 , 0.964)	0.891	(0.648 , 1.226)	0.544***	(0.356 , 0.833)
Index for actual quality of ANC received	0.952***	(0.933 , 0.972)	0.946***	(0.924 , 0.969)	0.966	(0.926 , 1.007)
Household wealth(ref=poorest)						
Middle	1.015	(0.816 , 1.262)	0.966	(0.764 , 1.222)	1.083	(0.348 , 3.366)
Rich	1.243	(0.909 , 1.701)	1.156	(0.785 , 1.702)	1.515	(0.497 , 4.615)
Community level variables						
Area type (ref=rural)						
Urban	1.389**	(1.028 , 1.878)				
Proportion of drugs available	2.669**	(1.090 , 6.539)	6.138***	(1.966 , 19.157)	0.456	(0.102 , 2.039)
Material deprivation index	0.975	(0.907 , 1.047)	0.955	(0.845 , 1.080)	0.982	(0.893 , 1.080)
Distance to nearest facility	1.001	(0.983 , 1.019)	0.999	(0.980 , 1.019)	1.006	(0.959 , 1.055)
Density of health facilities	5.098	(0.662 , 39.256)	17.300**	(1.211 , 247.145)	0.921	(0.037 , 22.773)
Prenatal care uptake	1.455	(0.700 , 3.024)	1.105	(0.407 , 3.000)	1.554	(0.528 , 4.571)
Constant	0.143***	(0.045 , 0.458)	0.088***	(0.020 , 0.382)	0.958	(0.124 , 7.405)
Log likelihood	-1931.3		-1255.7		-662.4	
AIC	3904.7		2551.5		1364.7	
BIC	4030.4		2662.9		1462.9	

*** p<0.01, ** p<0.05, * p<0.1

Table 3.6: Multilevel modelling of no ANC visit in the first trimester with individual covariates only, 2007 Zambia DHS

	Full (n=2,925)		Rural (n=1,925)		Urban (n=1,000)	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Individual level variables						
Parity (ref=1)						
2-4	0.895	(0.667 , 1.200)	0.812	(0.547 , 1.204)	1.059	(0.671 , 1.671)
5+	0.929	(0.671 , 1.288)	0.798	(0.527 , 1.209)	1.438	(0.807 , 2.561)
Religion (ref=Catholic)						
Protestant	0.980	(0.748 , 1.284)	0.996	(0.702 , 1.412)	0.941	(0.610 , 1.450)
Other	1.593	(0.571 , 4.441)	2.311	(0.614 , 8.700)	0.688	(0.127 , 3.725)
Household childcare burden						
Number of children under 5 in HH	1.243***	(1.099 , 1.407)	1.239***	(1.062 , 1.446)	1.226*	(0.993 , 1.514)
Woman's employment status (ref=unemployed)						
Employed	0.845	(0.685 , 1.042)	0.919	(0.703 , 1.200)	0.716*	(0.509 , 1.008)
Woman's education (ref=no education)						
Primary	1.079	(0.781 , 1.490)	1.134	(0.800 , 1.607)	0.505	(0.169 , 1.516)
Secondary and above	1.009	(0.686 , 1.485)	1.281	(0.790 , 2.079)	0.422	(0.139 , 1.279)
Partner's education (ref=no education)						
Primary	0.842	(0.606 , 1.170)	0.868	(0.592 , 1.272)	0.761	(0.385 , 1.506)
Secondary and above	0.679**	(0.488 , 0.945)	0.743	(0.489 , 1.129)	0.549**	(0.310 , 0.970)
Index for actual quality of ANC received	0.963***	(0.938 , 0.989)	0.981	(0.951 , 1.012)	0.884***	(0.833 , 0.937)
Household wealth (ref=poor)						
Middle	1.151	(0.873 , 1.517)	1.146	(0.846 , 1.551)	0.408	(0.049 , 3.371)
Rich	1.269	(0.932 , 1.728)	0.981	(0.608 , 1.583)	0.605	(0.075 , 4.849)
Constant	4.468***	(2.661 , 7.501)	4.420***	(2.349 , 8.319)	30.217***	(2.959 , 308.587)
Log likelihood	-1349.6		-885.5		-448.7	
AIC	2729.3		1801.1		927.4	
BIC	2819.1		1884.6		1001	

*** p<0.01, ** p<0.05, * p<0.1

Table 3.7: Multilevel modelling of no ANC visit in the first trimester with individual- and community level covariates, 2007 Zambia DHS

	Full (n=2,925)		Rural (n=1,925)		Urban (n=1000)	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Individual level variables						
Parity (ref=1)						
2-4	0.900	(0.671 , 1.207)	0.818	(0.551 , 1.214)	1.068	(0.676 , 1.688)
5+	0.935	(0.674 , 1.295)	0.814	(0.537 , 1.233)	1.418	(0.796 , 2.528)
Religion (ref=Catholic)						
Protestant	0.975	(0.744 , 1.279)	0.974	(0.687 , 1.381)	0.926	(0.602 , 1.424)
Other	1.532	(0.550 , 4.270)	2.099	(0.558 , 7.900)	0.717	(0.130 , 3.941)
Household childcare burden						
Number of children under 5 in HH	1.242***	(1.097 , 1.406)	1.224**	(1.049 , 1.429)	1.211*	(0.979 , 1.497)
Woman's employment status (ref=unemployed)						
Employed	0.830*	(0.673 , 1.025)	0.925	(0.706 , 1.211)	0.693**	(0.492 , 0.978)
Woman's education (ref=no education)						
Primary	1.083	(0.785 , 1.495)	1.124	(0.793 , 1.592)	0.505	(0.168 , 1.516)
Secondary and above	0.996	(0.677 , 1.465)	1.261	(0.777 , 2.046)	0.393*	(0.129 , 1.195)
Partner's education (ref=no education)						
Primary	0.856	(0.616 , 1.190)	0.873	(0.595 , 1.281)	0.795	(0.401 , 1.578)
Secondary and above	0.688**	(0.494 , 0.958)	0.758	(0.498 , 1.153)	0.556**	(0.314 , 0.985)
Index for actual quality of ANC received	0.961***	(0.936 , 0.987)	0.979	(0.949 , 1.010)	0.894***	(0.843 , 0.949)
Household wealth(ref=poorest)						
Middle	1.123	(0.847 , 1.489)	1.102	(0.812 , 1.495)	0.401	(0.048 , 3.316)
Rich	1.152	(0.766 , 1.734)	0.843	(0.512 , 1.387)	0.756	(0.093 , 6.143)
Community level variables						
Area type (ref=rural)						
Urban	1.266	(0.845 , 1.896)				
Proportion of drugs available	2.171	(0.645 , 7.303)	2.187	(0.447 , 10.696)	0.753	(0.116 , 4.904)
Material deprivation index	1.016	(0.923 , 1.117)	0.853*	(0.714 , 1.020)	1.043	(0.928 , 1.172)
Distance to nearest facility	1.002	(0.979 , 1.027)	1.007	(0.979 , 1.035)	1.021	(0.956 , 1.091)
Density of health facilities	4.140	(0.274 , 62.648)	1.344	(0.036 , 50.114)	15.415	(0.285 , 833.636)
Prenatal care uptake	1.024	(0.385 , 2.726)	2.294	(0.566 , 9.294)	0.496	(0.137 , 1.793)
Constant	1.964	(0.419 , 9.191)	1.133	(0.151 , 8.492)	44.477**	(2.236 , 884.836)
Log likelihood	-1348.1		-882.4		-444.8	
AIC	2938.2		1804.9		929.6	
BIC	2863.9		1916.4		1027.8	

*** p<0.01, ** p<0.05, * p<0.1

Importantly, the receipt of poor quality ANC is associated with inadequate use of ANC in both rural and urban areas, as well as with non-use during the first trimester in urban areas. Previous literature suggests that the quality of care provided shapes the women's decision to use ANC (Gabrysch and Campbell, 2009). Our results agree with earlier analyses; lower perceived quality of care is significantly associated with later antenatal visits (Van Eijk *et al.,* 2006). However, we find that the availability of better quality services, as proxied by ANC structural inputs, is a significant predictor of inadequate use of ANC in rural areas (Kyei *et al.,* 2012a). This result differs from most of the previous literature, finding that women are more likely to have adequate visits, due to the increased availability and accessibility of ANC (Gage and Calixte, 2006; Gage, 2007; Sagna and Sunil, 2012). Although unexpected, the result can be explained by the fact that the proxy for technically assessing quality of care in this study may differ from the perceived quality of care as determined by parturient women. Thus, one can speculate that health facilities with better technical quality of care may provide less interpersonal quality of care, and the latter may be deemed more important for ANC use (Gabrysch and Campbell, 2009; Kyei *et al.*, 2012a).

Surprisingly, and a departure from most of the previous literature (Gage, 2007; Simkhada *et al.*, 2008), wealthier women were more likely to have inadequate antenatal visits, compared to the poor. Similar findings, however, were found in Burkina Faso (De Allegri *et al.,* 2011). Since ANC in Zambia is provided for free, it is plausible that women from poorer households do not face other significant financial barriers, which can deter access to ANC. Importantly, in many settings, ANC is readily available, as it is provided even in small facilities that do not offer delivery services (Gabrysch and Campbell, 2009). It is also plausible that women from poorer households are encouraged to attend ANC, due to the free products dispensed during the ANC visits, such as insecticide-treated nets (ITNs), iron supplements and malaria prophylaxis tablets (De Allegri *et al.,* 2011). The distribution of ITNs is frequently done on the same days that ANC services are offered, since the financial cost of distributing ITNs through ANC are lower, compared to distribution via social marketing campaigns (De Allegri *et al.*, 2010). Another possible explanation is that long waiting hours during antenatal visits deter wealthier women from frequent utilisation of antenatal services. Since ANC is offered weekly, or on specific days, health facilities tend to be congested on these ANC days (Mathole *et al.,* 2004). One can also speculate that wealthier women are more likely to receive ANC in private health facilities. Thus, there is a need to further understand why wealthier women seek fewer antenatal visits, so as to design appropriate policies.

No evidence of the influence of the woman's education on ANC use was found, which differs from the previous literature (Addai, 2000; Gage and Calixte, 2006; Fan and Habibov, 2009; Halim *et al.*, 2011). However, consistent with the literature, husband's educational attainment was found to be positively associated with adequate ANC use in urban areas. Also, the woman's employment status varied positively with adequate ANC use, in line with previous literature from developing countries (Addai, 2000; Simkhada *et al.*, 2008; Gabrysch and Campbell, 2009). Employment helps overcome other financial barriers, increasing the woman's mobility. Although distance has been found to be a structural barrier that deters women from seeking ANC, we find that distance to the nearest health facility does not significantly influence the poor utilisation of ANC. Similar results were found in Kenya and rural Haiti (Magadi *et al.*, 2000; Gage and Calixte, 2006). Also, recent studies in Zambia find that distance does not play a significant role in deterring ANC use, but is important for delivery services (Gabrysch *et al.,* 2011; Kyei *et al.*, 2012a).

The observed lack of association between an ANC visit later than the first trimester and factors, such as, parity, woman's education and household wealth, suggests that non-utilisation of ANC in the first trimester affects people from different socio-demographic and economic profiles equally; however, a more detailed examination of inequality is left for future research. Also, ANC-seeking behaviour in the first trimester of pregnancy, according to these results, is not determined by geographic access, but, likely, by cultural perspectives around pregnancy announcement in the early stages. Evidence from Zimbabwe suggests that women are apprehensive in seeking care during the first trimester, due to cultural beliefs and fear that women are most vulnerable to witchcraft in the early period of pregnancy (Mathole *et al.*, 2004). Thus, the importance of socio-cultural barriers needs to be recognised in the effective implementation and continuance of FANC, deserving more attention in future research.

As earlier indicated, the results suggest that the inadequate use of ANC is not only determined by the observed individual and community level factors, but also by unobserved factors. The significance of the random intercept for both outcomes shows that some variables could not be controlled in our analysis. While the study accounts for some community level variation, through structural inputs at healthcare facilities, a large proportion of the variation remains unexplained. Possibly, structural inputs do not precisely capture the quality of health services, as they are only weakly linked to better quality (Donabedian, 1988). Moreover, previous studies have uncovered other important sociocultural factors influencing attitudes towards ANC utilisation (Chakraborty *et al.*, 2003). Such factors include perceptions and satisfaction with FANC, as well as cultures and customs in pregnancy care. Women's perceptions were found to play a more dominant role in seeking care in the first trimester (Ndidi and Oseremen, 2010). For instance, perception towards having fewer visits, such as the fear of inadequate learning during ANC and suspicion that four visits was inadequate for familiarisation with care providers, has been demonstrated to act as a barrier to seeking FANC (Aniebue and Aniebue, 2011). In Nigeria, late initiation of ANC was strongly determined by the perception that ANC is primarily curative and not preventative. However, such variables are not captured in the DHS surveys. Therefore, further research needs to identify other factors affecting the utilisation of ANC in the first trimester, particularly in the rural areas of Zambia, in order to translate utilisation of ANC into better maternal health outcomes.

The interpretation of the results needs to take into account the study limitations. By 2009, the FANC coverage rate in Zambia was about 63% (MoH, 2009); however, it was not possible to identify the exact districts in which FANC was introduced, due to unavailability of data. Thus, the analysis also includes some areas in which components of FANC may not, yet, have been introduced, and is likely to introduce a bias in the results. The bias generated could be problematic, if the characteristics of the women in uncovered areas are significantly different from those in covered areas. Additionally, while the 2005 Zambia Health Facility Census contains information on health facilities collected at one point in time, the availability or number of health facilities could have changed during the three-year period (2005–2007), covering ANC use in the sample. However, using health facilities data enabled us to include measures, such as distance, to assess accessibility, and these variables are not captured in the household survey. Unfortunately, the distances are measured in a straight line to the nearest health facility, and not necessarily to facilities that provide ANC. However, since most of the facilities covered in the Zambia HFC provide ANC services (93%) (Nyei *et al.*, 2012), any measurement error bias generated by including all facilities is expected to be minimal. Also, a potential bias in the true distance effects is possible, due to the random noise generated by the geo-scrambling procedure used by MEASURE DHS (http://www.measuredhs.com/What-We-Do/Gis.cfm), and by the differences in actual distances travelled to health facilities compared to the straight-line distances that are used in the analysis. Finally, due to data limitations, the analysis does not include women who died, due to childbirth-related complications and, thus, if inadequate ANC use is positively correlated with childbirth-related deaths, the results could overestimate the actual use of ANC.

3.5 Conclusion

In summary, the study uncovers evidence that, while both individual and community level factors are instrumental in determining adequate and inadequate ANC use, after the adoption of

FANC in Zambia, there are other unobserved factors which are important for explaining ANC use. The quality of care received during ANC, as well as the quality of health services offered in the rural communities, plays a crucial role in influencing ANC. Findings from this study call for the adoption of measures which will further improve the quality of ANC provided. The results also suggest that the education of the husband is strongly associated with adequate use of ANC. Thus from a policy perspective, awareness campaigns for FANC should go beyond the individual pregnant women to include the husbands. Health promotion interventions, which encourage participation of the husbands, may increase utilisation of ANC and need to be encouraged further. Although the general improvement in education may go beyond the scope of health sector interventions, the benefits of education in empowering and informing could be promoted through targeted interventions that proxy for the general role of education in improving knowledge of the use of antenatal services. Moreover, there is a need to invest in community health programmes to educate women on the benefits of focused ANC and the importance of early initiation of ANC. Investment in adequate policies, to address the identified factors associated with inadequate use of ANC, needs to take into account the cultural issues surrounding pregnancy, particularly in the rural areas.

CHAPTER 4

4 Assessing regional variations in the effect of the removal of user fees on institutional deliveries in rural Zambia.

4.1 Introduction

Improving maternal health remains a global challenge, particularly for countries in the sub-Saharan Africa region, where maternal mortality averages 680 per 100,000 live births and almost 50% of the approximately 350,000 annual maternal deaths occur (Hogan *et al.*, 2010; World Health Organisation, 2010). With the increased pressure to achieve Millennium Development Goal (MDG) 5, reducing the maternal mortality rate by 75% by 2015, there is a need to further facilitate skilled birth assistance and institutional deliveries (Campbell and Graham, 2006; United Nations, 2011; World Health Organisation, 2010). Institutional deliveries and skilled assistance at birth are important factors in reducing deaths arising from complications in pregnancy. It has even been suggested that skilled birth assistance is the single most important factor in preventing maternal deaths (World Health Organisation, 1999). Although skilled assistance at birth and institutional deliveries are key to the reduction in maternal deaths, only 20-40% of women in developing countries deliver in a health facility (Limwattananon *et al.*, 2011), while approximately 70% of births among poor women take place at home (Montagu *et al.*, 2011).

Economically, the limited use of institutional delivery services is expected to relate to demand and/or supply-side barriers that deter women from accessing these services (Amooti-Kaguna and Nuwaha, 2000; Fournier *et al.*, 2009; Gage, 2007; Gage and Calixte, 2006; Ronsman *et al.*, 2003; Wagle *et al.*, 2004). Supply-side, or health system factors, such as the quality of services, not often captured in household surveys, matter (Gabrysch and Campbell, 2009). More germane to this analysis, financial barriers, such as user fees, also discourage the utilisation of maternal health services, and possibly increase the use of informal care (Borghi *et al.*, 2003; Gage, 2007; Nanda, 2002; Stekelenburg *et al.*, 2004). In other words, these barriers may have equity implications, as well as health implications. There are more pronounced disparities between rich and poor in the use of delivery services, compared to other health services, as well as significant gaps between the two groups in the utilisation of ANC services (Gwatkin *et al.*, 2004).

User fees for health services were introduced in many developing countries in the late 1980s, with the aim of financing health care, including maternal health care. Advocates supporting healthcare user fees argue that they enhance the efficient allocation of goods and services by targeting the population in need of the good or service, i.e., low valuation consumers are screened (Oster, 1995). Also, if higher prices are perceived to reflect better quality, user fees could increase demand (Bagwell and Riordan, 1991), a potential virtuous cycle, at least in terms of revenue generation. However, the removal of user fees could also have negative effects on equity and access (Creese, 1991; Russell and Gilson 1997; Yates 2009). In an effort to increase healthcare accessibility, by reducing the direct financial cost associated with treatment, most countries in sub-Saharan Africa abolished or reduced user fees for health services, including maternity services and delivery services (De Allegri *et al*., 2011; Masiye *et al*., 2008; Nabyonga *et al*., 2005; Wilkinson *et al*., 2001), or exempted certain groups from payment (Penfold *et al*., 2007; Witter *et al*., 2007).

Only limited evidence relating national user fee reforms to women's uptake of maternity services, such as institutional delivery and skilled assistance at birth, is available (Dzakpasu *et al*., 2013). Although it has not been possible to examine whether maternal deaths will decrease as a result of a fee reduction, as has been proposed (Kippenberg *et al*., 2008; Prata *et al*., 2004), it has been possible to directly examine institutional deliveries and skilled assistance at birth. Witter *et al*. (2007) and Penfold *et al*. (2007) find a 10-36% increase in institutional deliveries in the Central and Volta regions of Ghana, although, when fees were temporarily reinstated, the number of institutional deliveries decreased. Deininger and Mpuga (2005) also report an increase in institutional deliveries after the abolition of user fees in Uganda. Skilled assistance at birth, on the other hand, does not increase following the abolition of user fees (De Allegri *et al*., 2011; Tann *et al*., 2007). Not only is the literature limited, it has generally ignored the role of supply-side factors (Cheelo *et al*., 2010; Lagarde, Barroy and Palmer, 2012; Masiye *et al*., 2008) or limited the analysis to a comparison of average utilisation before and after the policy change (Masiye *et al*., 2008). Although panel data has been available, previous studies have not accounted for that structure in the data (Lagarde, Barroy and Palmer 2012), and, thus, have been unable to control for potential time invariant confounders. For instance, in the reporting of administrative data, which is used here, there could be consistent over- or under-reporting of information. Similarly, within a region, there could be consistently more or fewer institutional deliveries, due to region-specific characteristics. Exploiting the information in the panel, allows one to address these concerns. However, estimates obtained from an aggregate analysis often mask important heterogeneities that may warrant further attention; we are also able to consider this possibility.

The context of the policy change in Zambia provides an opportunity to address the preceding concerns and improve our understanding of the relationship between user fees and maternal health services. User fees were removed in public health facilities in 54 rural districts in Zambia in April 2006 to improve access to health services, particularly for the poor, who mostly reside in rural areas.[4] Prior to the policy change, preventative services, such as ANC, family planning and counselling, were exempt from payment, but not delivery services. In terms of fee setting, health providers in various regions were allowed to set fees in line with locally defined affordability criteria, but the fees were to be approved by the Ministry of Health (Masiye *et al.*, 2008). Delivery fees at public health facilities varied from ZMK10, 000 ($3) to ZMK30, 000 ($9) (Cheelo *et al.*, 2010; Kamwanga *et al.*, 2002; Stekenlenburg *et al.*, 2004).[5]

Data from these districts is collated over 2003q1-2008q4 to construct a panel of the 9 provinces. We exploit the panel information in the subsequent analysis, and consider potential dynamic effects. The analysis is founded upon an Interrupted Time Series (ITS) design, complemented by a segmented regression analysis, which is adequate, when only retrospective longitudinal data, before and after an intervention, is available. We further disaggregate the data to obtain regional level estimates from Seemingly Unrelated Regressions (SUR), addressing spatial dependence within an error component framework. In contrast to much of the previous literature, the analysis incorporates supply-side factors, including quantitative measures of service quality, to assess the impact of user fee removal on institutional deliveries.

The outline of the rest of the chapter is as follows: Section 2 summarises the relevant empirical literature. Section 3 describes the data. The estimation strategy is outlined in Section 4, while the econometric results are presented and discussed in Section 5. Brief concluding remarks are presented in Section 6.

4.2 Relevant Literature

There is an extensive literature relating health financing policy changes to health service utilisation (Lagarde, Barroy and Palmer 2012; Masiye *et al.*, 2008; Nabyonga *et al.*, 2005; Ridde, 2003; Wilkinson *et al.*, 2001) however, much of that evidence could be biased (Lagarde and Palmer, 2008). Although a few studies have accounted for specific time-series properties and problems (Lagarde, Barroy and Palmer 2012; Wilkinson *et al.*, 2001), most of the analysis has focussed on a simple comparison of average utilisation before and after a policy change (Ridde,

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[4] Free health services included all aspects of preventative and curative services at Health Posts (HP) and Health Centres (HC), including Hospital Affiliated Health Centres (HAHC). Patients referred to first level hospitals were to be treated free of charge for all services at such facilities. Patients referred further upwards from level one hospitals were exempted from charges. Fee exempt services included: consultation, treatment, admission and diagnostic services (e.g. MoH, 2007).

[5] Unsurprisingly, when formal charges are not levied, indirect levies have been. In the absence of user fees in Ghana and Benin, women have been required to purchase supplies – bleach, to sterilise materials used during delivery, gloves and sanitary pads – when admitted to a health facility for delivery (Borghi *et al.*, 2003; Kowalewski *et al.*, 2002). Obtaining these supplies could easily delay or prevent the use of delivery services. At the household level, delivery services present additional financial implications, in terms of travel costs, as well as the patient's and the patient's companions' time. Additionally, relatives may have to bring food for the patient, as they await delivery (Borghi *et al.*, 2003).

2003; Nabyonga *et al.*, 2005; Masiye *et al.*, 2008). Even if the analysis has gone beyond a simple comparison before and after the change, which is not always the case, the impact of policy on curative and preventative care has been the predominant theme, rather than maternal health services. Evidence from this literature suggests that removing user fees increases access to curative services for the vulnerable groups (Deininger and Mpuga, 2005; Lagarde, Barroy and Palmer, 2012; Lagarde and Palmer, 2008; Masiye *et al.*, 2008; Wilkinson *et al.*, 2001), leads to provider choice substitution (Koch, 2012) but may negatively affect service quality (Lagarde and Palmer, 2008) and utilisation amongst non-targeted groups (Lagarde, Barroy and Palmer, 2012). Also, curative care utilisation increases could have been at the expense of preventative services (Wilkinson *et al.*, 2001). In Ridde and Morestin's (2011) review of 20 articles, they note that the abolition of user fees has generally had positive effects on the utilisation of health services.

With regard to maternal health services, as would be expected, user fees have had negative effects on utilisation (Nanda, 2002). Utilisation of antenatal care (ANC) services in Zimbabwe and Tanzania declined with the introduction of user fees. In Ghana, with the introduction of the fee exemption policy on deliveries, the proportion of institutional deliveries increased in the Central and Volta region, and, encouragingly, the increase was higher for women facing the greatest financial barrier to health care and were at the greatest risk of maternal mortality (Penfold *et al.*, 2007). Asante *et al.* (2007) provide further evidence of equity improvements; fee exemption policy reduced the overall costs of delivery by 8% to 22%, depending on the type of delivery.

Although user fees do matter, there are other factors affecting institutional deliveries. Gabrysch and Campbell (2009) identify 20 determinants, based on a review of 80 articles. They group determinants into four broad themes: (1) socio-cultural factors, (2) perceived benefit/need of skilled attendance, (3) economic accessibility and (4) physical accessibility. The identified factors influence decision-making at the individual and household level; they also include measures affecting the ability to pay and the role of distance as access obstacles. They suggest that other factors, such as the quality of care, are not easily captured in household surveys, although they are reported as being essential in qualitative studies. Thus, there is a need to examine the effect of supply-side factors, which is done here.

In addition to the factors mentioned by Gabrysch and Campell (2009), the use of ANC services positively affects the utilisation of institutional deliveries and skilled attendance (Gage, 2007), as does previous delivery at a health facility (Bell *et al.*, 2003; Stephenson *et al.*, 2006). Essentially, experiences with the health system, especially positive ones, gained through ANC visits or previous deliveries can affect delivery. Similarly, ANC provides opportunities for health workers to recommend a place of delivery, based on pregnancy risk assessments, although women with lower risks may be encouraged to deliver without a skilled assistant. Moreover, ANC attendance breeds familiarity with the health system and health facility; thus, women who seek ANC are more likely to use the same facility for delivery. However, the positive relationship observed between seeking ANC and delivering at a health facility could result from other confounding factors, such as the availability and access to services (Breen and Ensor, 2011; Gabrysch and Campbell, 2009); the same has been suggested for previous deliveries (Gabrysch and Campbell, 2009; Stephenson *et al.*, 2006). For instance, the use of ANC or delivery services may indicate the presence of a nearby health facility offering delivery services. In many developing countries, it should be noted, ANC services are provided through outreach services, mobile clinics and small facilities, many of which do not offer delivery services. To address these problems, we include factors to proxy for the availability of health services.

As implied by the previous discussion, quality of care, which covers both the perceived quality and the medical quality of care, is an important factor influencing the choice to deliver at a health facility. Although this implication has been confirmed in Hadley's (2011) qualitative study, few quantitative studies manage to capture the quality of care. Therefore, including such factors, when available, as is the case here, is a necessary addition to the literature.

Finally, alternative delivery options should also be considered, as they are likely to impact on institutional delivery and skilled birth attendance. In the African context, the primary alternative is a traditional birth attendant (TBA), an alternative that may or may not be an appropriate substitute. TBAs may not provide satisfactory assistance, due to low levels of literacy, non-existent to poor training and limited obstetric skills, all of which negatively affect the delivery process, especially when there are complications (Garces *et al.*, 2012; Singh *et al.*, 2012). On the other hand, TBAs could be better than nothing, especially if they are properly trained. Although maternal mortality rose after TBAs were banned in Malawi, they then fell, once TBAs were trained and reinstated (Ana, 2011). There is further evidence that trained TBAs reduce neonatal mortality (Gill *et al.*, 2012), and are a feasible and affordable option in countries with limited medical skills capital; however, they need an appropriate support network to work effectively (Stekelenburg *et al.*, 2004).

The evaluation of user fee abolition and institutional deliveries in Zambia, discussed below, highlights the importance of the aforementioned supply-side factors, such as quality of care, and demand-side factors, such as user fees and alternatives, in influencing the demand for institutional deliveries. A natural experiment in Zambia underpins the identification strategy in the empirical analysis, although additional practical realities must also be considered. The policy change in Zambia, a country consisting of 72 districts in 9 provinces, was implemented under different conditions. For instance, drugs and financing that were to be provided to some districts were not provided successfully (Carraso *et al.*, 2010), which could have compromised the quality of care in those districts, leading to an exodus of unsatisfied clients into other districts or provinces. Thus, policy implementation potentially plays an important role in the analysis, as there could be provincial or district interdependencies in the outcomes. Therefore, the experimental setting analysed is further complemented with tests for cross-sectional dependence, following Pesaran's (2004) CD test, as well as Breush and Pagan's (1980) Lagrange Multiplier (LM) test, and corrections for the identified dependencies. These tests and corrections address a major critique of panel data analysis; cross-sections are unlikely to be independent. Furthermore, quality of care, one of the important supply-side factors, is likely to differ by province and/or district, influencing effect size in these regions. Zellner's (1962) seemingly unrelated regression (SUR), which controls for spatial dependence, is used to estimate the potentially different effect sizes across regions.

4.3 The Data

4.3.1 Data source

The chapter uses routine quarterly data, collected within the Health Management and Information System (HMIS) administered by the Ministry of Health (MoH) in Zambia. The data include quarterly information on the supply and use of a wide range of health services at all public health facilities nationwide, but it is aggregated to the district level. Data from all 54 rural districts, in which user fees were abolished in April 2006, were available; complete data was only available for 46 of the districts.[6] From the district level data, it was possible to compile regional data for the 9 provinces from 2003q1 to 2008q4 (that is T=24 and N=9). Based on the available data and the previously discussed literature, we selected and included six quarterly time series: the proportion of institutional deliveries (ID); average health centre client contacts per day (CC), which measures the staff workload (defined as the total number of patient visits divided by the total number of staff per day); traditional birth attendants per 1000 of the population (TBAs); the proportion of drugs available, based on the percentage of stock-outs of drugs on the essential drug list (DA); the average number of antenatal visits per quarter (ANC); and the population in the province (POP). CC and DA capture the quality of services, while cultural preferences and alternative options are captured by TBAs. The variables used are presented in Table 4.1 and a

[6] Appendix C1 shows all the districts that abolished user fees in April 2006. Data from the following districts was discarded: Chibombo, Kapiri Mposhi, Serenje, Chienge, Chavuma, Lukulu, Siavonga and Milenge. In these districts, there were multiple missing months of information.

graphical description is presented in Appendix C2, a more thorough statistical discussion follows.

Table 4.1: Description of the variables

Variable	Description	N	T
ID	Proportion of institutional deliveries	9	24
ANC	Average antenatal Visits	9	24
CC	Average health centre client contact	9	24
TBAs	Number of traditional birth attendants per 1000 of the population	9	24
DA	Proportion of drugs available	9	24
POP	Population in province (transformed to logs)	9	24

4.3.2 Preliminary analysis

In Panel I of Table 4.2 we compare the means of the selected variables in the period prior to the abolition of user fees (2003q1-2006q1) to the means in the post-abolition period (2006q2-2008q4). A test of mean differences before and after the policy change finds statistically significant difference for antenatal visits, drug availability and health centre client contact, although these estimates do not control for any trends, prior to the abolition of user fees. Moreover, the standard errors do not account for any within-group correlation. Differences in means for institutional deliveries at the provincial level are presented in Appendix C3. Panel II of Table 4.2 shows the correlation between the variables in the system. Institutional deliveries are statistically significantly correlated with the first lag, suggesting persistence and justifying the dynamic specification in the analysis. It is also evident that many of the previously described relationships from the literature hold in this data, at least at the level of correlations. ID is positively correlated with ANC, but negatively correlated with DA and TBAs. However, correlation is not a result that can stand on its own.

Table 4.2: Data summary

		ID	ANC	DA	CC	TBAs	POP$
Panel I: Means and standard errors							
All	Mean	0.355	2.935	0.722	25.728	0.241	11.617
(n=216)	Se	(0.006)	(0.022)	(0.007)	(0.497)	(0.004)	(0.016)
Before	Mean	0.347	3.112	0.745	24.310	0.248	11.570
(n=117)	Se	(0.008)	(0.025)	(0.010)	(0.632)	(0.005)	(0.022)
After	Mean	0.364	2.714	0.696	27.061	0.233	11.672
(n=99)	Se	(0.008)	(0.025)	(0.011)	(0.767)	(0.006)	(0.024)
Diff+	Mean	0.016	-0.386*	-0.049*	3.098*	-0.015*	0.102
	Se	(0.012)	(0.035)	(0.014)	(0.972)	(0.008)	(0.032)
Panel II: Correlation Matrix							
	ID	1					
	ANC	0.219*	1				
	DA	-0.121*	0.095	1			
	CO	-0.032	-0.208*	-0.387*	1		
	TBAs	-0.139*	0.184*	0.503*	-0.217*	1	
	POP	-0.378*	-0.378*	-0.149*	0.442*	-0.397*	
	ID_1	0.830*	0.219*	-0.170*	0.013*	-0.388*	1

Notes: Panel I shows the cross regional means and standard errors of the seven variables. Standard errors are reported in parentheses. Panel II shows the cross regional average correlations among all the variables. * denotes significance at 5% level. + Diff gives the difference between before and after (After-before). $ Population has been transformed to log values.

4.4 Empirical Methodology

4.4.1 Properties of the data

4.4.1.1 Panel unit root tests

Before beginning, we examine the appropriate methodology to be applied. In order to detect and avoid problems of spurious regressions, we ascertain the time series properties of the data. Several statistics may be used to test for unit roots in panel data, however, since this panel data set is not too long, we implement the Im, Pesaran and Shin (IPS) (2003), which combines the information from the time-series and cross-section dimensions, such that fewer observations are needed for the test to have power. In contrast to the Levin, Lin and Chu (2002) test, the IPS (2003) t-bar test is based on the mean augmented Dickey-Fuller (ADF) test statistics, and is calculated independently for each cross-section of the panel. Based on Monte Carlo simulation results, IPS (2003) show that their test has more favourable finite sample properties than the Levine, Lin and Chu test. For a variable y_{it}, the p^{th} order Augmented Dickey Fuller (ADF) regression is given by

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i t + \sum_{j=1}^{p} d_{ij} \Delta y_{i,t-j} + u_{it} \tag{4.1}$$

where a_i and b_i are panel-specific intercepts and slopes, respectively, t is the time trend and u_{it} are assumed to be normally distributed stochastic terms for cross-section i, although variances are allowed to be heterogenous across panels. Whether or not the lagged dependent variable matters, statistically, underpins the empirical test; the null assumes not, while the alternative allows for correlation within at least one cross-section. In other words, the null

$$H_0 : b_i = 0, i = 1,..., N, \tag{4.2}$$

is tested against that alternative

$$H_1 : b_i < 0, i = 1,..., N_1; b_i = 0, i = N_1 + 1,..., N, \tag{4.3}$$

N_1 is such that N_1/N tends towards a nonzero fixed constant as N goes to infinity. To test the null hypothesis against the alternative, IPS (2003) propose computing the simple average of the t-ratios of the ordinary least squares estimates of b_i in equation (4.1), i.e.

$$IPS = \frac{1}{N} \sum_{i=1}^{N} \tilde{t}_i, \tag{4.4}$$

where $\tilde{t}_i$, is the ordinary least squares t-ratio of b_i in the ADF regression in (4.1). If the errors in the different regressions contain a common time-specific component, IPS (2003) proposes a cross-sectionally demeaned version of the test. As a robustness check, we also calculate the panel unit root tests by Breitung (2000), which is a modification of the Augmented Dickey Fuller statistics that has more power than the IPS (2003) if individual specific trends are included (Baltagi, 2008).

Table 4.3 presents the results from these two panel unit root tests. Columns (I) and (II) report Breitung (2000) and IPS (2003) test statistics, with and without the trend, respectively. Both tests reject the null of a panel unit root for all the variables, except antenatal visits without a trend. Given cross-section dependence, detected by the tests reported in Table 4.4, we further consider the sensitivity of the panel unit root test results. Specifically, the Breitung (2000) and IPS (2003) tests augmented with the cross section averages, taking into account cross-sectional dependence, are also examined. The modified Breitung (2000) and IPS (2003) tests address cross-section dependence through demeaning, subtracting cross-section averages from the series (Levin, Lin and Chu, 2002). It has been shown that ignoring cross-section dependence may cause substantial size distortions (Baltagi, 2008). The results obtained from the sensitivity tests are not reported, as they are similar to those presented in Table 4.3. Therefore, we conclude that all the variables are trend stationary.[7]

Table 4.3: Breitung and Im Pesaran and Shin (IPS) unit root test statistics

	(II)Breitung t-stat		(III)IPS Wtbar	
	Without trend	With trend	Without trend	With trend
ID	-2.778*	-3.414*	-3.320*	-3.774*
ANC	0.035	-3.535*	-1.547	-3.777*
CC	-4.204*	-4.212*	-3.090*	-4.380*
TBAs	-2.890*	0.228	-2.367*	-2.882*
DA	-2.896*	-1.621*	-2.761*	-3.341*
POP	1.567	-2.672*	-0.607	-4.812*
ID_1	-2.685*	-1.878*	-3.237*	-3.690*

Notes: * indicates that the test is significant at the 5% level.

4.4.1.2 Cross-section dependence test

As mentioned earlier, another problem that might arise in a panel context is the existence of cross-section dependence. In this case, cross-section dependence may be caused by spill over effects across boundaries of districts, due to the abolition of user fees. In fact, institutional deliveries in one region can be affected by not only a local change in fees charged (due to the abolition of user in the region), but also by similar changes occurring in other regions. In the presence of cross-sectional dependence of the error term, methods that assume cross-sectional independence would result in estimators that are inefficient, causing misleading inference. At a descriptive level, a statistic that captures cross-section dependence is the average pair-wise correlation coefficient:

$$\bar{\rho} = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \rho_{ij,} \tag{4.5}$$

where ρ_{ij} is given by

$$\rho_{ij} = \frac{\sum_{t=1}^{T} \mu_{it}\mu_{jt}}{(\sum_{t=1}^{T} \mu_{it}^2)^{1/2}(\sum_{t=1}^{T} \mu_{jt}^2)^{1/2}} \tag{4.6}$$

and μ_{it} are the residuals from equation (4.1), the ADF regression.

Given the potential for problems that might arise from cross-section dependence, we consider a diagnostic test, based on the above pair-wise correlation coefficients, Pesaran's (2004) CD test. Pesaran (2004) addresses shortcomings in Breush and Pagan's LM test, when N is large, and it is based on pair-wise correlations, rather than the square pairwise correlations used in the

[7] We also computed the Levin Lin and Chu (2002) and the results obtained were similar to those obtained using the IPS (2003) panel unit root tests.

LM test. The test is robust to non-stationarity, parameter heterogeneity and performs well, even in small samples (Pesaran, 2004)

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \tag{4.7}$$

Table 4.4 reports the average pair-wise correlation coefficient, and the Pesaran (2004) CD test statistic for all the variables, measured in levels. The results indicate the presence of cross-section correlation between the provinces for all the variables. Therefore, the analysis will make provision for this sort of correlation, when evaluating the impact of the policy change on institutional deliveries. Failure to do so may lead to misleading inference, especially if the source of the cross-section dependence is correlated with the regressors (Baltagi, 2008).

Table 4.4: Cross section dependence of all variables

Variable	$\bar{\rho}$	CD test
ID	0.331	9.72*
ANC	0.731	21.49*
CC	0.382	11.24*
TBAs	0.156	4.58*
DA	0.229	6.74*
POP	0.998	29.32*
ID_1	0.367	10.56*

Note: $\bar{\rho}$ and Pesaran (2004) CD test are computed as in (4.6) and (4.7) respectively.
* indicates that the coefficient is significant at 5% level.

4.4.2 Interrupted time series

Although randomised experiments are seen as a gold standard for evaluating health care interventions, they are difficult to implement (Ranson *et al.*, 2006). An alternative approach for the evaluation of policies, and recognised by the Effective Practice and Organisation of Care Group (EPOC) of the Cochrane Collaboration (Cochrane Effective Practice and Organisation of Care Review Group, 2002), is the interrupted time series (ITS) design (Cook and Campbell, 1979). In an ITS design, data are collected at multiple periods over time, but these periods must span both before and after the intervention or interruption is introduced. These data can be used to detect the intervention effect, parsing it from the underlying secular trend (Ramsay *et al.*, 2003). ITS designs allow researchers, particularly in developing countries, to analyse the impact of interventions using routine data; oftentimes, opportunities to conduct a pre-intervention or baseline survey were not available (Lagarde, 2011). Routine data on health information, however, is often available, even several years before the intervention. Although an ITS design is superficially simple to implement, it is a powerful quasi-experimental approach for evaluating interventions. In contrast to comparing simple averages before and after intervention, ITS designs allow for the statistical investigation of potential biases in the estimation of the effect of an intervention. Potential sources of bias, which can be addressed in the ITS framework include: the existence of secular trends or non-stationarity, cyclical or seasonal patterns in the outcome variable and autocorrelation (Cook and Campbell, 1979).

However, there are several threats to the internal validity of ITS results. The lack of a randomised control group within the ITS design, for example, threatens the validity of the study. Another major threat is the (near) simultaneous occurrence of an event in addition to the intervention event to be studied (Ramsay *et al.*, 2003). In this analysis, there does appear to be such an additional event. Although drug shortages occurred around the same time as the abolition of user fees, the shortages are incorporated in the analysis. Other threats are common to most empirical studies, especially not having enough data to identify the impact. If the time series of observations is too short, it becomes difficult to detect secular trends (Crosbie, 1995). As a rule of thumb, detecting a policy impact with 80% power, when the autocorrelation parameter is 0.4, requires 10 pre- and post-intervention data points (*ibid.*). In this chapter, the ITS design is analysed using segmented panel data regression. Segmented regression analysis of ITS data allows for the statistical assessment of the intervention effect, both immediately and over time. The analysis also incorporates factors, other than the intervention, which could explain the observed effect.

4.4.3 Model specification

As noted above, data is available for nine provinces (N=9), covering the period between 2003q1 and 2008q4 (T=24), while the analysis is founded upon panel time series modelling, since the time dimension is dominant (Baltagi, 2008). Due to the strong persistence observed in institutional deliveries, we specify a dynamic panel model, including one lag of the dependent variable, to assess the impact of the abolition of user fees on institutional deliveries.

$$ID_{it} = a_i + bTime_t + cPostslope_{it} + \beta Intervention_{it} + \delta' x_{it} + dID_{i(t-1)} + \varepsilon_{it} \tag{4.8}$$

where ID_{it} is the vector of institutional deliveries in the $N = 9$ provinces; x_{it} is a vector of explanatory variables and includes time dummies (t1, t2 and t3) to account for the cyclicality observed in the institutional deliveries, a_i is the regional fixed effect; $Time_t$ is a vector of continuous values indicating time from the start to the end of the study period ; $Intervention_{it}$ is a vector of indicators coded 0 for the pre-invention period and 1 for the post-intervention period; $Postslope_{it}$ is a vector of indicators coded 0 up to the last point before the intervention and coded sequentially from 1, thereafter; and ε_{it} is a vector of disturbances.

Statistical inference from the model in (4.8), however, might be influenced by spatial correlation or cross-sectional dependence, driven by regional proximity, heteroscedasticty and/or serial correlation (due to the upward trend in institutional deliveries). Therefore, the analysis must consider these issues. Pooled Ordinary Least Squares (POLS) serves as the baseline model; however, Fixed Effects (FE) and Feasible Generalised Least Squares (FGLS) are also considered. In contrast to the POLS estimator, which assumes homogeneity in intercepts and slopes, the FE and FGLS estimators relax this assumption, albeit in different ways. Specifically, FE control for time-invariant omitted variables that differ by province, such as the level of development, health infrastructure and health staff, and, thus, allows for intercept heterogeneity; an F-test (Pr>F=0.000) supports the existence of regional fixed effects. The FE method differences out the individual variability across regions, based on the idea that within-variation eliminates much of the error variance. Thus, the FE estimator results in a pooled OLS estimator on the differenced (demeaned) equation and yields unbiased estimates under the assumption of strict exogeniety. In the dynamic specification, the FE estimator with Driscoll and Kraay (1998) standard errors, which are robust to moderate levels of cross-sectional dependence in the error term, are implemented.[8] However, this adjustment does not correct for the Nickel bias. The inclusion of lags of the dependent variable in the FE regression yields biased estimates, when T is small, although the bias approaches zero as T approaches infinity (Nickel, 1981). Judson and Owen (1999) find a 20% bias, when T=30, although their coefficients were correctly signed. Although Kiviet (1995) suggests a bias-correction procedure suitable for small T and moderate N (10<N<20), results from the implementation of that procedure are not discussed here.[9]
While the FE estimator assumes random intercepts and homogenous slopes, it also disregards between-variation, which can yield biased standard errors and consequently incorrect inference. Differently from the FE estimator, the Feasible Generalised Least Squares (FGLS) treats parameters as random and does not impose any restriction on the error structure, allowing for

[8] Cross-section dependence is often managed through the inclusion of year dummies. In our case, inclusion of time dummies in the FE model – controlling for either cross-sectional dependence or global shocks affecting all provinces simultaneously – may create multicollinearity, due to the presence of indicator and time variables used to capture the policy impact.
[9] We implemented the Kiviet (1995) correction for FE small sample bias, but the results obtained were similar to those obtained without the correction

autocorrelation within panels, cross-section correlation and heteroscedasticity across the units (Kmenta, 1986). Specifically, the specification takes the form

$$ID_{it} = a_i + bTime_t + cPostslope_{it} + \beta_i Intervention_{it} + \delta' x_{it} + dID_{i(t-1)} + \varepsilon_{it} \tag{4.9}$$

In FGLS, the regression disturbances comprise three dimensions. The three separate components are associated with 1) time, 2) space and 3) with both time and space (Podesta, 2002). Furthermore, to link the differences in the policy change within regions to characteristics that vary across regions; we adopt Zellner's (1962) seemingly unrelated regression (SUR). The SUR is a system of individual regressions in which cross equation errors are allowed to be correlated and takes account of cross-section or spill-over effects among the regions. Therefore, FGLS can be interpreted as pooled SUR in which estimates represent the average values of the regional coefficients since they vary across regions. By stacking the observations in the t-dimension, the model has the following SUR representation

$$ID_t = a_t + bTime_t + cPostslope_t + \beta Intervention_t + \delta' x_t + dID_{(t-1)} + \varepsilon_t$$
$$t = 1,\ldots T \tag{4.10}$$

where ε_t is a vector of contemporaneous disturbances, and the rest of the variables have been described, above. With this specification, we allow for heteroscedasticity and correlation across separate equations for each year. The SUR model is best suited for estimation with cross-section dependence, since it captures the correlation in the error terms across cross-sections, especially when $T > N$ (Baltagi, 2008). It also allows for detailed region-specific analysis.

4.5 Estimation Results and Discussion

Analysis results are presented, first at the aggregate level, using the models discussed above, and then at the disaggregated level.

4.5.1 Impact of the policy change at the aggregate level

Results of the static and dynamic representations for the three estimators are presented in Table 4.5. Panel I contains results from a simple model with only ITS controls, and, therefore allows for POLS, FE and FGLS. Panel II, on the other hand, includes additional controls, but focuses on the static representation; therefore, results in panel II also include POLS, FE and FGLS. Finally, panel III contains results from the dynamic model, which includes one lag of the dependent variable; thus, only FE and FGLS results are potentially meaningful.

Table 4.5: Estimation results: POLS, FE and FGLS estimates of the impact of the abolition of user fees on institutional deliveries

	(I)Indicators only			(II)Static			(III)Dynamic	
ID	POLS	FE	FGLS	POLS	FE	FGLS	FE	FGLS
Inter	-0.014	-0.014	0.001	-0.004	-0.006	-0.003	0.009	0.012**
Postslope	0.005	0.005**	0.006**	0.004***	0.005***	0.005**	0.004**	0.001
Time	-0.001	-0.001	-0.001	0.002**	-0.008	0.002**	-0.007***	-0.000
t1	-0.020	-0.020**	-0.020***	-0.009	-0.039	-0.013***	-0.015*	0.010**
t2	-0.014	-0.014**	-0.014***	-0.010	-0.029	-0.011***	0.001	0.030***
t3	0.035*	0.035***	0.035***	0.029***	0.019	0.032***	0.047***	0.072***
ANC				0.050***	0.048***	0.038***	0.015	0.013
DA				0.156***	0.182***	0.067**	0.143***	0.039**
CC				-0.002	-0.002	0.000	-0.002**	0.000
TBAs				-0.096	-0.077	-0.048*	-0.003	-0.035*
POP				-0.048	1.149	-0.152***	0.797***	-0.022*
ID_1							0.470***	0.848***
Constant	0.354***	0.354***	0.342***	0.711	-13.062	1.940***	-9.088***	0.224
F-test (Pr>F)	0.017	0.000		0.000			0.000	
Wald test (Pr>Chi2)			0.000			0.000		0.000

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Because the assumptions associated with each set of models in each of the panels differ, it is necessary to whittle down the results to the one result or set of results that is most plausible. Within I, where all of the explanatory variables are based on the ITS design, the assumptions are: (i) there is no persistence in the dependent variable and (ii) no other variables influence institutional deliveries, other than the policy. Within II, assumption (ii) is relaxed, and, within III, both (i) and (ii) are relaxed. Persistence in the dependent variable leads to a preference for results in III, rather than results in either I or II. Additionally, recall that POLS is underpinned by homogeneity of all effects across regions and time, and, therefore, is not valid in a dynamic setting, while FE allows for time-invariant regional differentiation and FGLS allows for unspecified correlation in the errors. In this setting, both autocorrelation – (Pr>F=0.0045) based on a test outlined in Wooldridge (2001) and heteroscedasticity – (Pr>Chi2=0.000) following the modified Wald test outlined in Greene (2003) – are present in the data. Therefore, the FGLS specification is generally preferred. In other words, the results in the last column represent the preferred results.

Therefore, based on the FGLS estimates, we conclude that there was an immediate 1.2% increase, or 3.4% per quarter increase, following the policy change.[10] Despite that, no statistically significant quarter-to-quarter increase in the trend in institutional deliveries could be identified,

[10] We obtain the 3.4% increase in facility-based deliveries by dividing the percentage point change by the pre-intervention mean (1.2/0.349/=3.4%).

which means that institutional deliveries did not continue to rise after the immediate increase. However, the lagged dependant variable is positive and statistically significant, suggesting that previous deliveries in the facility affect current institutional deliveries, a result that is consistent with previous literature (Bell *et al.*, 2003; Nwakoby, 1994). Akin to previous literature, the coefficient on drug availability (DA), which proxies for the quality of services is positively associated with institutional deliveries, whilst the presence of TBAs is negatively associated with institutional deliveries (Gabrysch and Campbell, 2009) ANC visits, however, are not significantly associated with institutional deliveries and the result differs from previous analyses finding that ANC uptake is highly predictive of institutional delivery (Gage, 2007). Provincial-level population growth has a negative and statistically significant impact on institutional deliveries, which is expected, since population growth can strain the provision of health services, especially if the supply of healthcare inputs remains fixed.

4.5.2 Provincial-level analysis of the impact of the policy change

Although the preceding results imply that the elimination of user fees for delivery services increased the use of institutional delivery services, at least at the national level, that analysis could mask impact heterogeneity at the provincial level. We now turn to this consideration, through the estimation of a SUR model. The results of the analysis are presented in Table 6. Panel I contains region-specific regression results. In addition to the SUR estimates, we also report Breusch and Pagan's (1980) LM test of spatial independence. If rejected, the SUR estimator improves the efficiency of the region-specific estimates, through the incorporation of cross-equation residual correlation. Panel II, in Table 4.6, describes the degree of correlation between those residuals.

As might be expected in any country, more so in a developing country, policy impacts are not estimated to be the same across all regions. The results in Panel I suggest that the abolition of user fees led to a statistically significant and immediate negative reduction in institutional deliveries in two provinces. In the Copperbelt and Western provinces, that reduction was 8.3 percentage points (17% with reference to the baseline) and 4.7 percentage points (13% with reference to the baseline) per quarter respectively. However, post-intervention, there was a trend increase in institutional deliveries, quarter-on-quarter, in four of the nine provinces (ranging from 1.9% in Luapula to 6.8% in Lusaka), although Central province experienced a relatively small, but statistically significant, decrease in institutional deliveries (0.7 percentage point (2.3%) overtime. In addition to the previously uncovered differences across regions, cross-sectional independence is rejected (Pr=0.0249).

Table 4.6: Seemingly Unrelated Regression Estimates: Provincial level

	Central	Copperbelt	Eastern	Luapula	Lusaka	Northern	N/Western	Southern	Western
Panel I: Provincial estimates of the impact of the abolition of user fees on institutional deliveries									
Inter	0.044	-0.083***	-0.004	0.003	-0.031	-0.017	-0.003	0.018	-0.047**
Postslope	-0.007**	0.012***	0.004	0.006***	0.020***	0.001	0.006	-0.001	0.019***
Time	-0.000	-0.011***	0.005**	-0.001	0.000	0.002	0.002	-0.002	-0.003
t1	0.016	-0.072***	-0.011	-0.004	0.036**	-0.001	-0.013	0.001	-0.010
t2	0.016	-0.073***	0.015	0.014	0.041**	0.011	-0.008	0.006	0.010
t3	0.065***	0.008	0.065***	0.033***	0.021	0.028***	0.054**	0.028***	0.054***
ANC	-0.043	-0.063***	0.052	0.006	0.032	0.021	0.055	-0.100**	0.052*
DA	0.067	-0.248***	0.175**	0.217***	0.116	-0.005	0.129	0.185***	0.474***
CC	-0.001	-0.001	-0.003***	-0.006***	-0.006**	0.000	-0.004*	-0.006***	0.004*
TBAs	-0.100	-0.153***	0.264***	0.171***	0.352***	0.032	0.032	0.045	0.159
Lpop	0.024	0.115***	-0.019	0.012*	-0.023	0.016	0.026	0.041***	-0.020***
ID_1	0.500***	-0.341***	0.474***	0.391**	0.707***	-0.061	0.059	0.214	-0.096
Breush_Pagan test of independence: chi2(36) = 54.464, Pr = 0.0249									
Panel II: Correlation Matrix of residuals									
Central	1								
Copperbelt	0.431	1							
Eastern	-0.0862	0.0727	1						
Luapula	0.1857	0.4216	0.0954	1					
Lusaka	0.0786	-0.2938	0.3061	-0.2045	1				
Northern	0.0156	0.4126	-0.1628	0.1367	-0.2732	1			
N/Western	-0.2096	0.3159	0.1979	0.3097	0.0121	-0.1191	1		
Southern	0.2738	0.4985	-0.0193	0.2414	-0.2064	0.3901	0.041	1	
Western	0.1398	0.3188	-0.4521	-0.2136	0.2000	0.3318	-0.1129	0.1505	1

*** p<0.01, ** p<0.05, * p<0.1. Panel I shows the SUR estimates for each province. Panel II shows the cross-provincial correlation matrix

Although the reduction in institutional deliveries is unexpected, one can speculate that the reduction in user fees could possibly have increased the utilisation of other health services, which, in turn, had a negative effect on institutional deliveries. For instance, the Copperbelt province is a relatively urban province, and a hub for health care professionals; therefore, individuals from the surrounding regions often travel to the province to seek care. In fact, provincial level correlations between the residuals, described in the correlation matrix presented in Panel II, indicate a relatively high degree of correlation between the Copperbelt and other regions. Although it might also have been expected that provinces close to each other would exhibit relatively larger degrees of dependence, which is not entirely true in the analysis. For instance, about 5 provinces, namely, Luapula, Northern, North-western, Southern and Western provinces have a relatively high positive correlation with the Copperbelt province, but not necessarily with regions that are close to them (see map of Zambia in Appendix C4). Potentially, there is spatial autocorrelation, which needs to be addressed further, using spatial techniques taking into account the distance between regions.

Since user fees are not the only factors determining facility delivery, and, therefore, the relative importance of fees relative to other barriers (such as quality of care) is likely to vary from province to province, these results are not unexpected. Furthermore, some provinces may have greater capacity to deal with an increase in utilisation, and, thus, maintain the quality of care provided. In support of the previous hypothesis, there is evidence that the drugs and financing that were meant to be provided, ostensibly to help health centres deal with the hoped-for influx in deliveries, were not successfully delivered to all districts and facilities (Carraso *et al.*, 2010; Cheelo *et al.*, 2010).

4.5.3 User fees and traditional birth attendants

User fees were removed to increase access to health services and improve health outcomes particularly for the poor in rural communities. The abolition of user fees reduces the financial cost of treatment, and is expected to increase utilisation rates. Studies in Zambia and other developing countries have uncovered increases in the use of health services by some population groups, after the removal of user fees (Lagarde *et al.*, 2012; Masiye *et al.*, 2008; Nabyonga *et al.*, 2005; Wilkinson *et al.*, 2001), and our results at the national level are consistent with those in literature. Moreover, the findings highlight the importance of quality of services in encouraging institutional deliveries at the national level, but there are important variations at the regional level.

The national level findings suggest that TBAs statistically significantly reduce institutional deliveries. At the regional level, a similar result is found for the Copperbelt province, while in regions, such as the Eastern, Luapula and Lusaka provinces, the association is positive. The positive association suggests that harnessing the potential of TBAs, possibly providing the right environment for them to operate could lead to an increase in TBAs trained to carry-out deliveries and capable of referring more complicated cases to higher levels of care. Within Zambia, the involvement of trained TBAs in the delivery process remains an important strategy, particularly in rural areas, where health worker scarcity is a problem (Stekelenburg *et al.*, 2004). Furthermore, trained TBAs can reduce perinatal deaths, neonatal deaths and stillbirths (Ana, 2011; Gill *et al.*, 2012), although others argue that TBAs offer poor obstetric services (Garces *et al.* 2012, Singh *et al.*, 2012). Between 1970 and 1990, the World Health Organisation promoted TBA training, as one strategy to reduce maternal and neonatal mortality; however, there is insufficient evidence to establish the potential for TBA training to improve peri-neonatal mortality (Sibley *et al.*, 2012). Given that a larger share of women in Zambia were assisted by

TBAs in 2007 (23.5%) compared to 2001/2 (11.7%) (Central Statistical Office, 2009), the role of TBAs cannot be ignored. Similarly, the scarcity of health personnel in low-income countries, especially personnel focussed on women's health, means that non-institutional deliveries will continue to play a significant role in health service provision (Limwattananon *et al.*, 2011). Thus, reducing maternal mortality may require the implementation of interventions, which are country-specific and include TBAs, due to differences in the local contexts.

Additionally, although user fees were not a significant source of revenue to the health facilities, they were a flexible form of income used by health facilities in rural areas to support TBAs. For example, user fees were often redistributed to TBAs, in the form of tokens of appreciation, to encourage women to deliver at health facilities (Cheelo *et al.*, 2010). Fees were also used to purchase cleaning agents (bleach) and food for inpatients (ibid). However, with the abolition of user fees, TBA support has been significantly reduced; thus, the incentive for TBAs to encourage woman to deliver at health institutions has also reduced. Moreover, following the abolition of fees in Ghana, Benin and Zambia, women are reportedly required to bring bleach, gloves and syringes with them, when delivering at a health facility (Borghi *et al.*, 2003; Carrasso *et al.*, 2010). Additional requirements, such as these, act as a barrier to the utilisation of delivery services, and may even exceed the levels of the abolished user fees. Such barriers are problematic. In comparison, TBA delivery costs are reportedly affordable, especially for the poor, because the payments are negotiable, both in amount and timing, while in-kind payments are also accepted (Amooti-Kaguna, 2000).

4.6 Conclusion

This research investigates the impact of user fee abolition on institutional deliveries using a panel of 9 Zambian provinces covering the period 2003q1 to 2008q4. Different models are estimated to address heterogeneity, autocorrelation, heteroscedasticity and cross-section dependence within a panel data context. After the econometric issues were addressed, the aggregate results provide strong evidence that the abolition of user fees had an immediate positive impact on institutional deliveries. However, the increase was not sustained via an increase in the trend, and the increase was economically small, 1.2% or 3.4%, depending on how the increase is measured. The aforementioned aggregate increase could not be ascribed to an increase in any particular region. Instead, immediate decreases were uncovered in some regions, while trend increases were uncovered in other regions. In other words, the aggregate results mask interesting regional heterogeneity. From a policy perspective, that heterogeneity is likely to be important; local motivations for non-institutional delivery might be social or cultural, factors not easily altered through reductions in the direct cost of delivery. Similarly, although it was not possible to consider indirect charges, as data was not available, anecdotal evidence suggests that facilities have followed a cost-shifting strategy, and that strategy could account for the economically small user fee impacts estimated here.

In addition to user fee effects, the analysis also identified a TBA impact and a quality of service impact. At the aggregate level that TBAs are associated with a reduction in institutional deliveries; however, at the regional level, the impact was more varied. In some provinces, the association was positive, while in others it was negative. With respect to service quality, a strong positive impact was uncovered at the national level, a result that carried over to a number of provinces. Again, the aggregate results masked interesting regional heterogeneity.

Although the conclusions are reasonably general, there are some limitations worthy of further analysis. For example, the routine data used in the analysis could either be too sporadic or too frequent. Quarterly data provides less data than monthly data, and might hide trends in utilisation; however, both quarterly data and monthly data might also be too noisy for the identification of trends. Another concern is that routine data neither provides information about non-users nor provides socio-economic and related characteristics of users. Specific information about users and non-users is potentially useful in exploring response heterogeneity; user fee abolition may have affected poor women differently than non-poor women. Unfortunately, the observed increase could reflect better recording, rather than actual increases in institutional deliveries. Additionally, the routine data only covered public health facilities in Zambia. Thus, the observed changes in utilisation might not be a reflection of all health facilities in the country, since most private health facilities are not, yet, incorporated into the HMIS.

Future research, which is likely to complement this research, should seek to link individual-level data, from household surveys, to facility-level data. Such a link between the supply and demand sides of the market could underpin an analysis of the impact of the policy change on maternal health-seeking behaviour. Recent Demographic and Health Survey data include geographic positioning system (GPS) information, which can be used to tie sample clusters to routine data. Data tied together in this fashion could be used for the analysis of mother's health or child health, relating user fee abolition policies to maternal health outcomes and, subsequently, to child health outcomes. Finally, future research could consider modelling other types of spatial correlation which gives more importance to the distance between regions.

CHAPTER 5

5 Evaluating the impact of the removal of user fees on facility based deliveries in rural Zambia: a difference- in- differences approach

5.1 Introduction

For most developing countries, attaining the Millennium Development Goal (MDG) 5 – to improve maternal health – is still a major challenge (United Nations, 2011). In the sub-Saharan Africa region, where almost 50% of the approximately 350,000 maternal deaths occur annually, the average maternal mortality rate (MMR) is 680 per 100,000 live births (Hogan *et al.*, 2010; World Health Organisation, 2010). To reduce the MMR by 75% by 2015 (MDG5A), encouraging deliveries in a health facility and skilled birth assistance are crucial (World Health Organisation, 2010; Campbell *et al.*, 2006). They are key factors in reducing deaths arising from complications in pregnancy. In fact, the World Health Organisation (1999) identifies skilled birth assistance, which is mostly available at health facilities, as the key factor in preventing maternal deaths. Although skilled assistance at birth and facility-based deliveries are important, Montagu *et al.* (2011) find that, at most, 40% of women in developing countries deliver in a health facility, while approximately 70% of poor women in developing countries deliver at home.

Possibly, low usage rates are driven by demand-side and supply-side barriers deterring women from accessing these services (Fournier *et al.*, 2009; Ronsman *et al.*, 2003; Amooti-Kaguna and Nuwaha, 2000; Wagle *et al.*, 2004; Gage and Calixte, 2006; Gage, 2007). However, supply-side or health system factors, such as the quality of services, which influence the utilisation of maternal health services, are often not captured in household surveys (Gabrysch and Campbell, 2009). Notably, and of particular interest to this study, financial barriers such as user fees, may discourage use of maternal health services, and could increase the use of informal care (Nanda, 2002; Stekelenburg *et al.*, 2004; Borghi *et al.*, 2003; Gage, 2007). Substantial delivery costs can represent a considerable proportion of a household's income, possibly leading to impoverishment. In addition, the uncertainty surrounding birth outcomes leads to uncertainty in the cost of delivery, making it difficult for advanced planning, such as saving for the big day, particularly for poor households. In economic terms, large and uncertain costs often have different effects across the income distribution, and, therefore, it is not surprising to observe pronounced disparities. There are more variations observed between the rich and poor in the use of delivery services than in other health services, and the gaps are more pronounced in the utilisation of antenatal care (ANC) services (Gwatkin *et al.,* 2004). Given these disparities, as well as the importance of the provision of delivery services and ANC in the reduction of maternal and neonatal mortality, reducing these gaps, by increasing the use of maternal health services amongst the poor and generally increasing the use of maternal health care, is an important policy goal.

In an effort to increase accessibility to health services, most countries in sub-Saharan Africa abolished or reduced user fees for health services, including delivery services (Wilkinson *et al.,* 2001; Nabyonga *et al.,* 2005; Masiye *et al.,* 2008; De Allegri *et al.*, 2011), or exempted certain groups from the payment requirements (Witter *et al.*, 2007; Penfold *et al.*, 2007). User fees for health services were initially introduced in the late 1980s, with the aim of financing health care. Advocates of the fees argue that they enhance the efficient allocation of goods and services, because user fees target the population in need of the good or service, i.e., low valuation consumers are screened (Oster, 1995). Also, higher prices are often perceived to reflect better quality (Bagwell and Riordan, 1991), and, therefore, could improve the conveyance of information in the market. However, user fees did affect equity and access (Creese, 1991; Russell and Gilson, 1997; Yates, 2009).

While efforts to improve access to health services are laudable, whether these national reforms influenced the uptake of maternity services, such as facility-based deliveries and skilled assistance at birth is an open question. One systematic review, in particular, has highlighted the scarcity of robust evidence of the effects of user fee removal on the utilisation of maternal health services (Dzakpasu *et al.*, 2013). In the literature on utilisation of health services, there is compelling evidence that the abolition of user fees promotes health (James *et al.,* 2006). Specifically, the evidence suggests that the abolition of user fees increased access to curative services for the vulnerable groups of society (Wilkinson *et al.,* 2001; Deininger and Mpuga, 2005; Lagarde and Palmer 2008; Masiye *et al.,* 2008; Lagarde, Barroy and Palmer, 2012), although it may have led to substitution effects (Koch, 2012) or, otherwise, negatively affected service quality (Lagarde and Palmer, 2008) and utilisation by the non-targeted groups (Lagarde, Barroy and Palmer, 2012). In addition, Wilkinson *et al.* (2001) find that the increase in utilisation could possibly have been at the expense of preventative services.

If the abolition of user fees promotes maternal health utilisation, facility-based and supervised deliveries should increase with fee reduction, which will ultimately support a reduction in maternal deaths (Prata *et al.*, 2004; Kippenberg *et al.*, 2008). Witter *et al.* (2007) and Penfold *et al.* (2007) examine the effect of a delivery exemption policy in Ghana finding that deliveries in health facilities increased in the Central and Volta regions, and the increase ranged 10-36%; similarly, when fees were temporarily reinstated, the number of institutional deliveries decreased. Deininger and Mpuga (2005) report an increase in facility-based deliveries after the abolition of user fees in Uganda. In contrast, recent evidence suggests skilled assistance at birth does not increase, following the abolition of user fees (Tann *et al.*, 2007; De Allegri *et al.*, 2011). In other words, the effect of fee removal remains unclear, suggesting that there may be residual costs to women, constituting a further barrier to health facility deliveries and skilled birth attendance. These barriers could be driven by, for example, supply-side factors (James *et al.,* 2006; Gilson and McIntyre, 2005; Hadley, 2011). More so, an increase in the use of services following the policy reform can compromise the quality of free health care, yielding little or no increase in utilisation rates after the removal of the price barriers.

With respect to this research, the policy change in Zambia provides an excellent opportunity to evaluate the impact of user fee removal on maternal health services, particularly delivery services. The government of Zambia abolished user fees for health services in public health facilities in 54 rural districts in Zambia in April 2006. The policy was meant to improve access to health services, particularly for the poor, who mostly reside in rural areas.[11] Prior to the policy change, preventative services, such as ANC, family planning and counselling, were exempt from payment. However, delivery services were not previously exempt from payment.[12]

Interestingly, when formal charges are no longer levied, some of the delivery costs may be transferred to the patients. Borghi *et al* (2003) find that these additional costs are higher for deliveries and, more so, for complicated deliveries requiring specialised obstetric care. Studies in Ghana and Benin find that, in the absence of user fees, women have been required to purchase supplies – bleach, to sterilise materials used during delivery, gloves and sanitary pads – when admitted to a health facility for delivery (Kowalewski *et al.*, 2002; Borghi *et al.*, 2003). Obtaining the required supplies could easily delay or prevent the use of delivery services. At the household level, delivery services present additional financial implications, in terms of travel costs, as well as the patient's and the patient's companions' time. Additionally, relatives may have to bring food for the patient, as they await delivery (Borghi *et al.*, 2003).

Although the removal of user fees is likely to affect supply-side behaviour, as in the examples above, existing literature has generally ignored the role of the supply-side (Masiye *et al.*,

[11] Free health services included all aspects of preventative and curative services at Health Posts (HP) and Health Centres (HC), including Hospital Affiliated Health Centres (HAHC). Patients referred to first level hospitals were to be treated free of charge for all services at such facilities. Patients referred from level one hospitals and further upwards were to be exempt from charges. Services for which user fees were removed include consultation, treatment, admission and diagnostic services (MOH, 2007).

[12] In terms of fee setting, health providers in various regions were allowed to set fees in line with locally defined affordability criteria, but the fees were to be approved by the Ministry of Health (Masiye *et al.*, 2008). Delivery fees at public health facilities varied from K10, 000 ($3) to K30, 000 ($9) (Stekenlenburg *et al.*, 2004; Kamwanga *et al.*, 2002, Cheelo *et al.*, 2010).

2008; Lagarde, Barroy and Palmer, 2012; Cheelo *et al.*, 2010). Omitting important supply-side variables gives an incomplete picture, and may lead to erroneous conclusions and inappropriate policy formulation. In addition, Lagarde and Palmer (2008) highlight a scarcity of robust evidence in the assessment of the abolition of user fees in the literature on health service utilisation. The evidence is generally focussed on rather limited samples, analysing only usage patterns in the areas where user fees were removed, possibly by examining only facility data. Facility data, however, do not provide information on the socioeconomic or other characteristics of the users of the services, which are useful when exploring the effects of the policy across population groups. Furthermore, there is a paucity of literature examining the impact of user fee removal on maternal health care following a quasi-experimental design.

This research addresses these shortcomings by considering a nationally representative sample to evaluate the impact of the abolition of user fees on the utilisation of facility-based delivery using a difference-in-differences (DD) design within a (two-level) multilevel logistic framework. The staggered nature of the policy implementation provides an opportunity to analyse the effects of the policy change in a quasi-experimental setting: 54 districts implemented the policy change in April 2006, while public health facilities in the remaining 18 districts were not affected by the change. We further address one major limitation of household surveys, the lack of information on supply-side factors. By complementing the 2007 ZDHS with administrative and health facility census data, we are able to control for both demand-side and supply-side factors that influence the use of delivery services. To capture the actual content or quality of the ANC received, we construct a composite index, based on the key components of FANC, using correspondence analysis. In the literature on maternal health service utilisation, individual services received, such as whether the mother received iron supplementation or if two tetanus toxoid shots were administered, are included separately in the analysis (Navaneetham and Dharmalingam, 2002). However, Sunil *et al.* (2006) argue that conducting the analysis in this manner, may not capture the true content of the care received, as the content varies across women and facilities. Moreover, the composite index we construct captures the content of ANC received, which underpins the effectiveness of ANC in improving pregnancy outcomes, and should serve as a proxy for the expected quality of delivery services, should the mother choose to deliver at the facility.

The rest of the chapter is presented as follows: the next section presents a theoretical framework for the development of the empirical model outlined in Section 3; Section 4 describes the datasets and the variables used in the analysis. The results are presented in Section 5 and discussed in Section 6. Section 7 concludes the chapter.

5.2 Conceptual framework

The three delays model by Thaddeus and Maine (1994) identifies and summarises the main factors influencing the demand for obstetric or delivery care. The three types of delays are: (i) delay in recognising the problem by the household and deciding to seek care at a health facility; (ii) delay in arriving at the appropriate health facility; (iii) delay in the provision of adequate care at the health facility. In the first delay, the decision to seek care may be influenced by the distance and the cost of care, as well as the perceived quality of care provided. The second delay, the delay in arriving at the health facility once the decision to seek care has been made, is determined by the distribution and location of health facilities and health professionals trained to handle emergency obstetric and neonatal care, as well as the availability and cost of transportation and communication systems to reach the facilities. Undeniably, these delays affect both urban and rural areas, but are more severe in rural areas, where health professional shortages, limited transport and communication facilities and deplorable road conditions, depending on the season, are common problems. The third delay focusses on the health facility and provision of care, staff availability, staff attitudes and skills, availability of functioning equipment, adequate drug and medical supplies and management structures, which affect the quality of the care provided.

Gabrysch and Campbell (2009), in a review of 80 articles addressing the determinants of delivery use in sub-Saharan Africa (SSA), identify 20 determinants grouped in four themes: (1) socio-cultural factors, (2) perceived benefit/need of skilled attendance, (3) economic accessibility and (4) physical accessibility. The factors identified influence decision-making at the individual and household level. The factors also include measures affecting the ability to pay, and the role of distance, as an obstacle to reaching health facilities. Gabrysch and Campbell (2009) note that many factors, such as the quality of care, are not easily captured in household surveys, yet, such factors are reported as being crucial in qualitative studies.

Against this background, the decision to deliver at a health facility can be represented as a function of the costs and benefits associated with delivering at a health facility as follows; $U = U(C(P,T), B(Edu,Q,S))$. The utility associated with delivery (or not) at a health facility is a function of costs, $C(P,T)$, comprising of the opportunity cost of time, as well as the direct cost associated with reaching the health facility and receiving maternal care. The perceived benefits, $B(Edu,Q,S)$, are assumed to be a function of individual education, quality of health services provided and societal attitudes regarding maternal health care access. Better education and attitudes that encourage the use of maternal health care are assumed to ultimately increase understanding of the real benefits associated with health facility delivery, and, therefore, increase the size of the perceived benefits. Also, educational attainment may increase the benefit associated with maternal health care, by increasing the woman's human capital value and thus raising the investment value of health facility delivery (Breen and Ensor, 2011).

As indicated earlier, the quality of maternal healthcare is an important determinant of delivering at a health facility, and it encompasses both the perceived quality and the medical quality of care. Individuals perceive the quality of care, based on prior experiences with the health system. Some elements of perceived quality include staff attitudes and waiting times. Although waiting time is measurable, whether that time affects quality is subjective (Gabrysch and Campbell, 2009). Moreover, due to poor staff attitudes at health facilities, some women prefer to deliver with the care of a traditional birth attendant (TBA) or relative. However, the quality of care provided by the TBAs is, according to many health professionals, unsatisfactory, due to their low levels of literacy, lack of formal training and limited obstetric skills, and, therefore, TBAs tend to have a negative effect on the delivery process, especially when complications arise (Garces *et al.,* 2012; Singh *et al.,* 2012). Other health professionals, and some evidence, on the other hand, are more supportive of TBAs. In Malawi, maternal mortality rose after TBAs were banned, suggesting that TBAs, even untrained ones, provide some benefits. Importantly, following training and reinstatement, there are signs pointing to reductions in maternal mortality rates (Ana, 2011). Moreover, the use of trained TBAs mitigates neonatal mortality (Gill *et al.,* 2011) and is a feasible and affordable option in cases of severe human resource constraints, although getting the best outcomes from TBAs requires the right kind of support network (Stekelenburg *et al.,* 2004).

In addition to individual and household factors, the community or neighbourhood in which people live may influence health related behaviour, due to variations in the availability and accessibility of health services, infrastructure and prevailing attitudes towards health seeking (MacIntyre *et al.,* 1993). The statistical relationship between the neighbourhood and health outcomes, often referred to as the contextual effects, are well documented in literature (Pickett and Pearl, 2001). To account for community level effects, multilevel models are widely used in studies on maternal health care (Gage, 2007; Gage and Calixte, 2006). Apart from allowing for the measurement of the influence of community factors and unobservable community dynamics on health outcomes, multilevel models provide a robust method for the analysis of hierarchical data (Rabe-Hesketh and Skrondal, 2008). Studies, which examine the effect of community level factors on delivering at a health facility, find that the poverty and education level in the community is associated with deliveries at a health facility (Gage, 2007; Gabrysch and Campbell, 2009). In the next section, we present the empirical strategy, focussing on the elements presented above.

5.3 Empirical strategy

To estimate the impact of the abolition of user fees on the place of delivery, we apply difference-in-differences (DD), exploiting the staggered nature of the policy implementation. In 54 districts, the policy change was implemented in April 2006; in the remaining 18 districts, there was no change. DD is widely used in policy evaluation in a quasi-experimental setting (Bertrand *et al.,* 2004), following the seminal contribution by Ashenfelter and Card (1985). Below, we describe the empirical strategy, before discussing alternative specifications addressing potential threats to identification.

5.3.1 Main empirical strategy

In the simplest DD setup, outcomes are observed for two groups, one group is never exposed to the policy change or treatment, but the other group is exposed to treatment in only the second period, and not the first. Thus, the DD estimator enables an assessment of the effect of the abolition of user fees, by comparing the changes in average outcomes for women in districts that implemented the policy reform in 2006 (treatment group) to the average change in outcomes for women living in districts where the reform was not implemented (control group). The DD regression estimated by a (two-level) multilevel logistic regression (details on multilevel analysis are provided in the next section) over the sample of women who had a birth five years before the survey, can be defined as

$$Y_{ij} = \beta_0 + \beta_1 D_{2006} + \beta_2 D_{region} + \beta_3 D_{2006} \times D_{region} + \beta_4 x_{ij} + \beta_5 z_j + \upsilon_j \tag{5.1}$$

where Y_{ij} is the outcome of interest for a woman i in community j. The analysis on the place of delivery is performed separately on three binary dependant variables given as: 1 if the woman delivers at home (and 0 otherwise), in a public health facility (and 0 otherwise) or private health facility (and 0 otherwise). D_{2006} is a dummy variable equal to 1 if the woman delivers after the abolition of user fees (and 0 otherwise), and it captures aggregate factors that would cause changes in the place of delivery. D_{region}, equal to 1 if the woman lives in one of the districts that implemented the policy change (and 0 otherwise), captures possible differences between the treatment and control groups prior to the policy change, while x and z represent the individual and community level variables. We include, in x, dummy variables capturing the duration of residence, to address selective migration and residential stability. $\upsilon_j \sim N(0,\sigma^2)$ represents the random effects for the j^{th} community. The parameter of interest, β_3, is the DD estimate and it is an estimate of the average impact on women, who deliver in the treatment region in the post-reform period. Formally, the DD estimate is defined as the difference in the average outcome of interest in the treatment group, before and after the policy reform, minus the difference in the average outcome of interest in the comparison group, before and after the policy changes, and given as (Wooldridge and Imbens, 2007):

$$\hat{\beta}_3 = (\bar{Y}_{1,1} - \bar{Y}_{1,0}) - (\bar{Y}_{0,1} - \bar{Y}_{0,0}) \quad (5.2)$$

where the first subscript on the average outcome of interest represents the values of D_{region}, and the second represents the values taken on by D_{2006}. The DD estimate controls for biases that may arise from 1) permanent or systematic differences between the treatment and control groups and 2) the fact that, over time, differences in outcomes between the two groups could be due to the presence of natural or secular trends. The latter, also referred to as the 'baseline uniformity across time for the same region' assumption (Lee and Kang, 2006), entails that other time-varying processes should have similarly impacts on the treatment and comparison groups. Therefore, it is necessary to determine whether the differences in characteristics for women in the treatment and control groups are systematically related to the underlying changes in deliveries. If, for instance, the abolition of user fees was implemented in areas where facility-based deliveries were most responsive, this poses a threat to the identification of β_3.

To investigate the assumption of a common time trend between the treatment and comparison groups in the absence of the reform, we perform a placebo test, where we pretend that the abolition of user fees took place in the pre-reform period, and examine control variables before and after the reform. Significant effects in the placebo tests would suggest that the estimated policy impacts reflect differential time trends, rather than true policy effects. In examining whether there are differences in the control variables, simple means tests were considered. Although there are signs of stability for some of the population characteristics, there are notable differences that emerge. To control for these observed differences between the comparison and treatment groups, we include interaction terms between some characteristics of the women and the policy reform variable. We also take steps to make sure that selective migration of women into the treatment and comparison areas is not driving the results by including, as already noted, a measure of residence duration.

5.3.2 Multilevel analysis

The DD analysis is performed using a (two-level) multilevel regression. Multilevel analysis is an analytical approach appropriate for hierarchical data, where lower level units of aggregation are assumed to be nested within higher level units of aggregation (Bryk and Raudenbush, 2002). In the ZDHS data, samples are selected via multi-stage sampling, and, therefore, the data has a hierarchical structure; each respondent belongs to a household and each household is selected from a community or cluster of households. Therefore, while u_j is assumed to be independent of the covariates, x and z, the clustering violates the assumption of independently and identically distributed observations. Multilevel analysis accounts for not only the hierarchical structure of the data, but also enables the estimation of community level effects on the outcome variables (Gage, 2007). Ignoring observation clustering yields underestimated standard errors, and may result in spurious significant results (Gage, 2007; Luke, 2004; Rabe-Hesketh and Skrondal, 2008).

In this chapter, two-level multilevel logistic regression models, consisting of two sub-models at Level 1 and 2, were used. Level 1 represents the relationships among the individual-level variables, while level 2 examines the influence of community-level factors. Both individual and household characteristics are individual level variables, because the average number of women in a household is too small for the identification of a further level of analysis. To assess the influence of unobserved community level characteristics on the overall variation in the use of delivery services, we specify a null model (without covariates). Two extended model specifications are fitted that examine potential determinants of the (linear) probability of delivery at a specific type of facility. Model 1 includes individual characteristics, only, while Model 2 includes both individual-level and community-level variables. All the statistical analyses are carried out using xtlogit in Stata 12 (StataCorp, 2011).

5.4 Data and description of variables

5.4.1 Data

The primary source of data for the empirical analysis is the 2007 ZDHS, including the geo-referenced data on the location of clusters or communities. The ZDHS is a nationally representative survey collected in April-October 2007. The survey uses a multistage cluster sampling design to collect information on samples of reproductive women aged 15 to 49. Thus, each respondent is located in a cluster or community, and each community is located in a health district, which we can match to the policy. The survey provides information on key maternal and child indicators and explores the respondents' health related and socioeconomic characteristics. Detailed information about the ZDHS 2007 is available at http://www.measuredhs.com and in the report (CSO, 2009). The sample selected for this study comprises 3,618 women of reproductive age, who had their most recent child in the five years preceding the survey, and complete information on key covariates. The community-level data was obtained by linking the ZDHS with various sources. First, the sampled districts in the ZDHS were identified, using geo-referenced data on cluster location from the 2007 ZDHS. Second, to obtain distances to the health facilities, the point features provided by the geo-referenced data from the ZDHS were overlaid with geo-referenced data from the 2005 Zambia Health Facility Census (ZHFC). The 2005 ZHFC covered public, non-governmental organisation or mission and larger private-for-profit health facilities in the country. Straight-line distances from each ZDHS cluster to the closest health facility were calculated using ArcGIS and exported to Stata 12 for further analysis. Other district level data was obtained from the Health Management and Information Health System (HMIS) administered by the Ministry of Health (MoH). The HMIS data include monthly information on supply and use of a wide range of services by all public health facilities nationwide, aggregated to the district level. Supply-side variables, such as availability of drugs and traditional birth attendants in the district, were extracted from the HMIS data.

5.4.2 Description of variables

The three independent variables of interest are: delivery at home, delivery at a public health facility and delivery in a private health facility. We specify three binary outcomes equal to 1 if the woman delivered at home, public facility or private facility, and 0 otherwise. The main groups of independent variables broadly cover the individual characteristics, household characteristics, access to health services and community level variables. In order to address selective migration and residential stability, the duration of residence was included (Gage, 2007). Detailed definitions and descriptions of the variables used are presented in Table 5.1.

The variables included in the analysis are mostly self-explanatory and informed by previous research on factors associated with the utilisation of maternal health services (Gage, 2007; Gabrysch and Campbell, 2009; Babalola and Fatusi, 2009, Ndao-Brumblay *et al.,* 2012). In particular, birthing women with higher birth order may seek less maternal health services due to knowledge and experience gained from past births, lack of child support for the younger children and negative comments from the birth attendants at the health facility (Gage and Calixte, 2006; Ragupathy, 1996; Short and Zang, 2004, Gabrysch and Campbell, 2009). The woman's age was omitted from the regression due to high correlation (0.8) with parity (Gage, 2007). Since previous literature has demonstrated that household wealth is strongly related to the use of maternal health services, the education status for the woman and husband are expected to be positively associated with the utilisation of maternal health services (Sagna and Sunil, 2012; Gage, 2007; Fan and Habibov, 2009). The socio-economic status, as captured by the wealth index grouped into three categories: poor, middle and rich, is expected to be positively associated with the utilisation of facility-based deliveries. Even though user fees for delivery services were removed in Zambia, wealthier households are expected to be better equipped to cope with any other direct and indirect costs of seeking maternal health services (De Allegri *et al.,* 2011). Religion may influence attitudes towards modern health services, and may, therefore, affect the use of maternal health services. In the literature, a positive relationship between being catholic and utilisation of maternal health service utilisation is suggested, thus informing the expected signs of the relevant coefficients (Addai, 2000, De Allegri *et al.*, 2011). The use of antenatal care services during pregnancy not only breeds familiarity with the health system and health facility, but also provides an opportunity for health workers to promote the use of a place of delivery (Gabrysch and Campbell, 2009). Thus, it is expected that utilisation of ANC services may positively influence delivery at a health facility. To capture the actual quality of ANC received, we construct a composite index based on the essential ANC components.[13] Details of the elements included in the composite index and the actual construction are presented in Section 3.2.2.

At the community level, characteristics such as accessibility, economic status and other health system factors are expected to have an influence on utilisation of maternal health services (Gage, 2007; Gabrysch and Campbell, 2009; Ndao-Brumblay *et al.*, 2012). Based on data availability, community level factors in the analysis include: community type (urban or rural), distance to health facility, drug availability at community health facilities, community average ANC uptake and health facility density. Living closer to a health facility is expected to be positively associated with maternal health service utilisation, as both the direct and indirect costs associated with transport and travel time are identified as barriers to the utilisation of maternal health services (Gage, 2007; Gabrysch and Campbell, 2009). Objective measures of quality of care such as drug availability, included here, are often not captured in household surveys, but are reported to be essential for delivery services (Gabrysch and Campbell, 2009). Poverty status in the community, also captured, follows the material deprivation index (MDI). The MDI ranges from -4.65, least deprived, to 1.66, most deprived (Kabaso and Tembo, 2009). Moreover, previous literature suggests that ANC uptake in the community is positively associated with

[13] Recall that ANC coverage rates are extremely high, nearly universal, in this dataset.

utilisation of delivery services, while poverty concentration in the community is negatively associated (Gage and Calixte, 2006; Gage 2007; Sagna and Sunil, 2012; Kyei *et al.,* 2012a).

5.5 Results

5.5.1 Descriptive statistics

Table 5.2 shows descriptive statistics for the dependent variables and the set of covariates, separately, before and after the abolition of user fees for the treatment and comparison groups. There are some noticeable differential trends within the comparison and treatment groups, as well as between the groups. For instance, women in the comparison group have more education and are wealthier than those in the treatment group. However, this difference was not unexpected; the differences reflect the fact that women in the comparison group mostly reside in urban areas, and such characteristics are more common among urban women than their rural counterparts. Hence, it is important to control for these underlying differences, as these factors may be correlated with the utilisation of delivery services. We also control for the possibility that the observable differences between the comparison and treatment groups is a function of the policy change, by interacting the identified (significant) characteristics with the policy reform.

5.5.2 Results from the multivariate analysis

A (two-level) multilevel model was estimated, based on individual-level and community-level data. The characteristics at each level were incorporated into two main specifications. Model 2 is a general specification, incorporating all the variables of interest, while Model 1 excludes the community level variables. The specification at each level was tested using the following in-sample statistics: the Akaike Information Criterion (AIC); Bayesian Information Criterion (BIC); and the value of the maximised Log-likelihood function. The AIC is obtained from AIC=-2lnL+2K and the BIC is given as BIC=-2lnL+KLnN where lnL is the maximised log-likelihood, K is the number of parameters and N is the sample size. The preferred models are those with a lower absolute log-likelihood, AIC and BIC values. Based on the in-sample statistics, the general specification (Model 2) was preferred for deliveries at home and in a public health facility, indicating that, while the degrees of freedom are larger for the simplified model, the loss in explanatory power outweighs the gain in degrees of freedom. For private health facilities, Model 1 with individual variables, only, was the preferred specification. The significance of the likelihood ratio test for the selected models suggests that the inclusion of the random effects provides a model, which better fits the data than the Logit model (see Table 5.4). We estimate

Equation (5.1), with and without the set of controls capturing individual and community level characteristics. The main results are presented in Table 5.3, below.

In Table 5.3, the classic DD estimator suggests that the abolition of user fees did not have a significant effect on either deliveries in a health facility (whether public or private) or at home. With the inclusion of controls (see rows 8 and 12 in either Panel A or B), the DD estimator suggests that while home deliveries decreased, deliveries in public hospitals also decreased, while deliveries in private hospitals increased; however, all estimated effects are statistically insignificant.

In addition, the results provide a consistent picture of the influence of the traditional determinants of the utilisation of delivery services (see Table 5.4). Based on the full model for public and home deliveries, women of higher parity and women with a partner with primary education are more likely to deliver at home, and less likely to deliver in the public health facilities. On the other hand, wealthier women with four or more antenatal visits, more education and better quality of ANC have lower probability of home delivery and higher probability of delivery in public health facilities. None of the variables was significant for delivery at a private health facility.

Table 5.1: Description of variables used in the analysis

Variable name	Description	Mean	S.E.
Dependent variables			
Delivery at home	Dichotomous variable indicating whether woman delivered at home, 0 otherwise	0.472	0.008
Delivery at a public health facility	Dichotomous variable indicating whether woman delivered at a public health facility, 0 otherwise	0.481	0.008
Delivery at a private health facility	Dichotomous variable indicating whether woman delivered at a private health facility, 0 otherwise	0.047	0.004
Independent Variables			
Individual level variables			
Parity (ref=1)	Categorical variable indicating births by the woman		
1	1=if parity is 1, 0 otherwise	0.202	0.007
2-4	1=if parity is between 2-4, 0 otherwise	0.473	0.008
5+	1=if five and above parity, 0 otherwise	0.325	0.008
ANC utilisation	Dichotomous variable indicating the antenatal visits		
Four or more visits	1=if four or more visits, 0 otherwise	0.621	0.008
Religion (ref=Catholic)	Categorical variable indicating the woman's religion		
Catholic	1=if catholic, 0 otherwise	0.180	0.006
Protestant	1=if protestant, 0 otherwise	0.806	0.007
Other	1=if other, 0 otherwise	0.014	0.002
Household childcare burden	Continuous variable indicating the number of children under age 5 in HH		
Number of children under 5 in HH	Number of children in HH under age 5 years	1.717	0.015
Woman's employment status (ref=unemployed)	Dichotomous variable indicating the woman's employment status		
Employed	1=if employed, 0 otherwise	0.505	0.008
Woman's education (ref=no education)	Categorical variable indicating the woman's highest level of education		
No education	1=if no education, 0 otherwise	0.121	0.005
Primary	1=if completed primary education, 0 otherwise	0.595	0.008
Secondary and above	1=if completed secondary education or higher, 0 otherwise	0.284	0.008
Partner's education (ref=no education)	Categorical variable indicating the highest level of education for the woman's partner:		
No education	1=if no education, 0 otherwise	0.165	0.006

Primary	1=if completed primary education, 0 otherwise	0.428	0.008
Secondary and above	1=if completed secondary education or higher, 0 otherwise	0.407	0.008
Index for actual quality of ANC received	Index of the quality of ANC received by the woman	0.073	0.073
Household wealth(ref=poorest)	Index of household wealth		
Poor	1=if household wealth quintile is 1 or 2, 0 otherwise	0.402	0.008
Middle	1=if household wealth quintile is 3, 0 otherwise	0.227	0.007
Rich	1=if household wealth quintile is 4 or 5, 0 otherwise	0.370	0.008
Duration of residence (ref=previous res, rural)	Categorical variable indicating the duration of residence in the area		
0-4 (previous residence, rural)	1=if 0-4 years, previous residence rural, 0 otherwise	0.218	0.007
0-4 (previous residence, urban)	1=if 0-4 years, previous residence urban, 0 otherwise	0.167	0.006
5+	5+, 0 otherwise	0.615	0.008
Community level variables			
Area type (ref=rural)	Dichotomous variable indicating the area of residence of the woman		
Urban	1=if household reside in urban area, 0 otherwise	0.356	0.008
Proportion of drugs available	Continuous variable indicating the proportion of drugs available	0.710	0.002
Material deprivation index	Index for material deprivation of area	-0.374	0.032
Distance to nearest facility	Continuous variable indicating distance to the nearest health facility	6.968	0.101
Density of health facilities	Continuous variable indicating the density of health facilities in the area	0.136	0.001
Antenatal care uptake	Continuous variable the coverage of antenatal care in the area	0.953	0.002
TBA per 1000 of pop.	Continuous variable availability of TBAs per 1000 of the pop. in the area	0.452	0.005
Policy variables			
Region	1= Lives in one of the 54 districts that removed user fees, 0 otherwise	0.593	0.008
Year (2006)	1= delivered after user fees were abolished, 0 otherwise	0.412	0.008

Table 5.2: Comparison of comparison and treatment groups before and after the removal of user fees.

Variable	Comparison group			Treatment group		
	Pre-reform	Post-reform	Diff (Post-Pre)	Pre-reform	Post-reform	Diff (Post-Pre)
Dependent variables						
Delivery at home	0.312	0.354	0.042***	0.566	0.607	0.041**
Delivery at a public health facility	0.646	0.612	-0.034*	0.373	0.340	-0.033*
Delivery at a private health facility	0.042	0.034	-0.0081	0.061	0.053	-0.0078
Dependant Variables						
Individual level variables						
Parity (ref=1)						
1	0.242	0.266	0.024	0.173	0.162	-0.011
2-4	0.486	0.454	-0.033	0.461	0.488	0.027
5+	0.271	0.280	0.009	0.367	0.350	-0.016
ANC utilisation						
Four or more visits	0.669	0.524	-0.144***	0.674	0.564	-0.110***
Religion (ref=Catholic)						
Catholic	0.202	0.204	0.002	0.162	0.167	0.005
Protestant	0.786	0.787	0.000	0.822	0.815	-0.007
Other	0.011	0.009	-0.002	0.016	0.018	0.002
Household childcare burden						
Number of children under 5 in HH	1.467	1.877	0.410***	1.580	2.045	0.466***
Woman's employment status (ref=unemployed)						
Employed	0.521	0.438	-0.084***	0.554	0.467	-0.087***
Woman's education (ref=no education)						
No education	0.075	0.080	0.005	0.143	0.162	0.018
Primary	0.502	0.564	0.062**	0.649	0.632	-0.017
Secondary and above	0.423	0.356	-0.067***	0.207	0.206	-0.001
Partner's education (ref=no education)						
No education	0.164	0.146	-0.018	0.160	0.183	0.023*
Primary	0.318	0.383	0.066***	0.482	0.491	0.009
Secondary and above	0.518	0.470	-0.048**	0.357	0.326	-0.031*
Index for actual quality of ANC received	1.568	0.884	-0.683***	-0.591	-1.014	-0.423**
Household wealth(ref=poorest)						
Poorest	0.195	0.226	0.031*	0.518	0.561	0.043**
Middle	0.150	0.179	0.029*	0.272	0.274	0.002
Rich	0.655	0.595	-0.060***	0.210	0.165	-0.045***
Duration of residence (ref=previous res, urban)						
0-4 (previous residence, rural)	0.167	0.204	0.037**	0.224	0.268	0.044***
0-4 (previous residence, urban)	0.291	0.269	-0.021	0.090	0.083	-0.007
5+	0.542	0.526	-0.016	0.686	0.649	-0.038**
Community level variables						
Area type (ref=rural)						
Urban	0.655	0.599	-0.056**	0.178	0.151	-0.027*
Proportion of drugs available	0.726	0.739	0.013**	0.696	0.696	0.000
Material deprivation index	-1.633	-1.770	-0.137	0.512	0.545	0.033
Distance to nearest facility	3.775	4.374	0.600***	8.876	9.165	0.289
Density of health facilities	0.117	0.118	0.001	0.150	0.147	-0.004*
Prenatal care uptake	0.904	0.902	-0.002	0.988	0.988	0.001
TBA per 1000 of pop.	0.345	0.350	0.005	0.524	0.526	0.002

Table 5.3: Main results

Variable	**Home**		**Public**		**Private**	
	Odds ratio	**CI**	Odds ratio	**CI**	Odds ratio	**CI**
Panel A: Odds ratios						
Without controls						
Delivery after abolition of fees	1.213	(0.914 , 1.610)	0.919	(0.699 , 1.208)	0.516*	(0.248 , 1.075)
Lives in one of the 54 districts with policy reform	5.156***	(3.418 , 7.776)	0.198***	(0.133 , 0.294)	1.321	(0.559 , 3.124)
DD estimator	0.882	(0.620 , 1.255)	1.026	(0.725 , 1.453)	1.817	(0.762 , 4.333)
With individual level controls						
Delivery after abolition of fees	1.077	(0.802 , 1.446)	1.029	(0.773 , 1.370)	0.590	(0.275 , 1.266)
Lives in one of the 54 districts with policy reform	1.607***	(1.165 , 2.216)	0.543***	(0.388 , 0.759)	2.045	(0.833 , 5.021)
DD estimator	0.925	(0.645 , 1.327)	0.993	(0.695 , 1.419)	1.582	(0.649 , 3.861)
With individual and community level controls						
Delivery after abolition of fees	1.067	(0.793 , 1.435)	1.051	(0.788 , 1.400)	0.565	(0.260 , 1.225)
Lives in one of the 54 districts with policy reform	1.107	(0.790 , 1.552)	0.852	(0.597 , 1.216)	1.846	(0.601 , 5.676)
DD estimator	0.944	(0.658 , 1.356)	0.960	(0.672 , 1.371)	1.649	(0.669 , 4.065)
	Estimate	**S.E**	**Estimate**	**S.E**	**Estimate**	**S.E**
Panel B: Coefficient estimates						
Without controls						
Delivery after abolition of fees	0.193	(0.144)	-0.085	(0.140)	-0.662*	(0.374)
Lives in one of the 54 districts with policy reform	1.640***	(0.210)	-1.621***	(0.203)	0.279	(0.439)
DD estimator	-0.125	(0.180)	0.026	(0.177)	0.597	(0.444)
With individual level controls						
Delivery after abolition of fees	0.074	(0.150)	0.029	(0.146)	-0.528	(0.390)
Lives in one of the 54 districts with policy reform	0.474***	(0.164)	-0.612***	(0.171)	0.716	(0.458)
DD estimator	-0.078	(0.184)	-0.007	(0.182)	0.459	(0.455)
With individual and community level controls						
Delivery after abolition of fees	0.065	(0.151)	0.050	(0.147)	-0.572	(0.395)
Lives in one of the 54 districts with policy reform	0.102	(0.172)	-0.160	(0.181)	0.613	(0.573)
DD estimator	-0.057	(0.185)	-0.041	(0.182)	0.500	(0.460)

The results suggest that prior access to health services is associated with facility delivery. The positive association of the quality of antenatal care received with health facility delivery (and negative association with home deliveries) suggests that greater efforts during ANC could increase awareness of the importance of facility deliveries. However, the association between the effects of wealth on place of delivery are multifaceted. While better socioeconomic conditions are likely to mitigate the cost of delivery care, wealth is also strongly related to location, as is evident from the results that households in regions that are less deprived are more likely to deliver in health facilities. Furthermore, wealthier households tend to live in areas where the average distance to the health facility is lower than it is for poorer households. With regard to private health facility deliveries, as indicated earlier, the model with individual variables was the preferred specification. Only a few individual level variables were associated with deliveries in private health facilities. Being employed and the quality of ANC received are positively associated with delivery in a private health facility.

Notably, at the community level, a higher density of traditional birth attendants and distance to the health facility are associated with an increased probability of home delivery and reduced probability of delivery in public health facilities. Unexpectedly, the availability of drugs and density of health facilities is negatively associated with delivery in a public health facility. Plausible explanations for these findings are presented in the next section. Living in urban areas and less deprived areas is negatively associated with home deliveries and positively associated with deliveries in a public health facility.

Table 5.4: Full results-Coefficients

	Model 1						Model 2					
	Home		Public		Private		Home		Public		Private	
	Estimate	S.E	Estimate	S.E	Estimate	S.E	Estimate	S.E	Estimate	S.E	Estimate	S.E
Individual level variables												
Delivery post abolition of user fees	0.074	(0.150)	0.029	(0.146)	-0.528	(0.390)	0.065	(0.151)	0.050	(0.147)	-0.572	(0.395)
Lives in one of the district with policy change	0.474***	(0.164)	-0.612***	(0.171)	0.716	(0.458)	0.102	(0.172)	-0.160	(0.181)	0.613	(0.573)
DD estimator	-0.078	(0.184)	-0.007	(0.182)	0.459	(0.455)	-0.057	(0.185)	-0.041	(0.182)	0.500	(0.460)
Parity (ref=1)												
2-4	0.728***	(0.133)	-0.638***	(0.130)	-0.307	(0.299)	0.739***	(0.133)	-0.655***	(0.130)	-0.296	(0.299)
5+	0.837***	(0.144)	-0.836***	(0.142)	0.059	(0.328)	0.849***	(0.144)	-0.857***	(0.142)	0.083	(0.328)
ANC utilisation												
Four or more visits	-0.318***	(0.092)	0.251***	(0.092)	0.341	(0.216)	-0.333***	(0.092)	0.259***	(0.092)	0.356	(0.216)
Religion (ref=Catholic)												
Protestant	0.024	(0.120)	0.000	(0.120)	-0.136	(0.274)	0.017	(0.119)	0.021	(0.120)	-0.178	(0.275)
Other	0.439	(0.398)	-0.577	(0.408)	0.334	(0.815)	0.410	(0.401)	-0.538	(0.414)	0.267	(0.815)
Household childcare burden												
Number of children under 5 in HH	-0.030	(0.052)	-0.002	(0.053)	0.200	(0.122)	-0.046	(0.052)	0.013	(0.052)	0.199	(0.122)
Woman's employment status (ref=unemployed)												
Employed	-0.080	(0.093)	-0.011	(0.093)	0.438**	(0.219)	-0.094	(0.093)	0.023	(0.093)	0.378*	(0.220)
Woman's education (ref=no education)												
Primary	-0.405***	(0.139)	0.398***	(0.145)	0.236	(0.346)	-0.404***	(0.139)	0.394***	(0.144)	0.253	(0.346)
Secondary and above	-0.709***	(0.168)	0.692***	(0.171)	0.039	(0.410)	-0.674***	(0.167)	0.662***	(0.170)	0.020	(0.411)
Partner's education (ref=no education)												
Primary	0.292**	(0.137)	-0.306**	(0.139)	0.086	(0.332)	0.262*	(0.137)	-0.284**	(0.139)	0.126	(0.332)
Secondary and above	-0.032	(0.143)	-0.056	(0.142)	0.349	(0.325)	-0.032	(0.143)	-0.065	(0.142)	0.386	(0.324)
Index for actual quality of ANC received	-0.128***	(0.012)	0.101***	(0.012)	0.136***	(0.032)	-0.119***	(0.012)	0.092***	(0.012)	0.131***	(0.032)
Household wealth(ref=poorest)												
Middle	-0.238**	(0.117)	0.310**	(0.121)	-0.123	(0.309)	-0.100	(0.118)	0.185	(0.122)	-0.113	(0.313)
Rich	-1.294***	(0.146)	1.189***	(0.149)	0.491	(0.368)	-0.827***	(0.167)	0.771***	(0.168)	0.372	(0.408)
Duration of residence (ref=previous res, rural)												

0-4 (previous residence, urban)	-0.504***	(0.163)	0.497***	(0.157)	-0.581	(0.364)	-0.429***	(0.164)	0.432***	(0.158)	-0.606*	(0.366)
5+	-0.051	(0.108)	0.090	(0.110)	-0.277	(0.257)	-0.040	(0.108)	0.080	(0.109)	-0.284	(0.257)
Community level variables												
Area type (ref=rural)												
Urban							-0.884***	(0.182)	0.839***	(0.189)	0.426	(0.561)
Proportion of drugs available							0.340	(0.588)	-1.338**	(0.630)	3.612**	(1.807)
Material deprivation index							-0.123**	(0.054)	0.116**	(0.057)	0.046	(0.165)
Distance to nearest facility							0.044***	(0.012)	-0.044***	(0.013)	-0.012	(0.039)
Density of health facilities							0.885	(1.337)	-3.159**	(1.416)	10.744***	(4.081)
Prenatal care uptake							0.436	(0.476)	-0.802	(0.497)	0.837	(1.386)
TBA per 1000 of pop.							1.032***	(0.269)	-0.912***	(0.292)	-0.523	(0.872)
Constant	0.127	(0.274)	-0.244	(0.279)	-6.099***	(0.762)	-1.129	(0.741)	2.273***	(0.777)	-10.655***	(2.230)
rho	0.166		0.209		0.601		0.123		0.157		0.590	
LR test (Chi2 value)	495.3***		420.1***		44.47***		556.7***		486.3***		52.76***	
Log likelihood	-1833		-1869		-516.4		-1799		-1833		-511.0	
AIC	3708.356		3779.146		1074.76		3654.495		3722.224		1078.058	
BIC	3837.912		3908.702		1204.316		3827.237		3894.966		1250.8	

*** p<0.01, ** p<0.05, * p<0.1

Table 5.5: Specification tests

	Home		Public		Private	
	Estimate	S.E	Estimate	S.E	Estimate	S.E
No controls	-0.125	(0.180)	0.026	(0.177)	0.597	(0.444)
Controls	-0.056	(0.184)	-0.042	(0.182)	0.454	(0.454)
Controls+selective migration	-0.057	(0.185)	-0.041	(0.182)	0.459	(0.455)
Controls+interaction	-0.084	(0.186)	-0.008	(0.183)	0.450	(0.459)
Placebo reform (no controls)	0.375	(0.434)	-0.640	(0.415)	1.561	(0.955)
Placebo reform (with controls)	-0.172	(0.293)	-0.108	(0.305)	1.436	(0.962)

Table 5.5 reports the results from a series of specification tests, demonstrating that the effects of the removal of user fees on facility delivery are very similar across various specifications (Detailed results are presented in Appendices D.1-D.4). Our DD approach identifies the effects on place of delivery from the assumption of a common time trend in the treatment and comparison groups, in the absence of the reform. One concern that arises is that the effect may, instead, reflect differential time trends between the treatment and comparison groups, rather than the true policy impact. To investigate this possibility, we estimate the effects of a placebo reform, pretending that the abolition of user fees took place earlier than it did. Table 5.5 reports the results from the placebo reform regressions. The pre-reform sample is arbitrarily separated into two equal groups, and in this case, D_{2006} is equal 1 for one group and 0 for the other pre-reform group. If there were differential secular time trends in the treatment and comparison groups, then the estimated effect of the placebo reform should be significantly different from zero. To account for selective migration, due to the policy change, we continue to include variables capturing previous residence. The results show that the effect of the reform is robust to selective migration, as well as differential time trends across the groups.

5.6 Discussion

Overall, we find no evidence that the abolition of user fees in the 54 rural districts in Zambia 2006 had a significant impact on the place of delivery and that community level effects are valid for home and public health facility deliveries, but not for deliveries in the private health facilities.

Although the results are robust to a series of specification checks, the interpretation of the results needs to take into account the study limitations. The use of cross-sectional data allows us to examine neither the dynamics of the policy change over time nor the sustainability of the impact of the policy change. While the 2005 ZHFC contains information on health facilities collected at one point in time, the availability or number of health facilities could have changed, which could affect delivery location choices. However, using health facilities data enabled us to include measures, such as distance, to assess accessibility, and these variables are not captured in the household survey. Unfortunately, the distances are measured in a straight line to the nearest health facility, and not necessarily to facilities providing delivery services. While 93% of the facilities covered in the ZHFC provide ANC services (Nyei *et al.,* 2012), not all of them provide delivery services; bias could, therefore, be generated by including all the facilities in the distance calculations. Also, a potential bias in the true distance effects is possible, due to the random errors generated by the geo-scrambling procedure used by MEASURE DHS (http://www.measuredhs.com/What-We-Do/Gis.cfm), and by differences in actual distances travelled to health facilities, compared to the straight-line distances that are used in the analysis. Finally, due to data limitations, the analysis does not include women who died, due to child birth-related complications, and, therefore, the results may overestimate or underestimate the actual use of delivery services.

In spite of the caveats, the findings suggest potentially important policy implications. User fees in Zambia were removed, in order to increase access to health services, particularly for the poor in rural communities. With the abolition of user fees, which reduces the financial cost of treatment, it is expected that utilisation of health services rates would increase. In support of this hypothesis, studies in Zambia and other developing countries have shown an increase in the use of health services by certain population groups after the removal of user fees (Wilkinson *et al.*, 2001; Nabyonga *et al.,* 2005; Masiye *et al.,* 2010; Lagarde *et al.,* 2012; Koch, 2012). While user fees determine the direct cost of delivery services, in many developing countries, there are other indirect costs associated with deliveries, which have been shown to be more important. In line with evidence from other developing countries, this study finds evidence of such barriers (Odaga, 2004; James *et al.,* 2006; Hadley, 2011). For instance, the study finds that distance to the health facility is negatively associated with deliveries in a public health facility, but positively with home deliveries. It is obvious that the distance to health facilities providing delivery services can create significant indirect opportunity costs. Indirect costs for birthing women include the cost of transport, lodging or food for both the women and any accompanying relatives. Some health facilities often do not have waiting shelters and alternative accommodation for accompanying relatives has to be sought, if the birthing woman is admitted for in-patient care (Borghi *et al.,* 2003). Thus, an alternative for women, particular in rural areas, is to seek informal care through the use of traditional birth attendants (TBAs), who are often located within the communities and have negotiable payment terms (Gabrysch and Campbell, 2009).

In a similar vein, we find that the presence of TBAs in the communities significantly reduces the probability of delivery in a public health facility, and increases the probability of home delivery. In rural areas, TBAs are trained to carry out deliveries and advised to refer more complicated cases to higher levels of care. According to statistics from the Central Statistical Office (2009) a larger share of women were assisted by TBAs in 2007 (23.5%) compared to 2001/2 (11.7%). Thus, the involvement of trained TBAs during delivery remains an important strategy, particularly in rural areas, which are often affected by the scarcity of health workers (Stekelenburg *et al.,* 2004). Additionally, since women in rural areas often have to cover longer distances to get to the facility for delivery, compared to their urban counterparts, the construction of waiting shelters should be encouraged, in order to accommodate birthing women and, possibly, their accompanying relatives.

In addition, even though user fees did not provide a significant source of income for health facilities, they were a flexible form of income and were used by health facilities in rural areas to support the functions of TBAs, mostly in the form of tokens of appreciation for encouraging women to deliver at health facilities (Cheelo *et al.,* 2010). Other uses included the buying of cleaning agents (bleach) and food for inpatients. However, with the abolition of user fees, this support to TBAs has significantly reduced, as has the incentive for them to encourage the woman to deliver at health institutions. Moreover, with the abolition of fees, women are reportedly required to take bleach, gloves and syringes with them, when delivering at a health facility (Carrasso *et al.,* 2010). These additional requirements, following the removal of user fees, are a potential barrier to the utilisation of delivery services. Qualitative studies from the Eastern province in Zambia show that, in some cases, women are required to bring bleach, soap, nappies, a baby blanket, Vaseline, a baby suit and *chitenge* – a wrapper used by women – (Carrasso *et al.,* 2010). Women who struggle to provide these items may decide, instead, to deliver at home. Providing expectant mothers with incentives, such as baby layettes – a package containing basic requirements for a new born baby – as is done in some health facilities in Zambia, could encourage the utilisation of delivery services, since women who do not have them may feel they will be ostracized by health facility workers. Moreover, the costs associated with delivery by a TBA are reportedly lower than those faced when delivering at a health facility (Gabrysch and Campbell, 2009). Thus, there is also a need to provide TBAs with incentives for early referrals of birthing women to health facilities.

The observed positive association between the quality of antenatal care with facility-based deliveries not only calls for improvements in the quality of care provided, but also the need for the continued promotion of antenatal care attendance, in order to facilitate an increase facility-based deliveries. Although it is evident that, ultimately, a reduction in maternal deaths may be brought about by having adequate delivery care (WHO, 1999), often available only at health facilities, the findings from this study support existing evidence that antenatal care is key in encouraging facility-based deliveries (Bloom *et al.,* 1999; Vanneste *et al.*, 2000; De Allegri *et al.*, 2011). More so, the importance of the education status of both the woman and partner in positively influencing facility based deliveries suggests that improving awareness of the importance of maternal health care should go beyond the individual woman and include partners.

The most surprising finding from this analysis concerns the role of the technical quality of care in shaping the utilisation of facility deliveries. Marking a clear departure from previous qualitative literature (Gabrysch and Campbell, 2009), the technical quality of care, as captured by the density of health facilities and drug availability, are found to be negatively associated with delivery in public health facilities, and does not have a significant association with home deliveries. Although the community level effects are not valid for deliveries in private health facilities, a positive association is found with the technical measures of quality. This finding is in line with some studies indicating that women report better quality of care in private health facilities, even though that the cost deters them from using the service (Amooti-Kaguna and Nuwaha, 2000; Griffiths and Stephenson, 2001). A plausible explanation for the unexpected association between the technical quality of care and deliveries in public health facilities is that, although there may be some overlap, there are differences in the perceived quality of care and the technical quality of care. The perception of the quality of care largely depends on individuals' experiences with the health system or that of the users known to them (Thaddeus and Maine, 1994). Therefore, it is likely that the technical quality of care, as captured in the study, may differ from the perceived quality of care. More so, the technical measures used in the study may only be weakly linked to better quality (Donabedian, 1988).

In relation to the place of residence and community level poverty, the finding that women in urban areas and less deprived areas are more likely to deliver in health facilities is expected and consistent with previous literature (Gage and Calixte, 2006; Gage, 2007; Khan *et al.*, 2006). However, the link between wealth and facility-based delivery is confounded by the correlation between area of residence and financial resources. Although intuitive, since user fees for delivery services have been abolished in public health facilities in rural areas and households with greater wealth are more able and willing to access delivery services, it is also likely that this is a result of being closer to better quality services more than it is from the impact of the financial barrier *per se*. Breen and Ensor (2011) argue that the effect of household wealth is likely to result from being able to reach good quality health facilities. Thus, transport and opportunity costs are all lower for those who live closer to health facilities, and who are also more likely to be wealthier. This finding, potentially, suggests that a reduction in the link between socioeconomic status and use of delivery services could be brought about by providing poorer communities with the means to reach and access health facilities.

5.7 Conclusion

The study investigates the effect of the abolition of user fees on the place of delivery, exploiting the staggered nature of the policy implementation within a difference-in-differences framework. By analysing both individual-level and community-level effects. the value of this analysis goes well beyond the evaluation of the policy change on the place of delivery. Understanding the main determinants of the place of delivery is important in furthering our knowledge of the link between health care policy and birthing women's demand for delivery services.

The findings indicate that the removal of user fees to ensure improved access to maternal health care in public health facilities, especially for the rural poor, may, on their own, not be sufficient to increase facility-based deliveries. Although simple economic reasoning suggests that the removal of a price barrier should lead to an increase in utilisation of health services, economic behaviour can be slightly more complicated. The elimination of a price barrier, which is also a form of revenue, may lead to cost-shifting, resulting in an indirect non-price barrier. These additional indirect costs on patients considering delivery at a health facility are likely to deter the use of those services. For instance, the presence of TBAs in the community, who often provide more affordable services, but possibly inappropriate care, offers an alternative for women seeking delivery services. Thus, the role of TBAs cannot be ignored, and may need to be integrated in the maternal delivery care system by, possibly, providing TBAs with incentives for referrals to health facilities. Moreover, distance to health facilities and the quality of care provided continues to constitute significant barriers to the utilisation of facility-based deliveries. Findings from this study call for an improvement in the quality of services provided, and adoption of measures, such as the free provision of emergency transport.

Overall, the findings from the study clearly underline the importance of potential indirect costs in deterring birthing women from seeking delivery services at a health facility. To ensure that women, currently not seeking delivery services at a health facility, gain access, there is need to invest in adequate policies to address the non-financial barriers. A detailed analysis of the indirect costs incurred by the households during delivery could not be studied at this stage, due data inadequacies, but should be considered for future research.

CHAPTER 6

6 Summary and Conclusion

Since 1992, the Zambian government has embarked on health sector reforms, with a focus on two commitments, equity and quality. The two commitments are part of a combined goal of equitably providing quality health services. In that respect, and relevant for this thesis, Zambia has both scaled-up and introduced a number of maternal health care interventions over the past decade, in an attempt to improve maternal health. However, these interventions have not, yet, at least at the observational level, achieved the intended goal; as such, maternal health indicators continue to perform poorly. For instance, impressively high antenatal coverage rates, well over 90%, continue to coexist with relatively high maternal mortality rates (MMR). Therefore, Zambia is unlikely to attain the Millennium Development Goals (MDG) of reducing MMR by 75% by 2015. Given the poor performance towards attainment of the MDG, and its relevance to the overarching national health policy framework, there is a need to further our understanding of the factors, which could be quite different across regions, that influence the utilisation of maternal health services.

It is, however, somewhat difficult to reconcile the coexistence of high ANC coverage rates and high MMR, other than to suggest that the traditional ANC model has performed poorly, women do not receive proper care during delivery or some combination of the two. In this thesis, it has been implicitly assumed that the traditional ANC model has not performed adequately, while too few Zambian women receive proper delivery care. The first of these implicit assumptions, the poor performance of traditional (ANC), prompted the adoption of the new ANC model in Zambia, focussed ANC (FANC). The second was behind another recent change in policy. Concomitant to FANC adoption, user fees for maternal care, amongst other health care activities, were abolished, in an effort to improve access to health care, particularly for the poor. These recent policy changes offer an ideal opportunity, a natural experimental setting, in which to examine the utilisation of maternal health care in Zambia. The thesis focussed on two main objectives. The first objective was to assess the factors, which determine the use of ANC and FANC in Zambia. The second objective was to establish the extent, to which, the abolition of user fees affected the use of facility-based deliveries, on the assumption that institutional delivery care is better than at-home delivery care. These objectives were addressed empirically, using multiple datasets and empirical strategies, in four separate analysis chapters.

The initial analysis chapter, although primarily descriptive, focused on estimating the determinants of ANC use between 1996 and 2007. Based on three comparable household surveys, and an appropriate econometric framework, it was found that the utilisation of ANC involves two distinct decision processes, and is adequately represented by a two-part model (TPM) in all three survey years. The TPM performed better than models that have been used more recently in literature in the examination of health utilisation using cross-sectional data. From a policy perspective, as well as an econometric perspective, results depend on the correctness of the specification, and the fit of the model to the data. Correctly specified models lead to consistent estimates that are necessary for effective policy formulation. Although different sets of explanatory variables were related to the decision to seek ANC and the intensity of use, over the period, there was some overlap. Some variables which were important for the decision to seek ANC were not important for the intensity of visits and vice-versa. Generally, the decision to seek ANC and the frequency of use was found to be low among the poor, less educated, and there were differences in utilisation at the provincial level. To be more specific, the influence of maternal education was more pronounced for the decision to seek any ANC care than for the frequency of visits. At the regional level, compared to women from Lusaka province, which hosts the capital city and is mostly urban, women in relatively rural provinces were less likely to seek any ANC and had fewer visits. The results from this chapter call for concerted efforts to develop innovative strategies aimed at encouraging women in the identified categories to seek ANC and reducing regional disparities in the utilisation of antenatal health services. One limitation of household surveys is that the health system or supply-side data, which influences maternal health utilisation, are often not available.

To address this limitation, the analysis was extended to incorporate supply-side factors; the 2007 Zambia Demographic and Health Survey data was linked to administrative and health facility data using geo-reference information. The inclusion of health system or supply-side factors is necessary to more fully understand the utilisation of ANC, since changes in the utilisation of services can be due to changes in the demand for ANC, supply or both. Two multilevel logistic models were fit to the data to assess the individual-level and community-level factors associated with the utilisation of ANC, following the adoption of FANC. We found that, while both individual-level and community-level factors are instrumental in determining adequate and inadequate ANC use, there are other unobserved factors, which are important for explaining ANC use. Notably, the quality of care received during ANC, as well as the quality of health services offered in the rural communities, was observed to play a crucial role in influencing ANC. Additionally, the educational status of the husband was found to be strongly associated with adequate use of ANC. This result supports the notion that husbands, in addition to pregnant women, should be included in any FANC awareness campaigns, and such inclusion may increase utilisation of ANC. Admittedly, general improvements in education are affected by policies outside the scope of our analysis; however, the observed benefits of education suggest that empowerment could be promoted through targeted interventions, substituting for the general role of education in improving knowledge of the use of antenatal services. Similarly, the results imply that investments in community health programmes that would educate women on the benefits of focused ANC, and the importance of early initiation of ANC, could improve ANC usage and timing.

In the first few analysis chapters, the focus was on ANC use. In the subsequent analysis chapters, the focus switched from pre-delivery maternal behaviours to time-of-delivery behaviours. In so doing, the thesis initially examined the impact of the abolition of user fees on facility-based deliveries, using longitudinal clinic-level data from 9 Zambian provinces between 2003q1 and 2008q4. Different empirical models were estimated to address heterogeneity, autocorrelation, heteroscedasticity and cross-sectional dependence within the panel context. After addressing econometric issues, a number of implications could be discerned from the results. The aggregate results provide strong evidence that the abolition of user fees had an immediate and positive impact on facility-based deliveries. However, the increase was not sustained via an increase in the trend, and the increase was economically small, 1.2% or 3.4%, depending on how the increase is measured. Unexpectedly, the aforementioned aggregate increase could not be ascribed to an increase in any particular region. Instead, immediate decreases were uncovered in some regions, while trend increases were uncovered in other regions. In other words, the aggregate results mask interesting regional heterogeneity. From a policy perspective, that heterogeneity is likely to be important; motivations for non-facility-based delivery might be social or cultural, factors not easily altered through reductions in the direct cost of delivery. Similarly, although it was not possible to consider indirect charges, as data was not available, anecdotal evidence suggests that facilities have followed a cost-shifting strategy, and that strategy could account for the economically small user fee impacts estimated here.

In addition to user fee effects, the analysis also identified a Traditional Birth Attendant (TBA) impact and a quality of service impact. At the aggregate level, TBAs are associated with a reduction in facility-based deliveries; however, at the regional level, the impact was more varied. In some provinces, the association was positive, while in others it was negative. With respect to service quality, a strong positive impact was uncovered at the national level, a result that carried over to a number of provinces. Again, the aggregate results masked interesting regional heterogeneity, and remind the researcher and policymaker that one size, often, does not fit all.

In addition to examining policy reform at the level of the clinic, the impact evaluation was also considered at the level of the pregnant woman via a difference-in-differences strategy. Although at its most basic level, understanding the impact of policy reform on soon-to-be mothers is important, understanding other determinants of delivery decisions could improve current policies or lead to different policies aimed at reducing MMR. Although reductions in home deliveries were observed, as a result of the policy change, reductions in public health facility-based deliveries were also uncovered, along with increases in deliveries at private health facilities. In other words, the policy did not appear to have the intended average effect. However, these findings were statistically insignificant; suggesting that the abolition of user fees had little, if any, impact on the choice of location for childbirth. The statistically insignificant, but unexpected, causal effects further suggest that the removal of user fees have unintended consequences that could not be directly addressed in this analysis, but are worthy of further consideration. Possibly, for example, facility costs are transferred to the client, because of user fee revenue reductions, which would deter the utilisation of delivery services. Furthermore, and similar to the ANC utilisation results, we found that the education of both the woman and the husband are strongly associated with delivery at a public health facility suggesting that men should also be part of the process, when it comes to improving maternal health care awareness. Finally, a positive relationship between deliveries in public health facilities and access to reproductive health services, such as ANC, was uncovered. The result points to spill over effects from other programmes, suggesting that improvements in ANC quality care are likely to lead to increased trust in the sector and increases in facility-based deliveries.

While much has been uncovered about the utilisation of maternal health care in Zambia, using the available data, the work presented here was not without limitations. Furthermore, one should not be comfortable proclaiming that policies designed from only the results presented here will be a panacea to all the challenges facing Zambia, in its efforts to improve maternal health. The most obvious concerns are issues which arise when dealing with secondary data such as data quality and finding the right match between the data used and the problem being investigated. For instance, routine health information systems across most developing countries, including Zambia, are not perfect; yet, these data sources underscore decision-making and policy formulation for health system managers. It is possible that routine data is either too sporadic or too frequent for the decision or formulated policy to be relevant. More practically, observed increases in any activity recorded on the system, such as ANC or facility-based delivery, could reflect better recording, rather than actual increases. Moreover, quarterly data, such as that used in the analysis, is less frequent than monthly data, and, therefore, it might hide trends in utilisation. However, both quarterly data and monthly data might be too noisy for the identification of trends. Another concern about administrative data is it neither provides information about non-users nor includes socioeconomic and related characteristics of users. Specific information about users and non-users is more useful in exploring response heterogeneity, e.g. user fee abolition may have affected poor women differently than non-poor women. Unfortunately, the routine data used in the analysis mostly covered public health facilities in Zambia. Thus, the observed changes in utilisation is unlikely to reflect all health facilities in the country, since most private health facilities have not been incorporated into the health information system.

Another general concern that arises is that, even though the policy reform might have been announced, there is often a challenge associated with identifying the timing of implementation. In the case of this thesis, this challenge arose for FANC. By 2009, for example, FANC covered only 63% of the country; worse, we were unable to identify the exact districts in which FANC was introduced, due to unavailability of data. Therefore, the analysis also includes some areas in which components of FANC may not, yet, have been introduced, which affects both the results and the interpretations arising from the results. For the most part, the bias generated is only likely to be problematic, if the characteristics, especially unobservable characteristics, of the women in uncovered areas are significantly different from those in covered areas, and those differences somehow impacted on the district's ability to implement FANC. However, because actual availability of FANC is measured with error, any FANC impact is likely to be underestimated.

In attempting to address these problems, we made use of health facilities census (HFC) data, which enabled us to include measures not captured in the household survey, such as distance to the health facility, to assess accessibility. Unfortunately, distances are measured in a straight line to the nearest health facility, and not necessarily to facilities providing ANC or delivery services. While most of the facilities covered in the ZHFC provide ANC services, not all of them provide delivery services; including all of the facilities, therefore, could generate some bias in the results. One additional, but related, potential source of bias comes from the geo-scrambling procedure used to make the DHS respondents anonymous, since it generates noise in the distance measures. Finally, due to data limitations, the analysis does not include women who died, due to childbirth-related complications, and, therefore, assuming that more maternal deaths are associated with non-facility deliveries, women making use of facility delivery services are more likely to be alive to be surveyed. Thus, overestimation of facility delivery was a possibility.

Notwithstanding the limitations in the analysis, we feel that this thesis has contributed to our understanding of maternal health in Zambia. Undoubtedly, this thesis is topical in its examination of maternal health and related policies in Zambia, particularly with respect to the expectation that developing countries should meet the MDGs. The results from the thesis can be used as key inputs in the process to further improve maternal health in the country. As stated earlier, the country's primary health objective is to increase access to quality health care services, including maternal care, in the hope of improving outcomes. However, very little empirical evidence has been available in Zambia for the development of effective policies. Although we do not think that this thesis eliminates the need for further empirical research, we do feel that the results provide more detail than has been previously available.

The thesis results have shown that education, the quality of care provided and other characteristics are key determinants in the utilisation of ANC. It is, therefore, important to develop innovative strategies aimed at encouraging women to seek maternal care. The findings support a call for the adoption of measures, which will further improve the quality of ANC provided. Furthermore, the findings support the provision of community programmes that educate both women and their husbands, and men more generally, on the benefits of focused ANC and the importance of early initiation of ANC. Policies accounting for cultural practices related to pregnancy are needed, in order to address the identified factors associated with the non-use of ANC in the first trimester. While the place of traditional birth attendants in global health is widely debated, it cannot be overlooked in the Zambian set up, which hinges on strong cultural practices, particularly with the scarcity of health personnel in the health sector.

However, there are some areas that were not covered in the thesis, due to time and data limitations, but are important in Zambia's quest to improve maternal health care. For instance, there is need to further relate user fee abolition policies to maternal health outcomes, and, subsequently, to child health outcomes. Such analysis requires information on maternal and child health outcomes, which was not available for the study. Another aspect worthy of further analysis is the spatial correlation uncovered in the research. Recent advancements in spatial econometrics, which gives more importance to the distance between regions, could, for example, be used to examine how health policy and its effects emanate from the capital to the rest of country. This thesis has uncovered regional disparities, implying that the rural-urban maternal health services utilisation divide is real in Zambia. Further work is needed to understand the determinants of these observed disparities. More so, there is also need to identify other factors affecting the utilisation of ANC in the first trimester, particularly in the rural areas of Zambia, in order to translate utilisation of ANC into better maternal health outcomes.

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Appendix A

A Appendix for Chapter 2

A.1: Summary statistics for the explanatory variables, 1996 (N=4425)

Variable	Mean	S.D	Min	Max
no education	0.149	0.357	0	1
primary	0.638	0.481	0	1
secondary or higher	0.212	0.409	0	1
partner_no educ	0.148	0.355	0	1
partner_primary	0.446	0.497	0	1
partner_sec or higher	0.406	0.491	0	1
employed	0.526	0.499	0	1
parity 1	0.205	0.404	0	1
parity 2-4	0.440	0.496	0	1
parity 5+	0.355	0.479	0	1
catholic	0.227	0.419	0	1
protestant	0.756	0.429	0	1
other	0.016	0.127	0	1
poorest	0.295	0.456	0	1
poorer	0.179	0.383	0	1
middle	0.198	0.399	0	1
richer	0.183	0.387	0	1
richest	0.145	0.352	0	1
urban	0.338	0.473	0	1
household childcare burden	1.807	1.075	0	8
central	0.090	0.286	0	1
copperbelt	0.130	0.337	0	1
eastern	0.156	0.363	0	1
luapula	0.114	0.318	0	1
lusaka	0.117	0.322	0	1
northern	0.101	0.301	0	1
north-western	0.080	0.271	0	1
southern	0.111	0.315	0	1
western	0.101	0.301	0	1

A.2: Summary statistics for the explanatory variables, 2001/2 (N=3846)

Variable	Mean	S.D	Min	Max
no education	0.149	0.356	0	1
primary	0.626	0.484	0	1
secondary or higher	0.225	0.418	0	1
partner_no educ	0.146	0.353	0	1
partner_primary	0.468	0.499	0	1
partner_sec or higher	0.386	0.487	0	1
employed	0.600	0.490	0	1
parity 1	0.211	0.408	0	1
parity 2-4	0.440	0.496	0	1
parity 5+	0.349	0.477	0	1
catholic	0.225	0.418	0	1
protestant	0.752	0.432	0	1
other	0.023	0.150	0	1
poorest	0.234	0.423	0	1
poorer	0.215	0.411	0	1
middle	0.233	0.423	0	1
richer	0.187	0.390	0	1
richest	0.131	0.337	0	1
urban	0.288	0.453	0	1
household childcare burden	1.764	1.004	0	9
central	0.108	0.310	0	1
copperbelt	0.109	0.312	0	1
eastern	0.124	0.330	0	1
luapula	0.093	0.290	0	1
lusaka	0.103	0.304	0	1
northern	0.153	0.360	0	1
north-western	0.134	0.341	0	1
southern	0.100	0.299	0	1
western	0.077	0.266	0	1

A.3: Summary statistics for the explanatory variables, 2007 (N=3618)

Variable	Mean	S.D	Min	Max
no education	0.125	0.331	0	1
primary	0.595	0.491	0	1
secondary or higher	0.280	0.449	0	1
partner_no educ	0.167	0.373	0	1
partner_primary	0.432	0.495	0	1
partner_sec or higher	0.401	0.490	0	1
employed	0.507	0.500	0	1
parity 1	0.200	0.400	0	1
parity 2-4	0.471	0.499	0	1
parity 5+	0.330	0.470	0	1
catholic	0.179	0.384	0	1
protestant	0.803	0.397	0	1
other	0.017	0.130	0	1
poorest	0.206	0.404	0	1
poorer	0.202	0.402	0	1
middle	0.227	0.419	0	1
richer	0.225	0.418	0	1
richest	0.140	0.347	0	1
urban	0.352	0.478	0	1
household childcare burden	1.724	0.911	0	6
central	0.086	0.280	0	1
copperbelt	0.094	0.291	0	1
eastern	0.149	0.356	0	1
luapula	0.115	0.319	0	1
lusaka	0.106	0.308	0	1
northern	0.116	0.320	0	1
north-western	0.098	0.298	0	1
southern	0.126	0.332	0	1
western	0.110	0.313	0	1

B Appendix for Chapter 3

B.1: Description of two-level multilevel models

Multilevel analysis is an analytical approach appropriate for hierarchical data involving lower units nested within higher units (Bryk and Raudenbush, 2002; Rabe-Hesketh and Skrondal, 2008). In this type of analysis, the clusters or groups are not treated independently. Multilevel analysis allows the simultaneous examination of the effects of group-level and individual-level variables on individual-level outcomes (Goldstein, 1995). With hierarchical data, multilevel analysis enables one to conduct the following analysis: a) remove the effect of clustering in order to obtain valid estimates for the parameters and standard errors, b) to study the effect of variables that act at different levels of the hierarchy, and c) to study how the variance of the outcome is distributed across the levels of the hierarchy. It can then be determined at which level of the hierarchy the greatest variation occurs. Such information is often useful for policymakers, since interventions need to be targeted at the level where they can achieve the greatest effect.

Based on work from Goldstein (1995) and Bryk and Raudenbush (2002), this section provides a summary of two-level multilevel models for a binary outcome. A two-level model consists of two sub-models at level 1 and level 2. In this chapter, a (two-level) multilevel logistic regression model was used, consisting of two sub-models at level 1 and 2. Level 1 represents the relationships among the individual-level variables, while level 2 examines the influence of community-level factors. For the dichotomous outcomes, we specify a (two-level) multilevel model, predicated on binomial sampling and a logit link (Rabe-Hesketh and Skrondal, 2008). In the level 1 model, the outcome variable Y_{ij} for the i^{th} individual living in the j^{th} community is given as:

$$\mathrm{Prob}(Y_{ij} = 1 \mid B) = \pi_{ij}$$

$$\text{Level 1 variance} = [\pi_{ij}(1-\pi_{ij})]$$

$$\text{Predicted log odds } \eta_{ij} = \log[\pi_{ij}/(1-\pi_{ij})]$$

$$\eta_{ij} = \beta_{0j} + \sum_{q=1}^{Q} \beta_{qj} X_{qij}$$

Where π_{ij} is the probability that the outcome for the i^{th} individual in the j^{th} community is a success ('1' shows the occurrence of the event), β_{0j} is the level 1 intercept, β_{qj} are the level 1 coefficients and X_{qij} is level 1 predictor variable q for the i^{th} individual in the j^{th} community.

$OR = \exp(\eta_{ij})$ is used to convert the predicted log-odds to odds ratios, and $\pi_{ij} = 1/[1+\exp(-\eta_{ij})]$ converts the predicted log-odds to predicted probability.

In the level 2 model, each of the level 1 coefficients, as defined in the level 1 model, β_{qj}, becomes an outcome and can be expressed as:

$$\beta_{qj} = \gamma_{q0} + \gamma_{q1}W_{1j} + \gamma_{q2}W_{2j} + \ldots + \gamma_{qSq}W_{Sqj} + \mu_{qj}$$

$$= \gamma_{q0} + \sum_{s=1}^{S_q} \gamma_{qS}W_{Sj} + \mu_{qj}$$

Where γ_{qS}, *(q=0,1,…,S$_q$)* are level 2 coefficients, W_{Sj} are level 2 predictors and μ_{qj} is the level 2 random effect. All the level 2 random effects are assumed to follow a normal distribution, with mean 0 and variance τ_{qq}. A comparison of the variance (τ_{qq}) of the intercept β_0 and the corresponding standard error provides an indication of whether there are variations among the communities in terms of the outcome of interest.

C Appendix for Chapter 4

C.1: List of 54 districts where user fees were removed for the entire district on 1st April 2006.

Luapula Province	Western Province	North Western Province
Kawambwa	Kaoma	Kabompo
Chiengi	Lukulu	Kasempa
Milenge	Kalabo	Mwinilunga
Mwense	Senanga	Chavuma
Nchelenge	Sesheke	Zambezi
Samfya	Shangombo	Mufumbwe

Northern Province	Southern Province	Lusaka Province
Chinsali	Gwembe	Luangwa
Isoka	Itezhi-tezhi	Chongwe
Kaputa	Kalomo	Kafue
Chilubi	Kazungula	
Luwingu	Monze	
Mpika	Namwala	
Mporokoso	Siavonga	
Mpulungu	Sinazongwe	
Mungwi		
Nakonde		

C.2: Means of institutional deliveries at provincial level

	Before	After	Diff
Central	0.305	0.314	0.009
se(mean)	(0.008)	(0.007)	(0.012)
Copperbelt	0.476	0.387	-0.088**
se(mean)	(0.019)	(0.013)	(0.024)
Eastern	0.315	0.369	0.054**
se(mean)	(0.012)	(0.018)	(0.021)
Luapula	0.307	0.382	0.075***
se(mean)	(0.005)	(0.013)	(0.013)
Lusaka	0.296	0.356	0.060***
se(mean)	(0.009)	(0.020)	(0.021)
Northern	0.275	0.283	0.007***
se(mean)	(0.006)	(0.005)	(0.008)
N/Western	0.503	0.525	0.022***
se(mean)	(0.011)	(0.021)	(0.023)
Southern	0.278	0.291	0.014
se(mean)	(0.007)	(0.012)	(0.014)
Western	0.370	0.363	-0.006
se(mean)	(0.013)	(0.009)	(0.016)

[+] Diff gives the difference between before and after the intervention (After-before).

C.3 Graphical analysis of the abolition of user fees

In this section, we present a graphical inspection of the variables of interest. Figure C.3.1 plots the proportion of institutional deliveries at national and provincial level. The vertical line in 2006q2 indicates the quarter in which the user fees were abolished. Notice that the national and provincial means depict a slight upward trend in the period after the removal of user fees. However, in order to draw efficient conclusions, we need to conduct an assessment based on econometric modelling. A closer visual inspection of the data shows that, in general, institutional deliveries spike in the third quarter for the period 2003q1 to 2008q4. This cyclic nature of the data suggests that we must control for quarter-to-quarter conditions that may alter institutional deliveries.

C.3.1: Proportion of institutional deliveries at National and Provincial level, 2003q1-2008q4

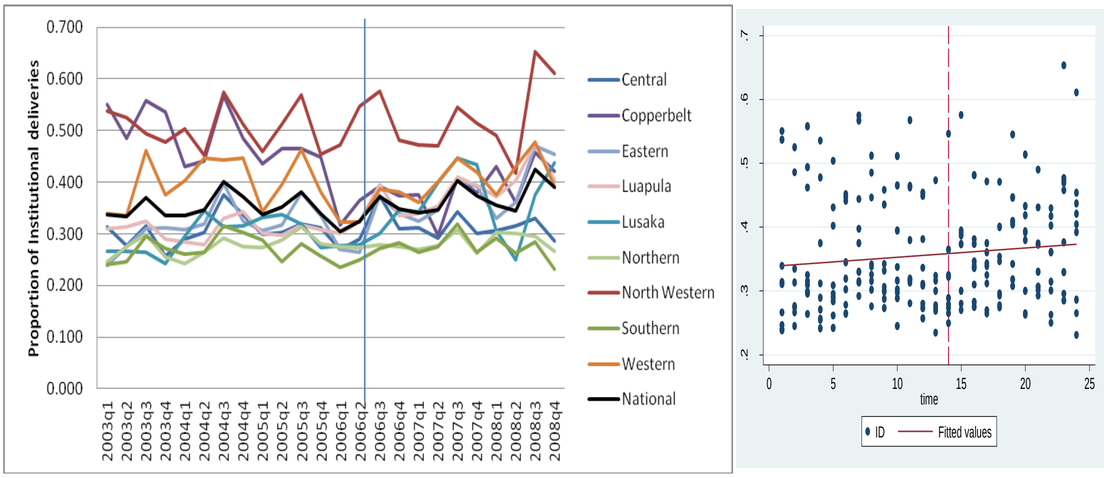


Figure C.3.2 plots the proportion of drugs available at national and provincial level from 2003q1 to 2008q4. In this figure, we see a slight downward trend in drug availability at national level before and after the abolition of user fees. There are variations in drug availability in the different provinces with Luapula province showing a lower mean before the abolition of user fees and higher mean post user fee abolition. On the other hand, North Western province appears to have a higher mean before the abolition of fees and a lower mean after. Indications are that in the months prior to the abolition of user fees, and immediately after, nationwide drug supply was low, which was remedied by 2006q4 (Masiye *et al.*, 2008).

C.3.2: Proportion of drug availability at National and Provincial level, 2003q1-2008q4

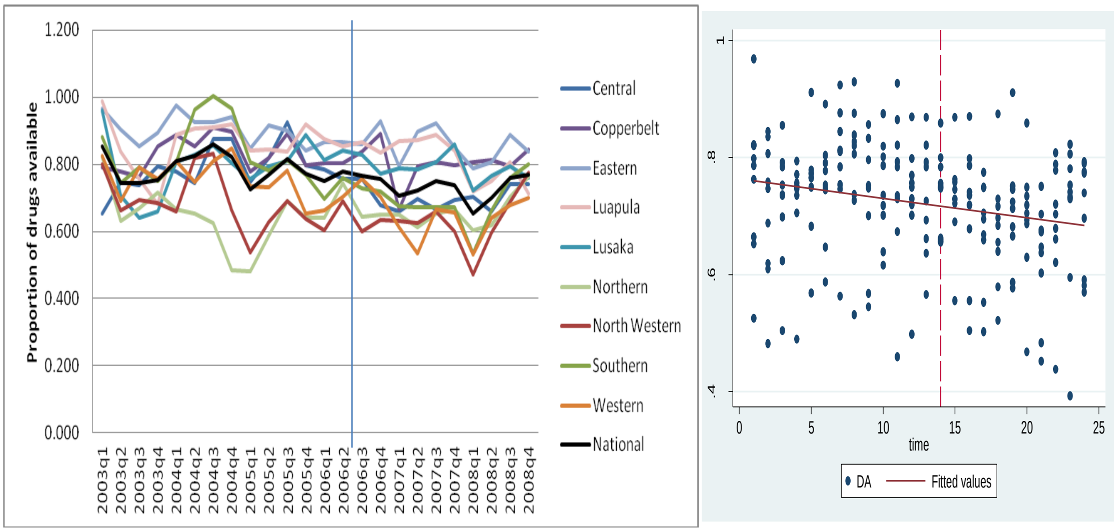
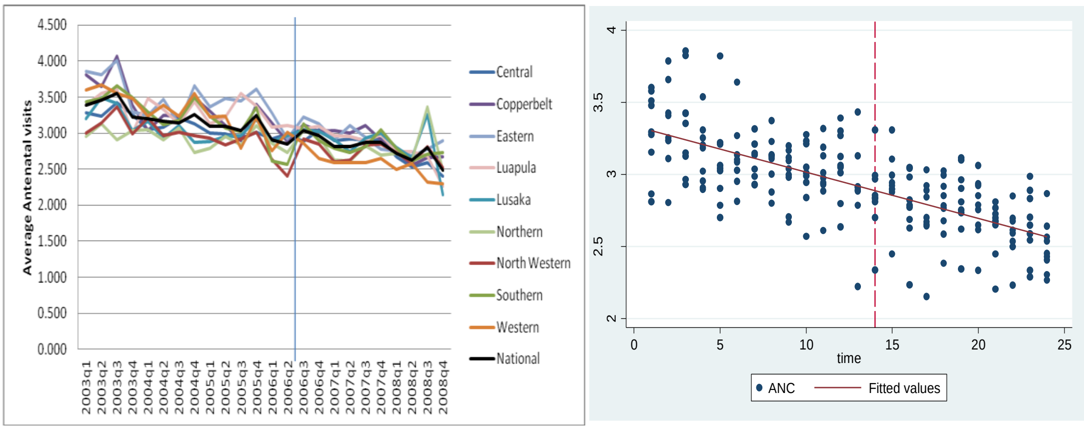


Figure C.3.3 shows the average antenatal visits at the national and provincial level for the period 2003q1 to 2008q4. At the national level, the data indicate a general declining trend. In 2003q1, antenatal visits at national level were on average 2.8, but this declined to 2.3 in 2008q4. Notice that all the provinces show a decline in average antenatal visits over the period 2003q1 to 2008q4. This decreasing trend reflects the introduction of the focussed antenatal care (FANC) in Zambia. FANC is a new approach advocated for by the World Health Organisation (WHO), which recommends at least four visits (instead of 12) for a woman without complications (Villar *et al.*, 2001). The approach emphasises quality of care during ANC visits over the quantity. Key elements of FANC were introduced in the National Strategic Plan in Zambia (MoH, 2005).

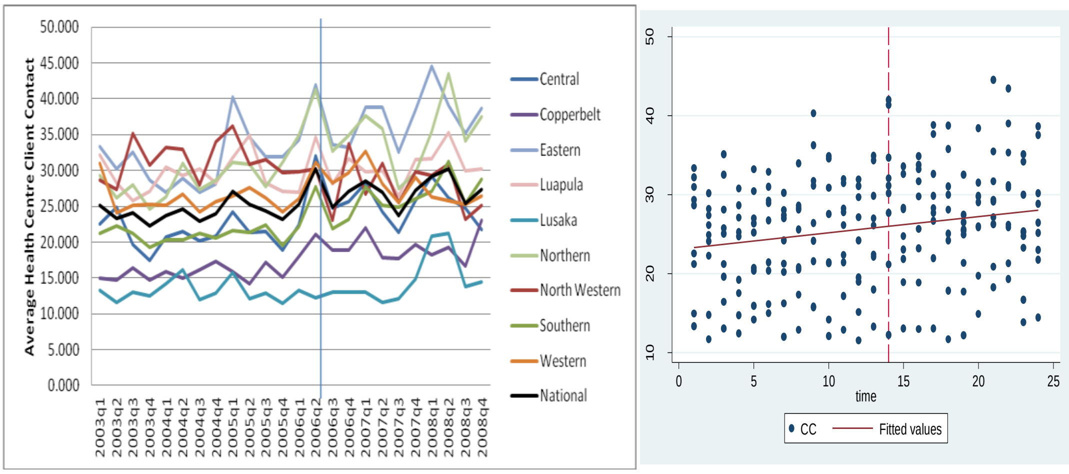
C.3.3 Average antenatal visits at National and Provincial level, 2003q1-2008q4



In Figure C.3.4, we plot the average Health Centre Client Contact per day at national and provincial level for the period 2003q1 to 2008q4. Notice that there is a short-lived spike in health centre client contact in 2006q2 when user fees were abolished in almost all the provinces.

Generally, there appears to have been an increase in staff workload, after the removal of user fees.

C.3.4: Average Health Centre Client Contact per day at National and Provincial level, 2003q1-2008q4



C.3.5: Trend in Population at National and Provincial level, 2003q1-2008q4

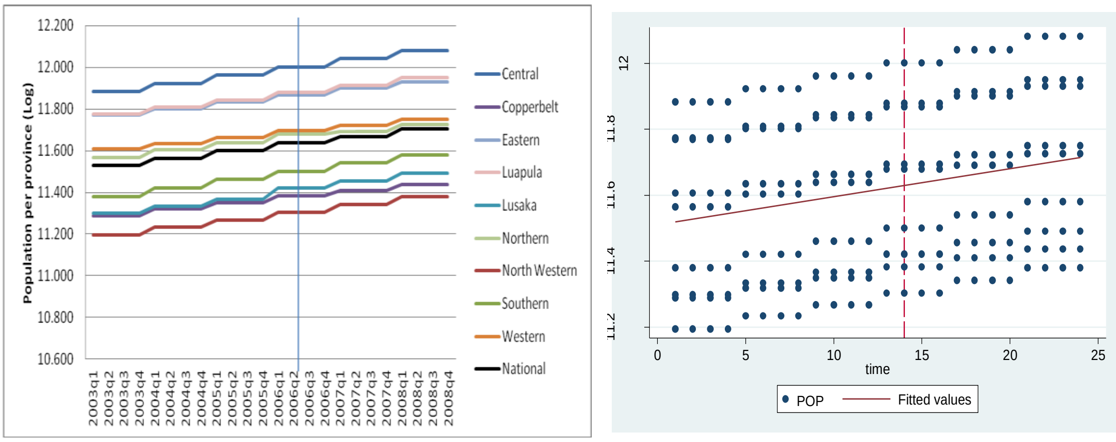
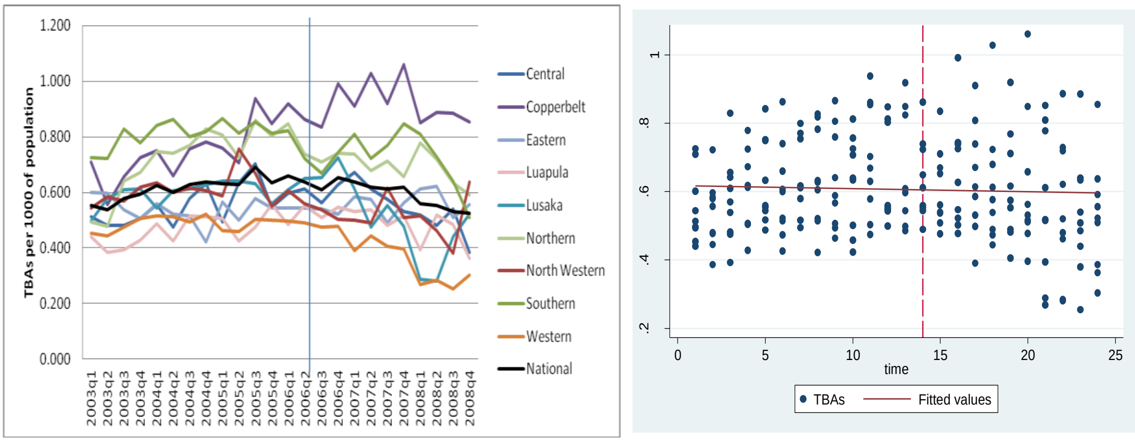
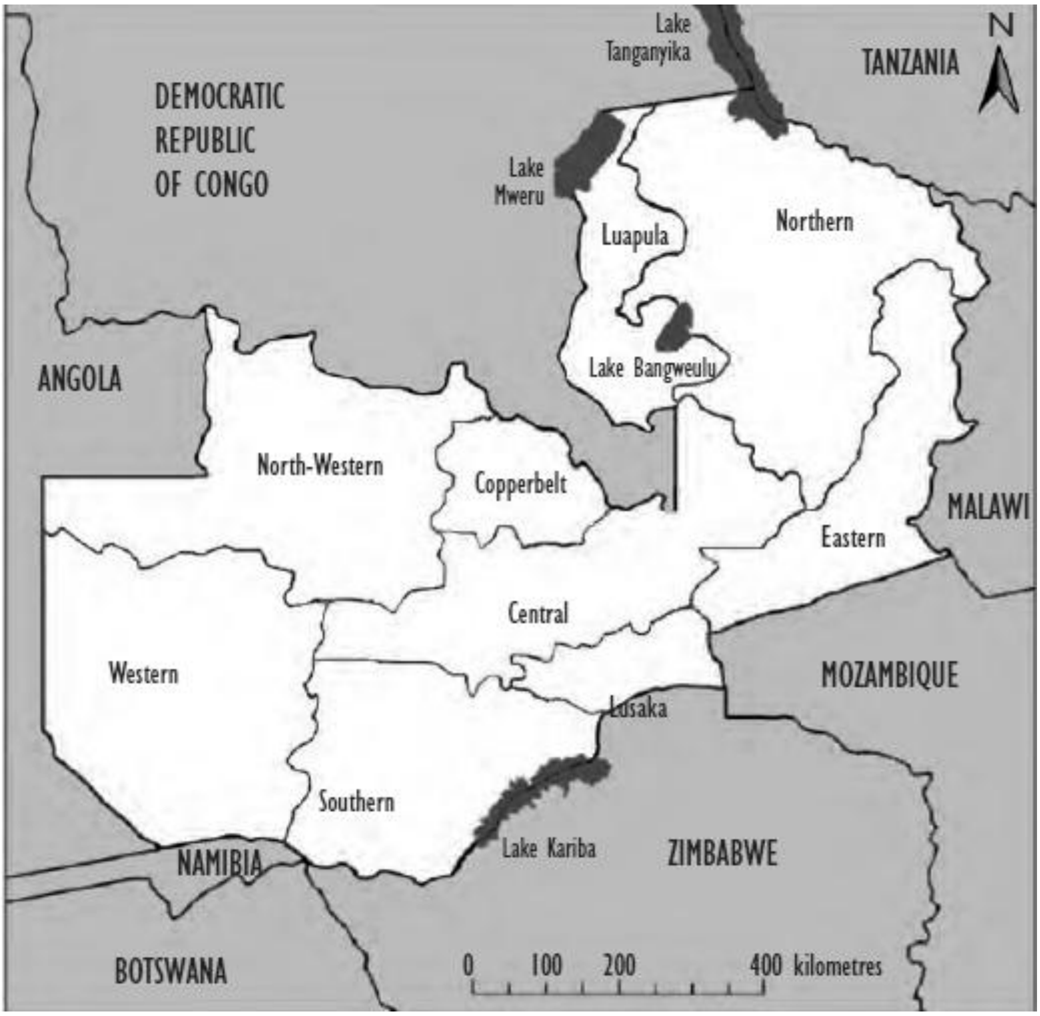


Figure C.3.5 reports the trends in population over the period of interest. As expected, we observe a general increase in population. In Figure C.3.6, we report the time series for the number of TBAs per 1000 of the population. In the figure, the quarter-to-quarter variations in TBAs per 1000 of the population dwarf any systematic trend over the period of interest. However, Table 4.2 which provides numeric estimates that coincide with the graphical representation in Figures C.3.6 suggests no significant difference in the number of TBAs per 1000 of the population before and after the abolition of user fees.

C.3.6: Number of TBAs per 1000 at National and Provincial level, 2003q1-2008q1



C.4: Map of Zambia showing provinces



Source: CSO, TDRC, UNZA, Macro International, 2009

D Appendix for Chapter 5

D.1: Full results-Odds ratios

	Model 1						Model 2					
	Home		Public		Private		Home		Public		Private	
	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Individual level variables												
Delivery after abolition of fees	1.077	(0.802 , 1.446)	1.029	(0.773 , 1.370)	0.590	(0.275 , 1.266)	1.067	(0.793 , 1.435)	1.051	(0.788 , 1.400)	0.565	(0.260 , 1.225)
Lives in one of the 54 districts with policy reform	1.607***	(1.165 , 2.216)	0.543***	(0.388 , 0.759)	2.045	(0.833 , 5.021)	1.107	(0.790 , 1.552)	0.852	(0.597 , 1.216)	1.846	(0.601 , 5.676)
DD estimator	0.925	(0.645 , 1.327)	0.993	(0.695 , 1.419)	1.582	(0.649 , 3.861)	0.944	(0.658 , 1.356)	0.960	(0.672 , 1.371)	1.649	(0.669 , 4.065)
Parity (ref=1)												
2-4	2.072***	(1.598 , 2.687)	0.528***	(0.410 , 0.681)	0.736	(0.409 , 1.323)	2.093***	(1.614 , 2.714)	0.520***	(0.403 , 0.670)	0.744	(0.414 , 1.338)
5+	2.310***	(1.741 , 3.064)	0.434***	(0.328 , 0.573)	1.061	(0.558 , 2.017)	2.337***	(1.762 , 3.100)	0.424***	(0.321 , 0.561)	1.086	(0.571 , 2.067)
ANC utilisation												
Four or more visits	0.728***	(0.608 , 0.871)	1.285***	(1.073 , 1.539)	1.406	(0.921 , 2.148)	0.716***	(0.599 , 0.857)	1.295***	(1.082 , 1.551)	1.427	(0.934 , 2.181)
Religion (ref=Catholic)												
Protestant	1.024	(0.809 , 1.296)	1.000	(0.790 , 1.267)	0.873	(0.510 , 1.494)	1.017	(0.805 , 1.285)	1.021	(0.808 , 1.291)	0.837	(0.488 , 1.434)
Other	1.551	(0.711 , 3.385)	0.561	(0.252 , 1.248)	1.396	(0.283 , 6.896)	1.507	(0.687 , 3.308)	0.584	(0.260 , 1.314)	1.306	(0.264 , 6.447)
Household childcare burden												
Number of children under 5 in HH	0.971	(0.876 , 1.076)	0.998	(0.900 , 1.106)	1.221	(0.961 , 1.551)	0.955	(0.861 , 1.058)	1.014	(0.915 , 1.123)	1.221	(0.962 , 1.550)
Woman's employment status (ref=unemployed)												
Employed	0.923	(0.770 , 1.107)	0.989	(0.825 , 1.187)	1.550**	(1.009 , 2.379)	0.910	(0.759 , 1.092)	1.023	(0.853 , 1.227)	1.460*	(0.949 , 2.247)
Woman's education (ref=no education)												
Primary	0.667***	(0.507 , 0.877)	1.489***	(1.121 , 1.978)	1.266	(0.643 , 2.494)	0.668***	(0.509 , 0.876)	1.482***	(1.118 , 1.965)	1.287	(0.654 , 2.535)
Secondary and above	0.492***	(0.354 , 0.684)	1.998***	(1.429 , 2.794)	1.040	(0.465 , 2.323)	0.509***	(0.367 , 0.707)	1.939***	(1.389 , 2.706)	1.021	(0.456 , 2.285)
Partner's education (ref=no education)												
Primary	1.339**	(1.023 , 1.752)	0.736**	(0.561 , 0.967)	1.090	(0.568 , 2.090)	1.299*	(0.993 , 1.701)	0.753**	(0.573 , 0.988)	1.134	(0.592 , 2.175)
Secondary and above	0.968	(0.732 , 1.281)	0.945	(0.715 , 1.250)	1.417	(0.750 , 2.677)	0.968	(0.732 , 1.281)	0.937	(0.709 , 1.239)	1.471	(0.779 , 2.777)
Index for actual quality of ANC received	0.879***	(0.859 , 0.900)	1.106***	(1.080 , 1.132)	1.146***	(1.076 , 1.220)	0.888***	(0.867 , 0.909)	1.097***	(1.071 , 1.123)	1.139***	(1.069 , 1.214)
Household wealth(ref=poorest)												
Middle	0.788**	(0.627 , 0.990)	1.363**	(1.076 , 1.727)	0.885	(0.482 , 1.622)	0.905	(0.718 , 1.140)	1.203	(0.948 , 1.527)	0.893	(0.484 , 1.648)
Rich	0.274***	(0.206 , 0.365)	3.285***	(2.453 , 4.400)	1.634	(0.794 , 3.360)	0.438***	(0.315 , 0.607)	2.161***	(1.554 , 3.007)	1.451	(0.652 , 3.231)

Duration of residence (ref=previous res, rural)												
0-4 (previous residence, urban)	0.604***	(0.439 , 0.832)	1.643***	(1.207 , 2.237)	0.559	(0.274 , 1.142)	0.651***	(0.472 , 0.899)	1.540***	(1.129 , 2.100)	0.545*	(0.266 , 1.117)
5+	0.950	(0.768 , 1.175)	1.094	(0.882 , 1.356)	0.758	(0.458 , 1.253)	0.960	(0.777 , 1.187)	1.083	(0.874 , 1.342)	0.753	(0.455 , 1.246)
Community level variables												
Area type (ref=rural)												
Urban							0.413***	(0.289 , 0.590)	2.314***	(1.598 , 3.351)	1.532	(0.510 , 4.601)
Proportion of drugs available							1.406	(0.444 , 4.451)	0.262**	(0.076 , 0.903)	37.041**	(1.073 , 1,278)
Material deprivation index							0.884**	(0.796 , 0.983)	1.123**	(1.005 , 1.254)	1.047	(0.758 , 1.448)
Distance to nearest facility							1.045***	(1.021 , 1.069)	0.956***	(0.933 , 0.981)	0.988	(0.915 , 1.068)
Density of health facilities							2.424	(0.177 , 33.282)	0.042**	(0.003 , 0.682)	46,357.818***	(15.559 , 1,381)
Prenatal care uptake							1.547	(0.608 , 3.935)	0.448	(0.169 , 1.187)	2.309	(0.153 , 34.90)
TBA per 1000 of pop.							2.806***	(1.657 , 4.754)	0.402***	(0.227 , 0.711)	0.593	(0.107 , 3.275)
Constant	1.135	(0.664 , 1.940)	0.783	(0.453 , 1.355)	0.002***	(0.001 , 0.010)	0.323	(0.076 , 1.381)	9.713***	(2.116 , 44.579)	0.000***	(0.000 , 0.002)
rho	0.166		0.209		0.601		0.123		0.157		0.590	
LR test (Chi2 value)	495.3***		420.1***		44.47***		556.7***		486.3***		52.76***	
Log likelihood	-1833		-1869		-516.4		-1799		-1833		-511.0	
AIC	3708.36		3779.15		1074.76		3654.5		3722.22		1078.058	
BIC	3837.91		3908.7		1204.32		3827.24		3894.97		1250.8	

*** p<0.01, ** p<0.05, * p<0.1

D.2: Specification test-without selective migration

	Home	S.E	Public	S.E	Private	S.E
Individual level variables						
Delivery after abolition of fees	0.063	(0.151)	0.048	(0.146)	-0.516	(0.389)
Lives in one of the 54 districts with policy reform	0.107	(0.173)	-0.165	(0.182)	0.760*	(0.454)
DD estimator	-0.056	(0.184)	-0.042	(0.182)	0.454	(0.454)
Parity (ref=1)						
2-4	0.736***	(0.131)	-0.651***	(0.129)	-0.309	(0.298)
5+	0.867***	(0.142)	-0.872***	(0.140)	0.043	(0.322)
ANC utilisation						
Four or more visits	-0.343***	(0.092)	0.269***	(0.092)	0.333	(0.216)
Religion (ref=Catholic)						
Protestant	0.015	(0.119)	0.022	(0.119)	-0.137	(0.274)
Other	0.416	(0.403)	-0.546	(0.414)	0.336	(0.810)
Household childcare burden						
Number of children under 5 in HH	-0.045	(0.052)	0.014	(0.052)	0.199	(0.123)
Woman's employment status (ref=unemployed)						
Employed	-0.086	(0.093)	0.016	(0.093)	0.434**	(0.218)
Woman's education (ref=no education)						
Primary	-0.402***	(0.139)	0.390***	(0.144)	0.235	(0.345)
Secondary and above	-0.688***	(0.167)	0.675***	(0.170)	0.020	(0.410)
Partner's education (ref=no education)						
Primary	0.260*	(0.137)	-0.284**	(0.138)	0.111	(0.329)
Secondary and above	-0.051	(0.142)	-0.047	(0.141)	0.360	(0.321)
Index for actual quality of ANC received	-0.120***	(0.012)	0.094***	(0.012)	0.133***	(0.032)
Household wealth(ref=poorest)						
Middle	-0.109	(0.118)	0.190	(0.122)	-0.144	(0.309)
Rich	-0.860***	(0.167)	0.801***	(0.168)	0.416	(0.366)
Duration of residence (ref=previous res, rural)						
0-4 (previous residence, urban)						
5+						
Community level variables						
Area type (ref=rural)						
Urban	-0.927***	(0.182)	0.879***	(0.189)		
Proportion of drugs available	0.298	(0.590)	-1.286**	(0.630)		
Material deprivation index	-0.114**	(0.054)	0.108*	(0.057)		
Distance to nearest facility	0.044***	(0.012)	-0.045***	(0.013)		
Density of health facilities	0.831	(1.343)	-3.095**	(1.418)		
Prenatal care uptake	0.450	(0.478)	-0.812	(0.497)		
TBA per 1000 of pop.	1.030***	(0.270)	-0.914***	(0.292)		
Constant	-1.162	(0.740)	2.326***	(0.774)	-6.328***	(0.744)
Rho	0.125		0.158		0.595	
Log likelihood	-1803		-1837		-517.7	
LR test (Chi2 value)	553.2***		482.9***		42.32***	

*** p<0.01, ** p<0.05, * p<0.1

D.3: Specification tests-including interaction terms

	Home	S.E	Public	S.E	Private	S.E
Individual level variables						
Delivery after abolition of fees	0.083	(0.152)	0.026	(0.146)	-0.521	(0.394)
Lives in one of the 54 districts with policy reform	0.338	(0.248)	-0.496*	(0.260)	0.956	(0.761)
DD estimator	-0.084	(0.186)	-0.008	(0.183)	0.450	(0.459)
Parity (ref=1)						
2-4	0.738***	(0.133)	-0.651***	(0.130)	-0.311	(0.299)
5+	0.844***	(0.144)	-0.852***	(0.143)	0.038	(0.329)
ANC utilisation						
Four or more visits	-0.334***	(0.092)	0.261***	(0.092)	0.338	(0.217)
Religion (ref=Catholic)						
Protestant	0.014	(0.120)	0.021	(0.120)	-0.136	(0.275)
Other	0.383	(0.401)	-0.506	(0.413)	0.299	(0.820)
Household childcare burden						
Number of children under 5 in HH	-0.047	(0.053)	0.013	(0.053)	0.201*	(0.122)
Woman's employment status (ref=unemployed)						
Employed	0.115	(0.154)	-0.160	(0.147)	0.444	(0.383)
Woman's education (ref=no education)						
Primary	-0.399***	(0.139)	0.384***	(0.144)	0.239	(0.347)
Secondary and above	-0.673***	(0.167)	0.654***	(0.170)	0.052	(0.411)
Partner's education (ref=no education)						
Primary	0.265*	(0.138)	-0.288**	(0.139)	0.089	(0.332)
Secondary and above	-0.032	(0.143)	-0.065	(0.143)	0.356	(0.325)
Index for actual quality of ANC received	-0.120***	(0.012)	0.092***	(0.012)	0.138***	(0.032)
Household wealth(ref=poorest)						
Middle	0.019	(0.228)	0.096	(0.232)	-1.646	(1.161)
Rich	-0.790***	(0.293)	0.637**	(0.295)	0.865	(0.677)
Duration of residence (ref=previous res, rural)						
0-4 (previous residence, urban)	-0.416**	(0.165)	0.427***	(0.158)	-0.592	(0.364)
5+	-0.032	(0.108)	0.075	(0.110)	-0.285	(0.257)
Community level variables						
Area type (ref=rural)						
Urban	-0.882***	(0.291)	0.729**	(0.298)		
Proportion of drugs available	0.359	(0.590)	-1.380**	(0.632)		
Material deprivation index	-0.118**	(0.056)	0.096*	(0.058)		
Distance to nearest facility	0.044***	(0.012)	-0.044***	(0.013)		
Density of health facilities	0.783	(1.342)	-3.098**	(1.422)		
Prenatal care uptake	0.430	(0.480)	-0.760	(0.501)		
TBA per 1000 of pop.	1.002***	(0.271)	-0.919***	(0.294)		
middle*2006	-0.175	(0.267)	0.110	(0.273)	1.693	(1.204)
rich*2006	-0.034	(0.346)	0.202	(0.349)	-0.697	(0.781)
urban*2006	0.015	(0.372)	0.256	(0.385)		
employed*2006	-0.325*	(0.191)	0.297	(0.188)	-0.017	(0.463)
Constant	-1.273*	(0.756)	2.500***	(0.794)	-6.267***	(0.908)
LR test (Chi2 value)	556.6***		487.3***		46.44**	
Log likelihood	-1798		-1831		-513.5	
rho	0.124		0.157		0.595	

D.4: Specification tests-placebo

	Home	S.E	Public	S.E	Private	S.E
Individual level variables						
Delivery after abolition of fees	0.299	(0.234)	0.106	(0.238)	-1.850**	(0.801)
Lives in one of the 54 districts with policy reform	0.116	(0.225)	-0.147	(0.237)	0.431	(0.704)
DD estimator	-0.172	(0.293)	-0.108	(0.305)	1.436	(0.962)
Parity (ref=1)						
2-4	0.517***	(0.173)	-0.434**	(0.169)	-0.261	(0.383)
5+	0.754***	(0.188)	-0.772***	(0.185)	0.129	(0.418)
ANC utilisation						
Four or more visits	-0.267**	(0.124)	0.246**	(0.124)	-0.049	(0.276)
Religion (ref=Catholic)						
Protestant	0.169	(0.159)	-0.116	(0.157)	-0.228	(0.347)
Other	0.054	(0.528)	-0.387	(0.542)	0.676	(0.941)
Household childcare burden						
Number of children under 5 in HH	-0.028	(0.070)	-0.034	(0.070)	0.314**	(0.155)
Woman's employment status (ref=unemployed)						
Employed	-0.225*	(0.123)	0.159	(0.122)	0.318	(0.277)
Woman's education (ref=no education)						
Primary	-0.453**	(0.188)	0.446**	(0.196)	0.363	(0.471)
Secondary and above	-0.622***	(0.224)	0.589***	(0.228)	0.155	(0.549)
Partner's education (ref=no education)						
Primary	0.456**	(0.183)	-0.455**	(0.184)	0.014	(0.435)
Secondary and above	0.141	(0.190)	-0.221	(0.188)	0.365	(0.421)
Index for actual quality of ANC received	-0.132***	(0.016)	0.098***	(0.016)	0.156***	(0.042)
Household wealth(ref=poorest)						
Middle	-0.082	(0.154)	0.245	(0.160)	-0.427	(0.404)
Rich	-0.605***	(0.217)	0.667***	(0.219)	-0.074	(0.539)
Duration of residence (ref=previous res, rural)						
0-4 (previous residence, urban)	-0.589***	(0.220)	0.648***	(0.210)	-0.982**	(0.483)
5+	-0.044	(0.146)	0.078	(0.148)	-0.262	(0.333)
Community level variables						
Area type (ref=rural)						
Urban	-1.133***	(0.223)	0.986***	(0.227)	0.565	(0.634)
Proportion of drugs available	0.360	(0.699)	-1.271*	(0.737)	3.172	(2.006)
Material deprivation index	-0.142**	(0.064)	0.149**	(0.066)	0.048	(0.183)
Distance to nearest facility	0.040***	(0.014)	-0.036**	(0.015)	-0.033	(0.045)
Density of health facilities	1.257	(1.597)	-3.522**	(1.683)	10.326**	(4.622)
Prenatal care uptake	0.171	(0.570)	-0.359	(0.591)	0.874	(1.543)
TBA per 1000 of pop.	1.285***	(0.320)	-1.131***	(0.341)	-0.739	(0.966)
Constant	-1.241	(0.908)	1.939**	(0.949)	-9.244***	(2.551)
LR test (Chi2 value)	368.5***		324.8***		43.61**	
Log likelihood	-1036		-1074		-331.9	
rho	0.112		0.150		0.577	

*** p<0.01, ** p<0.05, * p<0.1