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Essays in Health and Development Economics

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by

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Abstract

This dissertation examines three health and development issues in Sub-Saharan Africa. It analyzes the impact of policy changes and interventions on child mortality, household food consumption and cesarean section births. The study is motivated by the Millennium Development Goals and policies which could affect their achievement. In the first essay, I investigate the impact of debt relief on under-five mortality rate. A dynamic panel data estimator is employed in the analysis. The result shows that debt relief is associated with a statistically significant reduction in under-five mortality rate. I conclude that conditionality of debt relief or development aid can yield positive outcomes. The second essay examines the impact of private hospitals on the likelihood of cesarean section births in Uganda. The study is motivated by the increase in cesarean section births following the proliferation of private hospitals. The main method of estimation is a bivariate probit model. The results show that delivery at private hospitals increases the probability of cesarean section births, thus there is need to monitor private hospitals so that expectant mothers are protected from physician induced demand for avoidable cesarean section births. The final essay studies the impact of agricultural extension services on household food consumption in Uganda. The study exploits the variation in participation in the NAADS to estimate the impact of the program on household food consumption. I find that NAADS membership and training are associated with an increase in household food consumption, hence agricultural extension services can be used to reduce food insecurity. Policy recommendations and future studies are explored.

Chapter 1: Health and Development in Africa: An Introduction

1.1 Economic Development and the Millennium Development Goals

Measurement of economic development remains a controversial issue due to its multidimensional nature. The Basic Needs Approach emphasizes access to minimum needs such as health, food, shelter, and education among others (Singh, 1979), but it has been criticized for its concentration on consumption. The capability approach, on the other hand, emphasizes freedom and the ability of individuals to achieve the kind of life they value (Sen, 1985). Some of the components of capability and basic needs have been incorporated into various metrics of development including the Human Development Index .The Human Development Index (HDI) is an aggregate measure of economic development based on life expectancy at birth, education, and gross national income per capita.

The average HDI for Sub-Saharan Africa (SSA) is the lowest among all regions (Melber, 2013), however there are concerns about the use of the HDI as a measure of progress (McGillivray and White, 1993; Sagar and Najam, 1998; Anand and Sen, 2000; Leigh and Wolfers, 2006). This is because of the fact that HDI is not comprehensive and does not consider distributional issues as well as the inputs which influence the indicators. More inclusive measures of development such as the Inequality Adjusted Human Development Index (IHDI), the Gender Development Index (GDI), and the Multidimensional Poverty Index (MPI) have been developed to address the shortcomings of the HDI. But like all indices, they still suffer the problems associated with composite measures and aggregations.

It appears that measuring economic development on a single index remains controversial. It may be informative to analyze each indicator of human development on their own merits. In September 2000, the United Nations Millennium summit resolved to reduce extreme poverty with set targets to be met by 2015. These targets became known as the Millennium Development Goals (MDGs). The MDGs set quantitative objectives for a number of indicators such as poverty, hunger, diseases, shelter, gender inequality, child health, maternal health, education, and environmental sustainability. SSA is afflicted by most of the problems targeted by the MDGs. Improvement in each of the targets would signal improvement on one dimension of human development and welfare. For instance, if households can afford to have regular and nutritious foods, welfare could be improving. Similarly, reduction of child mortality rate and maternal mortality rate may signal better healthcare provision. In this way, progress on human development can be tracked and appropriate interventions can be implemented to improve specific indicators. This dissertation is organized on the theme of the MDGs with major focus on hunger, under-five mortality rate and maternal health in SSA. The focus on these topics is premised on the fact that a well fed population ensures effective labor supply necessary for economic growth. Furthermore, the survival of children ensures that the next generation of workers are available to sustain economic growth. Hence, the dissertation analyzes interventions and policy changes in relation to under-five morality rate, maternal health, and hunger as components of the MDGs and economic development in general.

1.2 **Statement of Research Problem**

Each of the three essays in this dissertation answers a research problem under the unified theme of the MDGs. To make the essays tractable, I state the research problem for each essay. The first essay analyzes the impact of debt relief on under-five mortality rate (U5MR) in SSA. The

Highly Indebted Poor Countries (HIPC) Initiative involved cancelation of external debt of the world's poorest countries. This was meant to reduce the debt burden of poor countries and enable them focus on poverty reduction and the provision of social services. Healthcare is one of the social services which could be impacted by the additional resources released by debt relief initiative. Whereas increased resources are necessary for the provision of healthcare services, it may not necessarily yield better health outcomes. This essay examines the impact of debt relief on under-five mortality rate as one indicator of health outcomes and a component of the MDGs.

The second essay investigates the impact of hospital types on cesarean section births. MDG number 5 is concerned with improvement in maternal health. Following the implementation of the Structural Adjustment Programs (SAPs), many private hospitals sprung up in developing countries. Hospitals and physicians influence maternal health through the supply of maternal healthcare services. In health economics literature, it is noted that healthcare services are provided amidst information asymmetry and principle-agent relationships due the fact that physicians and hospitals have better information through their specialization and experience. They are in a position to influence the demand for the services they offer. This can lead to supplier induced-demand which could impact the decisions of healthcare consumers. In the case of maternal health, physicians/hospitals can influence the choice of method of delivery which in turn impacts health outcomes such as maternal mortality and infant health. The study focuses on Uganda where the rate of cesarean section births have been rising and there is public concern about cost and health outcomes of mothers who deliver through the procedure. The increase in cesarean section births was experienced after the increase in the number of private hospitals following the implementation of SAPs in the 1990s. I examine whether hospital type influences the likelihood of cesarean section birth in Uganda.

The third essay investigates the impact of agricultural extension services on household food consumption in Uganda. Poor households in many developing countries often face hunger. The first Millennium Development Goal emphasizes the need to reduce abject poverty and hunger. This requires a number of interventions geared towards raising farm output. In Uganda, the National Agricultural Advisory Services (NAADS) is one of the programs setup to empower farmers to demand agricultural extension services and technologies suited to their needs. It is a complete change from the top-bottom approach to agricultural extension service provision to a demand driven mode. This study examines whether households which participate in the NAADS program experienced welfare improvement in terms of increased food availability/consumption.

1.3 Objectives of the Study

a) The first objective is to test whether the amount of debt forgiven under the HIPC Initiative have had any statistically significant impact on under-five mortality rate in SSA. This is met by estimating the coefficient of debt relief per capita using a dynamic panel data (DPD) estimator.

b) The second objective of the dissertation is to examine the impact of conditionality and participation in the HIPC initiative on under-five mortality rate. This is tested using a dynamic panel data (DPD) estimator. The coefficient of a dummy variable indicating HIPC participation is the estimate of major interest.

c) The third objective of the study is to provide an alternative microeconomic explanation of supplier-induced demand for cesarean section births. This is achieved through a theoretical derivation based on plausible assumptions.

d) The fourth objective of the dissertation is to empirically test the impact of privately owned hospitals on the likelihood of cesarean section births in Uganda. This objective is achieved through application of bivariate probit regressions.

e) The fifth objective of the dissertation is to estimate the impact of agricultural extension services on household food consumption in Uganda. This is achieved through application of fixed effects, propensity score matching, and negative binomial regressions.

1.4 Testable Hypotheses

From the research problems stated in subsection 1.2, the following are the testable null hypotheses.

1. H_0: The HIPC debt relief initiative had no impact on under-five mortality rate in Sub-Saharan Africa.
2. H_0: The likelihood of cesarean section birth is not influenced by hospital types in Uganda.
3. H_0: Household food consumption is not impacted by agricultural extension services in Uganda.

1.5 Scope of the Study

The geographical scope of the study is limited to Sub-Saharan Africa. The choice of scope hinges on my interest in examining development challenges and opportunities in Sub-Saharan Africa. SSA is one of the poorest regions and often attracts a lot of attention and intervention from international development organizations, thus inducing a need to evaluate some of the interventions using robust econometric techniques. The first essay on debt relief and under-five mortality follows a macroeconomic approach. The remaining two essays follow a microeconomic approach and applied microeconometrics with a focus on Uganda.

1.6 Major Findings

i. Participation in the HIPC debt relief initiative is associated with a decrease in under-five mortality rate in Sub-Saharan Africa.

ii. The amount of debt relief has no statistically significant impact on under-five mortality rate in Sub-Saharan Africa.

iii. The probability of a cesarean section birth increases with delivery at private hospitals.

iv. Information asymmetry and household wealth influences physician induced demand for cesarean section births.

v. Households' participation in agricultural extension service increases food consumption in Uganda.

1.7 Contributions and Relevance of the Study

The dissertation addresses three development issues (child mortality, food availability and maternal health) in relation to the MDGs. The results from this study can be of policy relevance in the implementation of the Sustainable Development Goals (SDGs), the successors of the MDGs. The results from the analysis of the HIPC Initiative and child mortality indicates that poor countries in SSA can be assisted to improve welfare. This requires some degree of conditionality such as the ones used to determine eligibility for debt relief. The study also shows that conditionality can be incentive-compatible when development aid is being provided. Therefore, appropriate conditionality in international development aid is not necessarily bad.

The second unique contribution of this dissertation is the study of physician-induced demand in Sub-Saharan Africa. This is the first study which analyzes the impact of private hospitals on the likelihood of cesarean section using data from Africa. While there has been an increase in

the number of private healthcare providers in Africa, regulation remains weak. This exposes patients and expectant mothers to health risks and avoidable medical bills. The results from the analysis of physician-induced demand for cesarean section births indicates the need for closer monitoring of private hospitals in order to protect less informed patients . This may safeguard expectant mothers from the harms associated with avoidable cesarean section births.

The third essay provides empirical evidence about the impact of demand-driven agricultural extension services on food consumption. The positive impact of the NAADS program in Uganda shows that training farmers in modern farming methods can reduce food insecurity. The government can strengthen the program so that extension services meet farmers' needs.

1.8 Limitations of the Study

Although I applied a number of robustness checks, there are some caveats that should be borne in mind. In the study of the impact of debt relief on under-five mortality rate, it was not possible to disaggregate the debt relief amounts which were channeled to the healthcare sector and child survival programs. The identification of the parameter relies on econometric methodology.

The second study on cesarean section births excludes births which took place outside hospitals/clinics. This limits the sample size and makes it difficult to identify self-selection into cesarean section births. The use of controls such as distance to the nearest hospital and differential distance between public and private hospitals addresses part of endogeneity problem. The impossibility of separating patient-initiated cesarean section births from medically necessary ones on the one hand, and physician-induced cesarean section births on the other remains a challenge. This information could only be obtained by interviewing the mothers who gave birth at the various hospitals. Due to confidentiality reasons, the survey data does not provide information which can

be used to identify and trace respondents. The limitation of the third study on food consumption and NAADS is largely due to the way the frequency of food consumption is measured. The information was collected through interviews and the reliability of the data depends on the recall of the respondents. This could result in understatement or overstatement of the frequency of meals in the households. Secondly, the quantity and nutritional content of the food consumed by households could not be ascertained with the available information. Households may have increased food consumption but if the foods are not nutritious, welfare and labor productivity may not improve significantly.

1.9 References

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Chapter 2: The Impact of Debt Relief on Child Mortality in Sub-Saharan Africa

2.1 Introduction

This chapter examines the effects of debt relief under the Highly Indebted Poor Countries (HIPC) Initiative on under-five mortality rate (U5MR). High under five mortality rate (U5MR) is still a problem in many SSA countries. According to Umar and Osinusi (2014), the U5MR in SSA is about seven times higher than the European rate. The United Nations' International Children's Emergency Fund (UNICEF) and the World Health Organization(WHO) showed that the U5MR in Niger was as high as 320 per thousand in the 1990s. Figure 1 indicates the high level of U5MR in SSA relative to the world and industrialized country averages. It is a development concern as it undermines human capital accumulation which is critical for economic growth as highlighted in Bloom and Canning (2003) and Bleakley (2007). The major causes of high U5MR are preventable diseases such as pneumonia, diarrhea, malaria, measles, HIV/AIDS, among others as listed in Wagstaff et al. (2004) and Caulfeld et al. (2004). Prevention requires a number of interventions, which in turn depends on healthcare financing.

Unfortunately, most households in SSA are too poor to afford healthcare services and most SSA governments are constrained by limited resources amidst weak institutions to deliver healthcare services. The average annual SSA government expenditure on healthcare is about $25 per person (Boyce and Ndikumana, 2011) which is inadequate to provide quality healthcare services necessary to tackle the causes of child mortality. In addition, many SSA countries contracted huge external debt in the 1970s and 1980s due to high oil prices. The United Nations Conference on Trade and Development (UNCTAD) reports that between 1970 and 1979, SSA's external debt

to export ratio was 66%. However, the ratio jumped to 159% between 1980 and 1989 and peaked at 243% in the 1990-1996 period (UNCTAD, 2004). High external debt service crowds out public good provision (Naiman and Watkins, 1999). This can lead to poor healthcare service and associated adverse health outcomes such as high U5MR. Due to the poor development indicators of SSA and other low income regions, philanthropists and Non-Governmental Organizations (NGOs) like OXFAM and the Jubilee Debt Coalition lobbied for debt forgiveness for highly indebted low income countries. The World Bank and the International Monetary Fund (IMF) agreed to forgive external debt of poor countries through the HIPC Initiative. Since the implementation of the HIPC Initiative, external debt service obligation of SSA countries decreased in the eligible countries.

Although U5MR is still high in SSA, the WHO (2013) reported an average 4.2 percent annual reduction between 2000 and 2013. Lozano et al. (2011) also found out that under-five death rates have been on a downward trend in 106 countries between 2000 and 2011. The period 2000-2011 coincided with the implementation of the HIPC Initiative. Could the decrease in U5MR in SSA be partially explained by participation in the debt relief initiative?

To answer this research question, I use datasets from the WHO, the International Monetary Fund (IMF), and the World Bank. A robust dynamic panel data estimator is used in the regressions. I test the hypothesis that participation in the HIPC Initiative reduces U5MR through reforms and through the increase in public healthcare expenditures. The results show that SSA countries which participated in HIPC initiative achieved an average 4.7 reduction in child deaths per thousand live births. However, the effect of the amount of debt relief per capita is statistically insignificant.

This chapter is of health and development significance to SSA. It contributes to the literature on the relationship between debt forgiveness and health outcomes. Previous research in this area focused on the impact of debt forgiveness on health expenditures/health budget. However,

citizens and policy makers are more interested in improvements in health outcomes than in health expenditures per se. To my knowledge, this the first study to analyze the effect of the HIPC Initiative on a specific health outcome in African countries. The chapter is organized as follows: I provide background and a description of the debt relief program in section 2.2. This is followed by a review of related literature in section 2.3. Thereafter, the econometric strategy and data description are presented in sections 2.4 and 2.5, respectively. This is followed by a discussion of the results in section 2.6. A conclusion of the chapter is presented in section 2.7.

2.2 Background: The Debt Relief Initiatives

The oil price shocks of the 1970s and 1980s led to high indebtedness of many developing countries. The countries borrowed heavily from the Paris Club group of countries[1], the World Bank and the International Monetary Fund (IMF) to finance oil imports. Data from the United Nations' Conference on Trade and Development (UNCTAD) show that servicing of external debt was taking over 150% of export value during the 1970-2002 period. This potentially crowded out public goods provision. The indebtedness and poverty in developing countries attracted the attention of non-governmental organizations (NGOs) who lobbied for cancellation of the debts on the premise that funds meant for external debt repayment would be used for poverty alleviation programs. The IMF and the World Bank designed and implemented the HIPC Initiative starting in 1996. Under the HIPC Initiative, the amount of external debt forgiven is earmarked for the provision of social services such as healthcare, water and sanitation, and education.

[1] Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Japan, the Netherlands, Norway, the Russian Federation, Spain, Sweden, Switzerland, the United Kingdom and the United States of America

Participation in the HIPC Initiative is a two-step process. Eligible countries initiate the process by committing to economic reforms and preparing Poverty Reduction Strategy Papers (PRSPs). According to the World Bank and the IMF, a country is eligible if, in present value terms, the debt to export ratio exceeds 150 percent. At the initiation point, participating countries get partial and conditional debt relief. The second stage of the program, known as the completion point, is reached when a country achieves macroeconomic stability, structural reforms and successful implementation of PRSPs for at least one year. At completion point, the countries get total debt relief equivalent to the amount determined at the decision point.

This suggests two pathways through which the HIPC Initiative could affect health outcomes. The requirement for HIPCs to make reforms and work towards poverty reduction, including improvement in healthcare delivery, is one such possible pathway. For this reason, the HIPC Initiative participation is hypothesized to have a significant impact on U5MR. The second possible pathway through which the HIPC Initiative could affect U5MR is the amount of debt forgiven. If the amount of resources devoted to social service provisions has positive impacts on healthcare services, one would expect the amount of debt relief to have an impact on under-five mortality. Therefore, I include both an HIPC Initiative dummy variable and the amount of external debt forgiven per capita in the empirical model. The impact of the two variables differs because reforms at the HIPC Initiative decision point can change the healthcare system as a whole but the amount of debt relief may lead to increased inputs to the healthcare sector through PRSPs.

Table 1 shows the list of SSA countries that benefited from the HIPC Initiative as well as those who did not. In total, 33 SSA countries participated in the HIPC Initiative program. The non-HIPCs are middle-income countries whose external debts were deemed sustainable or they are low-income countries with civil strife and human right violations. There is variation in the decision

points and completion points due to eligibility criteria and the pace of reforms. Table 1 also indicates that Benin reached the decision point in 2000 and the completion point in 2003, while Chad reached decision point in 2001 and has not reached completion point to date. Uganda reached both the decision and completion points within the same year (2000). This indicates a large variation in timing of debt relief program participation and benefits. Again, Table 1 shows that most HIPCs had external debt to export ratios (EDXR) of more than 150% whereas the non-HIPCs had moderate rates except Eritrea and Sudan. The mean export values of the HIPCs are also low compared to non-HIPCs. This variation is useful in identifying the impact of participation in the HIPC initiative.

2.3 Related Literature

High under-five mortality rate is a problem in many developing countries due to poor healthcare systems and a number of environmental and epidemiological factors. The availability and allocation of more resources towards the healthcare sector can improve child survival. Umar and Osinusi (2014) pointed out that the major causes of under-five mortality in SSA are preventable diseases such as malaria, pneumonia, measles, under nutrition, and HIV, but many households in SSA are too poor to mitigate the causes of child mortality. A significant proportion of households in SSA rely on government provision of healthcare services. However, governments in SSA have weak health systems which limits access to quality healthcare services.

Andersen (1995) shows that access to healthcare services depends on the health system (infrastructure, policy, financing and organization), socioeconomic and demographic factors, as well as personal health behaviors. Rutherford et al. (2009), through a systematic literature review, indicate that governments in SSA need to increase access to healthcare services in order to reduce

child mortality. It is plausible that debt relief could lead to improvement in healthcare financing by freeing resources which were used to service external debt (Kaddar and Furrer, 2008, Domeland and Kharas, 2009). This study provides new results on the impact of debt relief on under-five mortality rate (U5MR) in SSA. The following review of previous studies highlight the factors which influence under-five mortality and link them with the HIPC Initiative. A number of studies have shown that public health expenditure influences health outcomes including U5MR. For instance, Akinci et al. (2014) applied a pooled least squared method and a Taylor-Hausman panel data method and they found that an increase in both private and government spending on healthcare led to significant reduction in under-five mortality in the Middle East and North Africa. They noted that a one percent increase in government expenditure on health per capita is associated with a reduction in infant mortality by 7.2 to 8.6 per thousand live births.

Focusing on Sub Sharan Africa, Anyanwu and Erhijakpor (2009) used a panel of 47 SSA countries to examine the impact of government expenditure on health outcomes. Their results show that an increase in government health expenditure is associated with a reduction in U5MR. In a broader study, Farag et al. (2013) applied fixed effects models on panel data from 133 countries and found that government health expenditure significantly reduces infant and under-five mortality rate. Bokhari et al. (2007) used a generalized methods of moments (GMM) and showed that the elasticity of under-five mortality rate with respect to government expenditures lies between -0.25 and -0.42. It is evident from these studies, notwithstanding the disparate methods and datasets, that increasing healthcare expenditure is one strategy that can be used to reduce under-five mortality rate. In this study, debt relief is analyzed as one of the ways through which the governments of SSA countries changed health sector budgets and potentially impacted healthcare service provision and U5MR.

Studies from other regions have shown that governments play significant roles in reducing child mortality. For instance, Nixon and Ullmann (2006) employed a fixed effects model on a panel of 15 European Union countries for the period 1980-1995. They found that increased healthcare expenditure was associated with a statistically significant reduction in infant mortality. Cremieux et al. (2005) showed that Canadian provinces with higher health spending levels on medicine had better health outcomes. Their simulated results indicate that if all Canadian provinces increased per capita health expenditure above the observed highest expenditure, infant deaths would be reduced by 584 per annum.

Using National Family Health Survey of India and state level data, Farahani et al. (2010) found that a 10 percentage increase in government expenditure on healthcare in India would reduce the probability of death among the young by about 2 percent. Other studies which showed that increases in public health expenditures lead to improvements in health outcomes include Gupta et al. (2000), Martin et al. (2008), and Craigwell et al. (2012).

As much as debt relief affected government budget positions, it may also be considered as a development aid since it is meant to help poor countries use available resources for provision of social services as well as instituting reforms. Considering the usefulness of aid, Burnside and Dollar (2000), showed that foreign aid has a significant impact on reducing infant mortality when the recipient country has good governance. They show that an increase in aid by 1 percent of GDP would reduce infant mortality by 0.9 percent if governance is strong. Mishra and Newhouse (2009) used data from 118 countries observed between 1973 and 2004 to investigate the impact of health aid on infant mortality. They showed that health aid leads to a statistically significant reduction in infant mortality.

Other studies which find a positive effect of health aid on health outcomes include Feeny and Ouattara (2013), Bendavid and Bhattacharya (2014) and Gyimah-Brempong (2015). Therefore the HIPC initiative, which was spearheaded by the IMF, the World Bank and the Jubilee 2000 campaign, may have similar impact as aid for health, despite not being sector specific.

It should be noted that the allocation of more resources towards the health sector may not lead to improvements in health outcomes in the absence of proper governance and accountability mechanisms. Rajkumar and Swaroop (2008) showed that the effectiveness of government spending in reducing child mortality depends on the quality of governance. Thus, there is a need for good institutional and policy environment for interventions (Haddad and Fournier, 1995, Wagstaff et al., 2004). In this respect, Freytag and Pehnelt (2009) and Lala et al. (2006) found a positive relationship between grants and institutional quality. They observe that conditionality and assessment of HIPCs by international financial institutions in the process of making decisions on debt relief motivated improvement in governance quality.

Foster and Leavy (2001) noted that the objective of conditionality of aid is based on the assumption that government values the aid to the extent that it can change behaviors so as to meet donor preferences. Therefore, the HIPC Initiative conditionality for increased social expenditure and poverty reduction have the potential to impact U5MR since progress is monitored before debt is cancelled.

Dessy and Vencatachellum (2007) showed that between 1989 and 2003, the debt relief led to a significant increase in the share of resources allocated towards public health and education in SSA. Figure 3 indicates that the share of public healthcare expenditure in national budgets increased in HIPCs between 1998 and 2012. In this study, a dummy variable which indicates HIPC Initiative status of a SSA country is used to identify the impact of conditionality.

I also note that healthcare expenditure is only an input in the production function of health (Grossman, 1972) and the increase in expenditure may not necessarily translate into better health outcomes. For this matter, there are studies which find ambiguous impact of health expenditure on health outcomes. For instance, Fisher et al. (2003) used US Medicare data and found that patients in regions with high medical expenditures received more health services than those in lower-spending regions but there was no statistically significant differences in health outcomes between the regions.

This implies that the impact of health expenditure on health outcome depends on other factors. One such factor can be the fungibility of funds within health sector. Van de Walle and Mu (2007) observed that fungibility of funds make foreign aid ineffective. Dieleman and Hanlon (2014) and Lu et al. (2010) found out that external aid to health is fungible and tend to displace government health financing. This implies that beneficiaries of the HIPC initiative may not allocate the canceled debt service towards social services if governments are ineffective and less responsive to the healthcare needs of the citizens. Moreover, the HIPC debt relief is not restricted to healthcare sector but embraces general macroeconomic management and poverty reduction as a whole. On a positive note, Van de Sijpe (2013) showed that if off-budget health aid are explicitly included as a covariate in cross country regressions, the degree of fungibility found in Lu et al. (2010) is reduced remarkably. In addition, Fagernas and Roberts (2004) and Ouattara (2006) showed that many developing countries have large off-budget aid and therefore the degree of aid fungibility could be overestimated.

There are several studies which find insignificant impacts of government health expenditure on health outcomes. Babazono and Hillman (1994) found no relationship between health expenditures per capita and health outcomes in OECD countries. They argue that the way resources are allocated and utilized within the health sector is more important than the actual amount spent. This, in essence, is related to the probable impact of HIPC Initiative participation which required institutional reforms and implementation of PRSPs. Thus it might be plausible to find an insignificant effect of the amount of debt relief but a strong impact of program participation.

Zakir and Wunnava (1999) used a cross sectional dataset of 117 countries for the year 1993 and found that government expenditure on healthcare, as a proportion of GNP, does not significantly influence infant mortality rates. It is probable that the HIPC Initiative, which focuses on macroeconomic reforms and institutional strengthening, could influence under-five mortality through better healthcare management than through the increase of resources.

To conclude the survey of the related literature, I note that there are mixed conclusions about the impact of healthcare expenditure on health outcomes. Increased public healthcare spending provides necessary inputs in the production of healthcare services. Therefore the HIPC Initiative could have led to improvement in healthcare services in the participating countries through availability of additional resources. Furthermore, the reforms which eligible countries were expected to make through PRSPs could also impact healthcare systems and institutions. This could have made healthcare sectors more effective in the provision of services and hence impact outcomes including U5MR. However, the relationship between increased resources and U5MR is not direct and could depend on other factors which need to be controlled for in the empirical analysis.

It is also noted that no other study examined the direct impact of the HIPC debt relief initiative on under-five mortality in SSA. The most recent and closest research to this work is Dessy and Vencatachellum (2007) which considers debt relief and social spending. I extend the analysis by examining the direct impact of HIPC participation and the amount of debt forgiven on under-five mortality rate. This can be of interest to policy makers and citizens who are often interested in health outcomes rather than in inputs in the production of healthcare.

2.4 Econometric Strategy

To identify the impact of debt relief on under-five mortality rate, I exploit the variation in the timing of HIPC Initiative status across the SSA countries. As shown in Table 1, each country has a unique date at which it qualified for debt relief. For instance, Uganda is the first country to receive debt relief in the year 2000. Tanzania and Mozambique qualified in 2001. Mauritania and Burkina Faso benefited in 2002. The Democratic Republic of Congo, Comoros, Republic of Congo, Liberia and Togo benefited as late as 2010. Chad, though designated as a HIPC has not completed the necessary reforms to receive full debt cancellation. The variations in the dates of debt relief helps in the identification of the HIPC Initiative impact over time. Secondly, the non-uniform participation of SSA countries in the HIPC Initiative is akin to a natural experiment. The HIPCs could be taken as a pseudo experimental group while the non-HIPCs serve as a control group. Figure 4 is a comparative map which indicates HIPC Initiative status of a country and the percentage reduction in U5MR between 1996 and 2012. The spatial distribution of U5MR reduction and HIPC Initiative status seems to overlap.

In the empirical analysis, a dummy variable with value equal to one for years a country had its external debt forgiven represents program participation in the pseudo-experimental group. The control group (non-HIPCs) is coded zero. Furthermore, the external debt forgiven, measured in real per capita values, is used to indicate the level of benefit from the program. There is significant variation in the amount of debt relief as shown in Table 1.

I apply a dynamic panel data method in the estimation and the approach is similar to that used by recent studies on health aid such as Mishra and Newhouse (2009) and Bendavid, Bhattacharya (2014), and Gyimah-Brempong (2015). I assume that there is a linear relationship between U5MR (y), participation in debt relief ($DEBT$), real external debt forgiven per capita under HIPC ($ADEBT$), lagged under-five mortality rate (y_{it-1}), and a vector of controls (X) which potentially influences U5MR. Symbolically the dynamic linear relationship is specified as:

$$y_{it} = \alpha + \rho y_{it-1} + \mu_1 ADEBT_{it} + \mu_2 DEBT_{it} + \beta X_{it} + c_i + \lambda_t + \varepsilon_{it} \ , \quad (2.1)$$

where X_{it} includes government expenditure on healthcare as a percentage of Gross Domestic Product (GDP), real Gross National Income (GNI) per capita, fertility rate, urbanization, and government effectiveness measured on a scale from zero to one hundred . In the model, c_i denotes country fixed effects. The year fixed effects, λ_t , capture general improvement in health technology over time while ε_{it} is the stochastic error term. I posit that changes in $ADEBT$ and $DEBT$ are associated with changes in under-five mortality rate.

To eliminate country-specific effects which would be correlated with the explanatory variables, I take the first differences of equation (2.1) to obtain equation (2.2).

$$\Delta y_{it} = \rho \Delta y_{it-1} + \mu_1 \Delta ADEBT_{it} + \mu_2 \Delta DEBT_{it} + \beta \Delta X_{it} + \Delta \lambda_t + \Delta \varepsilon_{it} \quad (2.2)$$

The impact of the amount of debt relief per capita is represented by μ_1, while the impact of HIPC Initiative participation as opposed to non-HIPC is represented by μ_2.

Assuming strict exogeneity, equation (3) could be estimated by a pooled least squares regression. The same result could be obtained using a fixed effects (FE) estimator, which involves applying ordinary least squares regression to time demeaned variables, however, contemporaneous correlation between explanatory variables and the stochastic term introduces endogeneity and inconsistency in estimates. The problem of endogeneity, biases, and inconsistencies in dynamic panel data has been dealt with in Arellano and Bond (1991) and Blundell and Bond (1998) using instrumental variables (IVs). Arellano and Bond (1991) proposed the first difference DPD estimator which uses lagged differenced variables as instruments in GMM estimation.

Blundell and Bond (1998) and Roodman (2009) notes that the first difference DPD introduces more data gaps in unbalanced panel data during the process of differencing. Lagged differences are also weak instruments in highly persistent series in levels. To avoid weak instrument and finite sample problems, the efficient two step system GMM introduced by Blundell and Bond (1998) is applied. The system DPD estimator combines the difference and level equations and estimate them jointly as a system to increase efficiency. Lagged levels are used as instruments in the differenced equation while lagged differences are used as instruments in the level equation. The advantage of system GMM is that it preserves time-invariant regressors which would have been wiped out in the first difference GMM (Roodman, 2009). This is critical for this study since $DEBT$ is a dummy variable of major interest. I also note that the systems estimator may suffer from proliferation of instruments which could lead to inconsistent estimates. To reduce the number of instruments, I restrict lagged instruments to the fourth and fifth lags of the endogenous variable. I test for the validity of the over-identifying restrictions as well as the presence of auto-correlated errors.

2.5 Data Description

The dataset represents panel data from 43 SSA countries covering the 1998-2012 period. Of the 43 countries, 30 are HIPCs whereas 13 are non-HIPCs. The list of countries and the dates of HIPC qualification and completion are contained in Table 1. In the analysis, the dependent variable is the under-five mortality rate (U5MR) which measures the number of deaths per thousand children under-five years of age in each country on an annual basis. Data on U5MR are obtained from the Global Health Observatory of the World Health Organization (WHO). The explanatory variables of major interest are the program participation in the HIPC Initiative ($DEBT$) and the real debt relief per capita received ($ADEBT$). $DEBT$ is measured as a dummy variable that is equal to one for the years in which a country received debt relief but zero for years when there was no debt relief.

Data on the status of a country as HIPC or non-HIPC as well as the amount of debt relief were extracted from IMF's Annual Statistical Updates on the HIPC Initiative. $ADEBT$ is computed as the real total external debt relief under the HIPC initiative divided by the total population of a given country in a year. The control variables are real national income per capita, government expenditure on health, female education, urbanization, fertility rate, government health expenditure, and government effectiveness. The inclusion of the controls is guided by existing literature on health outcomes (Musgrove, 1996, Filmer and Pritchett, 1999, and Rutherford et al. 2009). I measure income as real Gross National Income (GNI) per capita. GNI is more closely related to disposable income available to citizens and can potentially impact health outcomes through remittances; a common phenomenon in SSA countries.

Government health expenditure ($GHEALTH$) is measured as the government health expenditure to GDP ratio. Fertility rate is measured as the average number of births per adult female (BR). Female education is measured by the female enrollment ratio ($ENROL$), while urbanization ($URBAN$) is the ratio of population that lives in urban areas. Data for the control variables were obtained from different sources including the World Bank (2013)[2].

Burnside and Dollar (2004) argue that aid (and its components) is effective only in countries with better governance or policy environments. For this reason, a measure of government effectiveness is included in the model and data are obtained from the World Bank's Worldwide Governance Indicators, 2015 update. Government effectiveness captures perceptions of the quality of public services and the degree of its independence from political pressures, quality of policy formulation and implementation, and the credibility of the government's commitment to such policies as defined in Kaufmann et al. (2011). It is measured in percentile rank relative to other countries' rank which ranges from zero (lowest rank) to one hundred (highest rank). I posit that effective governance would lead to better healthcare service delivery in government owned clinics/hospitals and impact under-five mortality rate.

Descriptive statistics of the variables with sub-sample means and differences in means of key variables are provided in Table 2. The summary statistics indicate a modest increase in government healthcare expenditure as a proportion of GDP during the sample period. The summary statistics also show that HIPCs spent relatively more on healthcare than non-HIPCs. The small but statistically significant difference indicates that the conditionality of the HIPC Initiative to allocate more funds towards social services could have encouraged budget allocation for the healthcare sectors. HIPCs also have higher U5MR than non-HIPCs and the difference in means is statistically

[2] downloaded from data.worldbank.org Accessed on 04/04/2015

significant. There is also a statistically significant difference in Gross National Income (GNI) per capita, net female school enrollment ($ENROL$), and urbanization ($URBAN$). To avoid spurious results, the Levin et al. (2002) and Im et al. (2003) panel unit tests were performed and the test statistics show that the dependent variable (U5MR) is stationary and hence meets the assumptions of the system GMM estimator.

2.6 Results

In estimating the models, I applied the Windmeijer (2005) finite sample correction to the two-step system GMM. This is to account for the small sample size. Therefore, all diagnostic and statistical tests are based on small sample statistics. The estimates are contained in Table 3. Column (1) presents the baseline results without the debt relief variables. Column (2) presents the estimate that uses $ADEBT$ as the measure of debt relief, while Column (3) contain estimates for the equation that include only the $DEBT$ dummy variable. The Arellano and Bond (1991) test for second order autocorrelation shows that there is no second order auto-regression (AR) in the differenced residuals. The Hansen-J statistic shows that we cannot reject the null hypothesis of the validity of the over-identifying restrictions I impose on the estimations. The Hansen-C statistic indicates that the instruments are exogenous for all the equations. For the overall goodness of fit of the model, the F-statistic shows that the model fits the data well.

The baseline results in Column (1) indicate the effect of the control variables on U5MR. The coefficients have the expected signs as found in previous research (Filmer and Pritchett, 1999 and Rutherford et al, 2009). Column (2) shows the impact of debt relief per capita ($ADEBT$) while excluding the $DEBT$ dummy variable. The coefficient for debt relief per capita is not statistically significant. This could be due to fungibility of debt relief funds which were not restricted to the

health sector. Moreover, the relationship between expenditures and outcomes tends to be vague (Clemens et al, 2007). Thus, an increase in health expenditure is a necessary but not sufficient condition for better health outcomes. This is similar to the results of previous research that find no statistically significant effect of health aid on health outcomes.

The signs of the coefficients of the control variables are as expected and are significantly different from zero at the conventional levels of significance. In particular, the coefficient of government effectiveness is negative and significant while that of the lagged U5MR is positive and significantly different from zero at the one percent level. The coefficient of lagged U5MR is less than unity; indicating a stable relationship between the dependent variable and the explanatory variables in this equation.

Column (3) presents the estimates that uses the $DEBT$ dummy variable as the measure of debt relief in the model. The coefficient of the $DEBT$ dummy variable is -4.72 and it is statistically significant at the one percent level. This indicates that, on average, countries which benefited from debt relief had a 4.72 reduction in under-five mortality rate relative to non-HIPCs. The magnitude of the impact seems modest, but as Easterly (2009) argues, the success or failures of SSA countries should be judged on the progress made rather than on the predetermined levels stated in the MDGs.

As in Column (2), the estimates of the control variables have the expected signs and are significantly different from zero. Considering government effectiveness as one of the controls which mediates the effectiveness of the HIPC Initiative, the coefficient is statistically significant at 5 percent level. The coefficients show that a 10 unit increase in government effectiveness rank is associated with a1.48 reduction in under-five mortality rate. This suggests that good governance complements debt relief in addressing child mortality. This is a plausible result since good governance ensures improvements in the healthcare system.

This result supplements Dessy and Vencatachellum (2007) who find that the interaction between debt relief and changes in political institutions have a statistically significant impact on the share of healthcare expenditure. The coefficient of the lagged U5MR is positive and less than unity, indicating a stable relationship between U5MR and the explanatory variables.

Overall, the results indicate that participation in the HIPC Initiative significantly reduces under-five mortality in SSA countries. It is probable that the estimates depend on model specification. To test for this possibility, I conduct some robustness tests. I maintain the dynamic panel data framework but include the lags of $ADEBT$ and $DEBT$ dummy variable. This is meant to test the idea that the impact of interventions occurs contemporaneously as well as with a lag. The results are contained in Table 4.

Column (1) of Table 4 presents the estimates of the equation that measures HIPC Initiative as the amount of per capita debt relief while column (2) presents the estimates of the equation that indicates participation in the program using a dummy variable($DEBT$). The diagnostic statistics suggest that this specification fits the data well. The overall finding is not affected. The impact of the amount of debt relief per capita remains statistically insignificant.

The coefficient of the $DEBT$ dummy variable is negative and statistically significant at one percent level but the magnitude decreased to 3.99. The coefficients of lagged $ADEBT$ and lagged $DEBT$ are insignificant, suggesting that both $ADEBT$ and $DEBT$ have contemporaneous effects on $U5MR$ but not lagged effects.

It is possible that debt relief has a statistically significant impact on $U5MR$ only in countries with good governance or policy environments. To test for this possibility, I included an interaction between the governance index and $DEBT$ as an added control variable in the $U5MR$ equation. The estimates are presented in Columns (3) and (4) of Table 4. The diagnostic statistics indicate a good

fit to the data but the coefficient of lagged U5MR is unity. The coefficient of $ADEBT$ is negative but insignificant while that of the $DEBT$ dummy is negative and significant at the one percent level. The estimate of the interaction term (governance and $DEBT$) in both equations is insignificant. The coefficient of lagged $U5MR$ is positive, relatively large in Column (3) and significantly different from zero. However, it is not significantly different from unity, suggesting that the relationship is not stable over time and the specification can be discarded.

Further robustness checks to test the effect of health aid are presented in Table 5. I include the amount of aid for health as a control and the results show that the impact of participation in HIPC Initiative remains statistically significant. The insignificant impact of health aid could be attributed to the correlation between aid and debt relief (ρ = -0.1128 and significant at α=0.01).

I conclude from this exercise that the results do not depend on model specification. The finding that the participation in the HIPC Initiative, rather than the amount of debt forgiveness ,is one of the drivers of the decrease in U5MR shows that PRSPs and reforms required by the HIPC Initiative contributed to the observed decrease in U5MR in SSA. This interpretation of the results is consistent with the conditional effectiveness of aid hypothesis (Burnside and Dollar, 2004).

2.7 Conclusion

This study used panel data covering the 1998-2012 period to investigate the impact of debt forgiveness under the HIPC Initiative on under-five mortality rates in SSA countries. I find that the decision of a country to accept and participate in the HIPC Initiative has a statistically significant effect in reducing under-five mortality rate. Allowing for lagged effects, the impact of HIPC Initiative participation remains statistically significant, though the magnitude decreases to about 4 per thousand. The estimates are also robust to changes in model specification. The impact of the

amount of debt relief per capita is statistically insignificant. This suggests that the amount of debt cancelled may not be important but the PRSPs and reforms in social service provision are the transmission mechanisms. These findings provide new insights about aid, debt relief and international cooperation as strategies that can be used to improve child survival in SSA.

The result suggests that monitored reforms in the provision of social services can lead to the achievement of desired outcomes. Thus, the conditions and reforms prior to qualification for debt cancellation seem more important than the actual amount of debt forgiven. Although the overall reduction in U5MR has not reached the MDG of reducing under-five mortality to two thirds of the 1990 level, the HIPC Initiative has contributed to the reduction in under-five mortality rate.

The maps in Figure 4 show that countries which benefited at the onset of the program (Uganda, Tanzania, Mozambique, Ethiopia and Niger) experienced the largest reduction in U5MR between 1996 and 2012. This pictorial illustration and the empirical estimates indicate that the HIPC Initiative impacted U5MR in SSA. These results should, however, be interpreted with caution. In the empirical analysis, I proxy the impact of the HIPC Initiative by a dummy variable indicating participation and the per capita debt forgiven under the program. It is not possible to measure the degree of improvement in healthcare services during the HIPC Initiative decision points nor was I able to determine how much of the debt forgiven was devoted to healthcare or the effective utilization of these resources. This could affect the results.

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Table 1: HIPC Status and Mean External Debt Export ratio (EDXR)

Country	Decision point	Completion point	DEBT	EDXR*	Exports*
Benin	2000	2003	719	171.09	859
Burkina Faso	2000	2002	881.4	319.6	859
Burundi	2005	2009	284.5	1487	103
Cameroon	2000	2006	870	212.52	4,547
Central African Republic	2007	2009	312.2	360.1	206
Chad	2001		411.7	169.1	2,347
Comoros	2010	2010	47.5	390.76	55.92
Cote d'Ivoire	2009	2012	1678	178.50	6,927
Congo Republic	2006	2010	175.6	192.22	5,279
Dem. Rep. of Congo	2003	2010	1390.1	193.15	4,215
Ethiopia	2001	2004	2585	371.22	2,291
Gambia	2000	2007	196.8	256.49	208
Ghana	2002	2004	3229.4	168.89	6,287
Guinea	2000	2012	792.5	307.84	1,081
Guinea-Bissau	2000	2010	147.4	1081.69	103
Liberia	2008	2010	501.2	591.8	222
Madagascar	2000	2004	1778.7	276.09	1,601
Malawi	2000	2006	1487.3	329.064	852
Mali	2000	2003	1348.1	233.109	1,643
Mauritania	2000	2002	572	171.92	1,142
Mozambique	2000	2001	1738.8	398.041	2,099
Niger	2000	2004	821.2	326.916	728
Rwanda	2000	2005	540.6	546.71	374
Sao Tome and Principe	2000	2007	44.2	1492.61	18
Senegal	2000	2004	1797.8	174.43	2,367
Sierra Leone	2002	2006	416.7	952.35	247
Tanzania	2000	2001	3107.6	285.48	3,647
Togo	2008	2010	615.3	226.62	828
Uganda	2000	2000	2977.7	289.88	1,887
Zambia	2000	2005	1966.6	313.28	3,659
Angola	NON-HIPC			85.4	30340
Botswana	NON-HIPC			18.5	4420
Djibouti	NON-HIPC			163.7	262
Eritrea	NON-HIPC			261.8	98
Kenya	NON-HIPC			138.8	5780
Lesotho	NON-HIPC			62.9	672
Mauritius	NON-HIPC			30.0	3953
Namibia	NON-HIPC			30	3207
Nigeria	NON-HIPC			85.4	53300
Seychelles	NON-HIPC			878.8	303
South Africa	NON-HIPC			77.3	68270
Sudan	NON-HIPC			690.2	5712
Swaziland	NON-HIPC			22.8	1771
Zimbabwe	NON-HIPC			144.3	2560

Source: IMF HIPC Statistical update 2014

*Mean values over the period 1998-2012. Exports and DEBT are in millions of US dollars.

Table 2: Means and Differences in Means

Variable	HIPC Mean	NON-HIPC Mean	Differences in Mean
U5MR	130.734	108.0556	22.678***
	(44.320)	(46.518)	(4.030)
Real GNI per capita	1377.375	3262.1	-1884.724***
	(1847.563)	(4438.985)	(241.894)
Govt Health expenditure-GDP ratio	11.087	9.664	1.423***
	(3.470)	(3.755)	(0.322)
Urbanization rate	36.825	40.372	-3.547**
	(11.155)	(16.421)	(1.132)
School Enrollment	62.620	69.569	-6.948**
	(19.611)	(20.60913)	(2.188)
Government Effectiveness	29.104	27.25	1.84
	(17.506)	(21.176)	(1.654)
Observations	160	545	703

Notes

***p < 0.01, ** p < 0:05, *p < 0.1. Standard errors are in parentheses. HIPC indicates the group of countries which benefited from the debt relief initiative and has implemented the required conditionality, while NON-HIPC is the pseudo control group. Govt indicates Government. The Levin Lin and Chu (2002), and Im-Pesaran-Shin (2003) unit-root test were performed to check for unit roots and they show that U5MR is stationary.

Table 3: Two Step System GMM Results

VARIABLES	(1)	(2)	(3)
Lagged U5MR	0.982***	0.969***	0.893***
	(0.0636)	(0.0589)	(0.0505)
ADEBT		-0.0123	
		(0.0126)	
DEBT			-4.715***
			(0.969)
GOV	-0.151**	-0.172***	-0.148***
	(0.0652)	(0.0602)	(0.0517)
Other Controls	YES	YES	YES
Year Dummies	YES	YES	YES
Observations	310	310	310
Number of Countries	40	40	40
A-B Test for (AR 2) [p value]	[0.367]	[0.524]	[0.524]
Hansen-J statistic	30.49	29.00	25.77
p-values	[0.441]	[0.465]	[0.638]
Hansen-C statistic	14.68	9.43	15.41
p-values	[0.197]	[0.583]	[0.165]
F-Statistics: F(11,40)	5095.54 ***	3199.76 ***	3447.73***

Notes:

*** p < 0.01, **p < 0.05, *p < 0.1. Robust standard errors are in parentheses. The dependent variable is the under-five mortality rate. DEBT is a dummy variable which is equal to one if a country is a beneficiary of the debt relief initiative and has implemented the required conditionality. ADEBT is the amount of debt relief per year divided by total population. GOV is a measure of government effectiveness. Control variables include birth rate, GNI per capita, urbanization rate, female school enrollment, and government spending on health. Hansen's test of over identifying restrictions; H_0: over identifying restrictions are valid. The null hypothesis cannot be rejected in all regressions. A-B is the Arellano and Bond test for zero autocorrelation (AR) in first-differenced errors. The null hypothesis of no AR (2) cannot be rejected in all regressions.

Table 4: Robustness Check

VARIABLES	(1)	(2)	(3)	(4)
Lagged U5MR	0.994***	0.895***	1.002***	0.961***
	(0.100)	(0.049)	(0.062)	(0.093)
ADEBT	-0.008			-0.001
	(0.01)			(0.008)
Lagged ADEBT	-0.003			
	(0.010)			
DEBT		-3.995***	-6.841***	
		(1.02)	(2.50)	
Lagged DEBT		-0.80		
		(1.03)		
GOV	-0.129*	-0.137**		
	(0.069)	(0.052)		
DEBT×GOV			0.063	-0.0001
			(0.053)	(0.055)
Other controls	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
Observations	305	305	305	312
Number of Countries	40	40	40	42
A-B Test for (AR 2) [p-values]	[0.278]	[0.473]	[0.270]	[0.161]
Hansen-J-statistic	30.40	24.48	29.77	28.26
p-values	[0.345]	[0.656]	[0.425]	[0.504]
Hansen-C statistic	16.77	8.86	12.88	11.00
p-values	[0.115]	[0.635]	[0.301]	[0.443]
F-Statistics:	2991.24***	4135.66***	8064.25***	7748.67***

Notes

*** $p < 0.01$, **$p < 0.05$, * $p < 0.1$. Robust standard errors are in parentheses. The dependent variable is the under-five mortality rate. DEBT is a dummy variable which is equal to 1 if a country is a beneficiary of the debt relief initiative and has implemented the required conditionality. ADEBT is the amount of debt relief per year divided by total population. GOV is a measure of government effectiveness. Other control variables include birth rate, GNI per capita, urbanization rate, female school enrollment, and government spending on health. Hansen's test of over identifying restrictions; H_0: over-identifying restrictions are valid. The null hypothesis cannot be rejected in all regressions. The A-B is the Arellano and Bond test for zero autocorrelation (AR) in first differenced errors. The null hypothesis of no AR (2) cannot be rejected in all regressions.

Table 5: Robustness Check with Aid for Health

VARIABLES	(1)	(2)	(3)	(4)	(5)
Lagged U5MR	0.864***	0.866***	0.863**	0.891***	0.903***
	(0.052)	(0.060)	(0.072)	(0.076)	(0.063)
GOV	-0.125	-0.053	-0.140	-0.196	-0.206*
	(0.123)	(0.139)	(0.109)	(0.168)	(0.118)
Health aid	0.016	-0.027	-0.028	0.050	0.058
	(0.077)	(0.083)	(0.091)	(0.087)	(0.051)
DEBT	-5.050**	-5.314**			
	(2.221)	(2.541)			
ADEBT	0.009			-0.009	
	(0.021)			(0.037)	
Lagged DEBT	-0.962	-1.179	-3.113		
	(2.528)	(2.494)	(2.689)		
Lagged ADEBT	-0.004			0.002	-0.004
	(0.008)			(0.011)	(0.012)
Other controls	YES	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES	YES
Observations (N)	305	310	310	305	305
Number of Country	40	40	40	40	40
A-B Test [p-value]	[0.721]	[0.521]	[0.744]	[0.794]	[0.525]
Hansen-J statistic	11.93	12.74	17.20	17.16	11.45
p-values	[0.534]	[0.622]	[0.373]	[0.309]	[0.407]
Hansen-C statistic	4.93	5.78	12.51	5.08	2.98
p-values	[0.841]	[0.761]	[0.186]	[0.827]	[0.965]
F-Statistics:	4927.67***	3229.91 ***	3624.49***	4140.73***	7059.97***

Notes:

*** p < 0.01, ** p < 0.05, * p < 0.1. Robust standard errors are in parentheses. The dependent variable is the under-five mortality rate. DEBT is a dummy variable which is equal to 1 if a country is a beneficiary of the debt relief initiative and has implemented the required conditionality. ADEBT is the amount of debt relief per year divided by total population. GOV is a measure of government effectiveness. Other control variables include birth rate, GNI per capita, urbanization rate, female school enrollment, and government spending on health. Hansen's test of over identifying restrictions; H_0: over-identifying restrictions are valid. The null hypothesis cannot be rejected in all regressions. The A-B is the Arellano and Bond test for zero autocorrelation (AR) in first differenced errors. The null hypothesis of no AR (2) cannot be rejected in all regression.

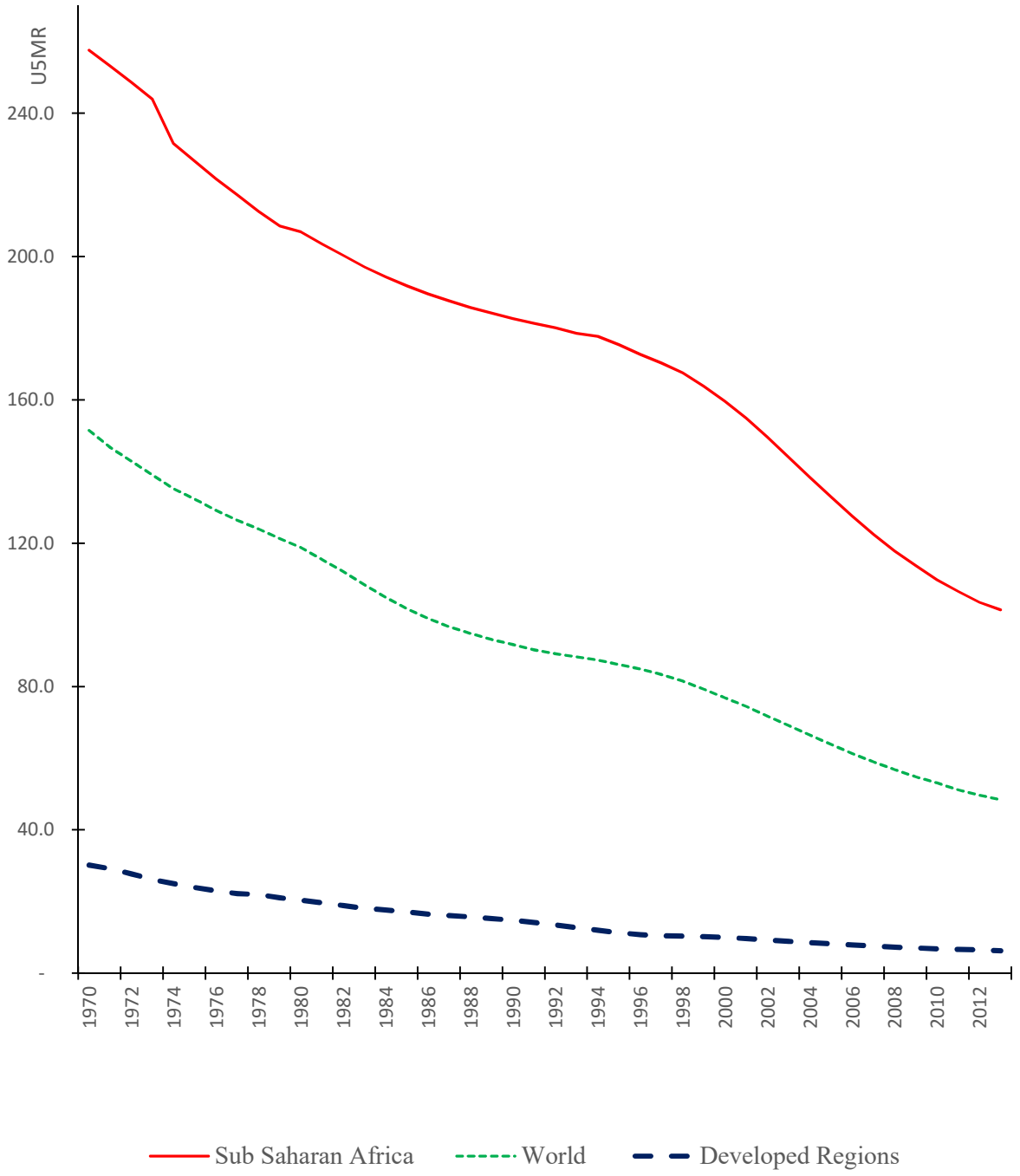

Figure 1: Comparative Trend of Under-five Mortality

Data source: World Health Organization; Global Health Observatory.

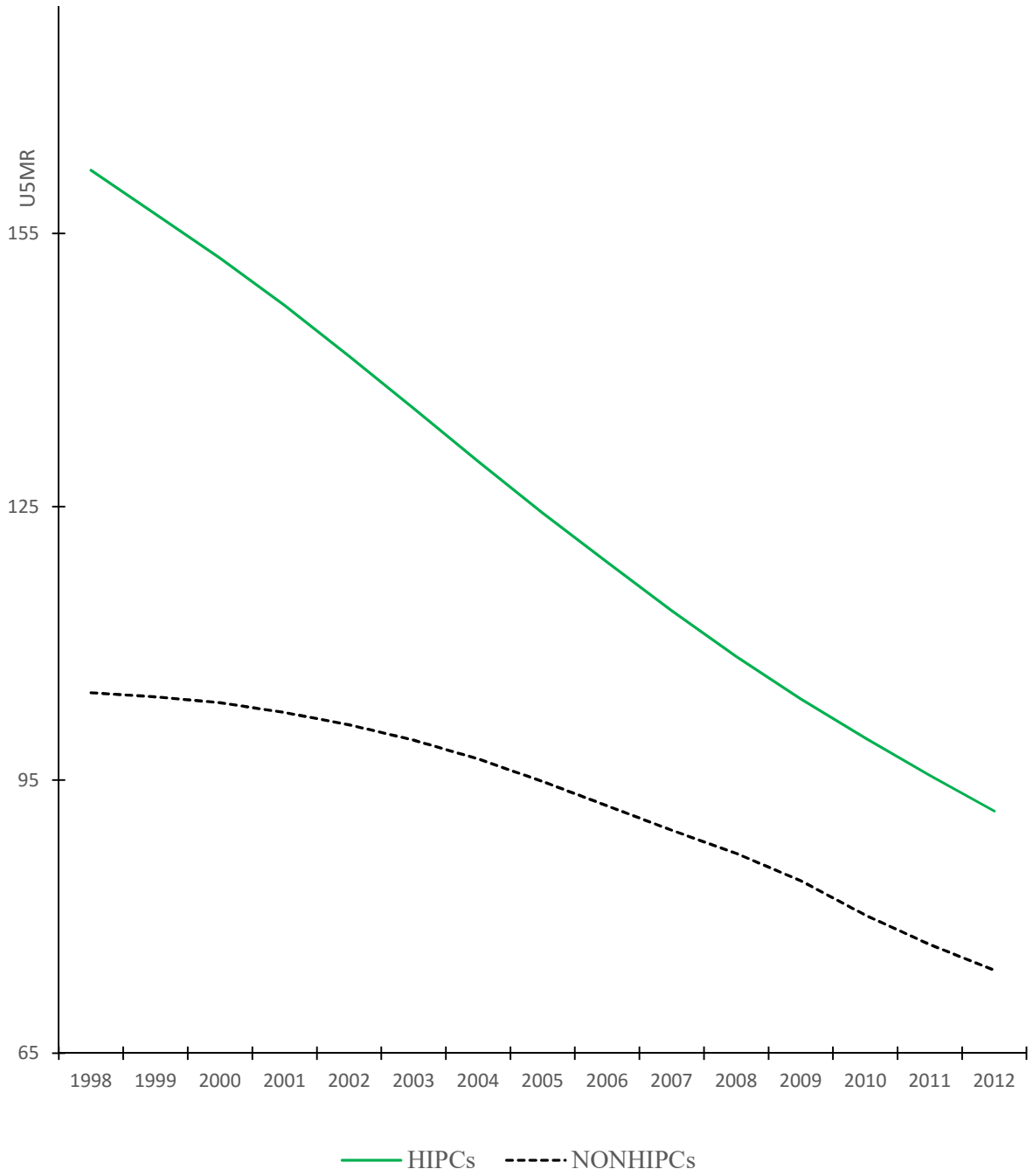

Figure 2: Trend of Under-five Mortality Rate in HIPCs and Non-HIPCs

Source: Author's computation

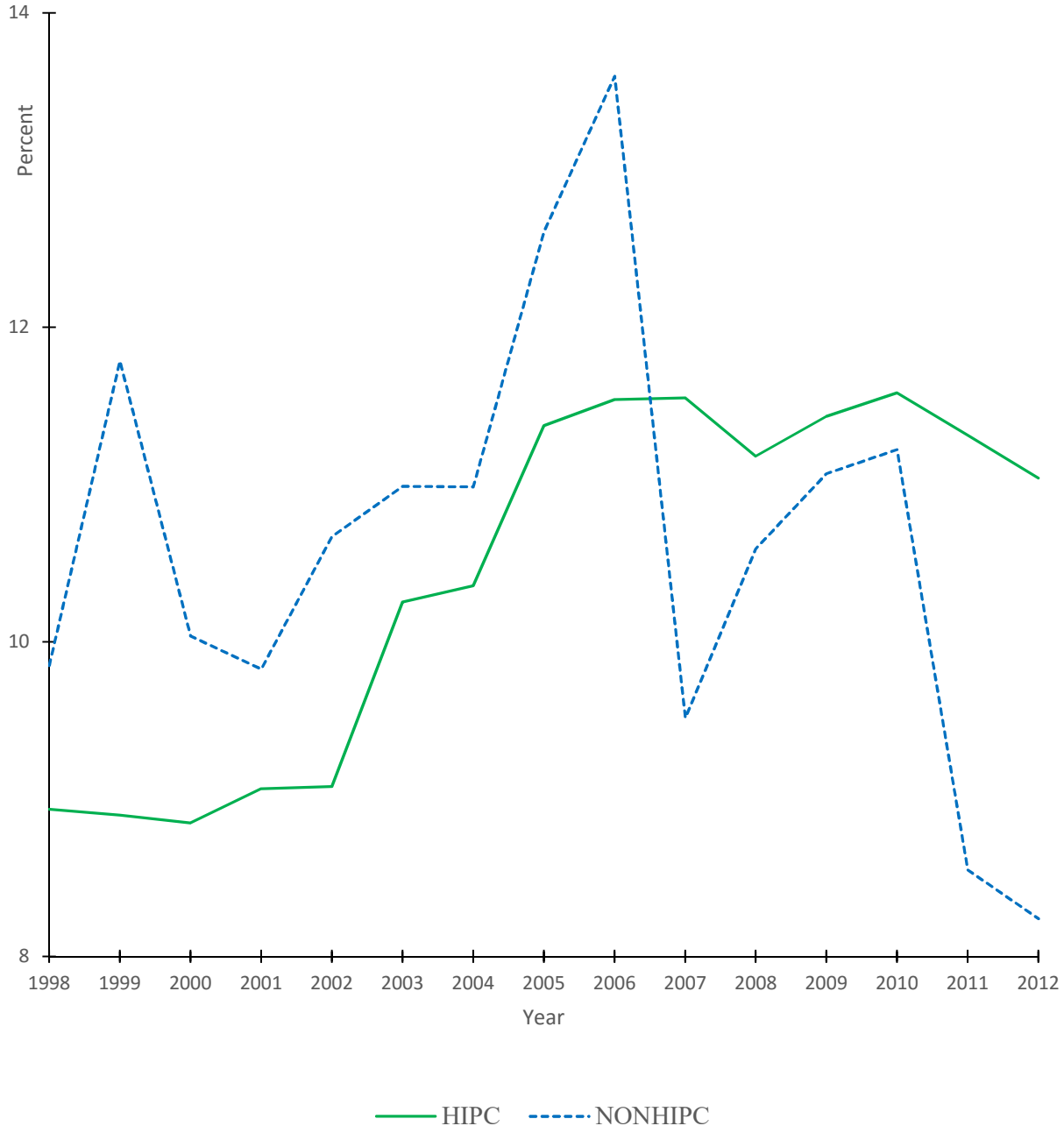

Figure 3: Health Sector Budget Allocation in SSA (1998-2012)

Source: Author's computations.

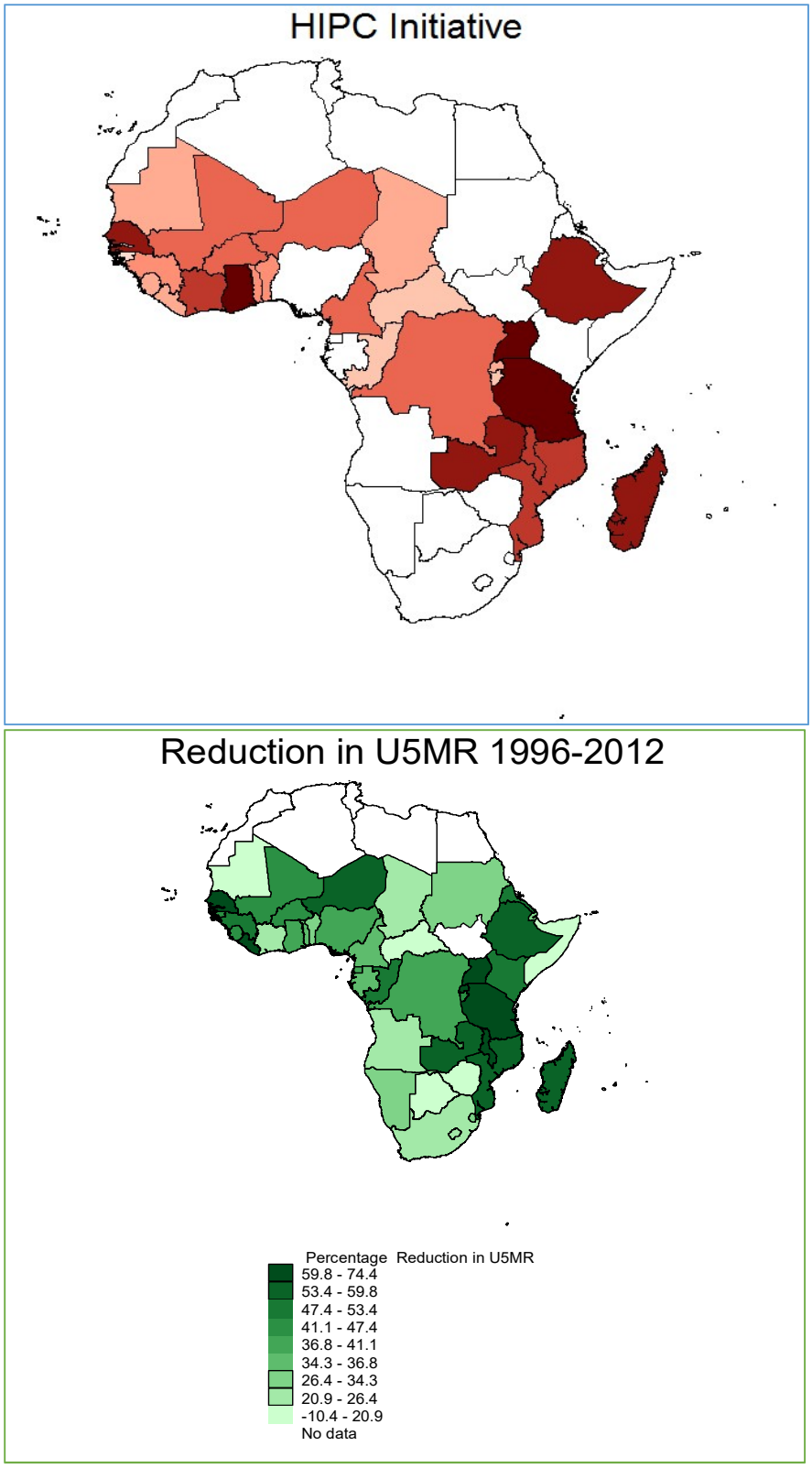

Figure 4: HIPC status and percentage reduction in U5MR

Source: Author's computation.

Chapter 3: Physician-Induced Demand for Cesarean Sections

3.1 Introduction

The increase in the rate of cesarean section (CS) births is a public health concern worldwide (Betran et al. 2007, Stanton and Holtz, 2006, Gibbons et al., 2012, and WHO, 2015). Niino (2011) and Villar et al. (2006) show that globally, most CS births are associated with little medical benefit but elevated health risks. According to Minkoff and Chervenak (2003), mothers who have had a CS delivery have a high risk of reproductive health problems.

Furthermore, babies born via CS tend to have elevated risks of respiratory problems and difficulties initiating breastfeeding than those delivered naturally. CS also impose a financial burden on households and the healthcare system since it is a complicated and expensive procedure (Niino, 2011). In Uganda, there are public outcries about the rising number of CS births[3]. This chapter examines the impact of private healthcare facilities (PHC) on the probability of CS births in Uganda.

The study is of relevance from both public health and economic perspectives since avoidable CS births impose financial burdens on households and can increase maternal mortality rates. Recent studies such as Kinfu et al. (2009), Kiguli et al. (2009), and Ssengooba et al. (2007) underscore the scarcity of medical supplies and healthcare workers in Uganda and the need for optimal

[3] Okot (2008) and the Independent (2010) are newspaper articles which report high cesarean birth rates of 15-25 percent in private hospitals in Uganda. The reports indicate that for every CS procedure, the doctor who performs it gets a share of the amount of the fee charged. The public suspects that the monetary gain encourages doctors to recommend expectant mothers for cesarean section births. There are reports of doctors extorting payments from expectant mothers as reported in http://www.monitor.co.ug/News/National/Police-hold-two-doctors-over-extortion/-/688334/3020142/-/ghwan3/-/index.html . This study provides empirical evidence from a nationally representative Demographic and Health Survey dataset.

use of the available resources. It is probable that CS births could adversely affect healthcare resource allocation, therefore this study is of policy relevance on maternal healthcare reforms in Uganda in relation with MDG number 5. It is noted that decisions about CS births are made under principal-agent relationships, a type of contractual arrangement under which the principal engages another entity (agent) to perform a service on their behalf. In this study, the expectant mother is the principal while the physician/private healthcare facility (PHC) is the agent, who is expected to act in the interest of the expectant mother, although this is often not the case. According to Wendler (2010), even if physicians are guided by codes of ethics, they sometimes put their personal interests above the patients' needs. This phenomenon could arise due to limited time to serve all patients and/or the personal motives of the physician where there is limited regulation.

Goodrick and Salancik (1996) note that hospital characteristics are influential in determining the use of CS and uncertainties during birth provides the greatest degree of discretion. In Uganda, the PHCs are owned and operated by physicians; a situation which could encourage the pursuit of revenue maximization. Compensation for employee physicians in PHCs also depend on the kind of services they offer. All these factors may align the profit motive of the PHCs with the income maximization objective of physicians, creating a potent environment for physician induced-demand for CS. Data from the Uganda Demographic and Health Survey (DHS) indicate a rising trend in CS births, from 2.6 percent in 1995 to 5.4 percent in 2011, however, anecdotal evidence such as that presented by Okot (2008) indicates that the CS birth rate is higher in private hospitals and clinics. The increase in the CS birth rate coincided with the rise in the number of private healthcare facilities in Uganda following economic liberalization under Structural Adjustment Program (SAPs).

Doherty (2011) notes that SAPs led to proliferation of private-for-profit hospitals and clinics in many African countries. The increase in PHCs is a shock which could have influenced the behavior of physicians and consequently health outcomes. This study examines the relationship between the type of healthcare facility and the likelihood of CS births. The contribution of the study to the literature is both theoretical and empirical.

Whereas the existing literature on CS births such as Cromwell and Mitchell (1986), Gruber and Owings (1996), Gruber et al. (1999) and Grant (2009) explain physician induced demand for healthcare services in developed market economies, there is no literature on the same phenomenon in SSA. To my knowledge, this is the first study to provide an empirical analysis of physician induced-demand for CS births using data from an African country. It potentially opens a new direction of research on African healthcare markets given the increase in the number of private hospitals and health insurance schemes.

The second contribution of the chapter is theoretical. The formulated model of physician induced-demand for CS explicitly links the profit objective of PHC with the utility maximization objective of expectant mothers. The model shows that information asymmetry increases the likelihood of physician induced demand and expectant mothers are more likely to accept CS when the severity of health conditions increases. I also show that the price expectant mothers are willing to pay for CS implicitly depends on household wealth and disutility of natural births[4].

In the main empirical analysis, I consider births which took place at hospitals only since cesarean sections cannot be safely performed outside hospital environments. The dataset for the study comes from the 2011 Uganda DHS. The DHS contains information on births which occurred

[4] Here and thereafter, I broadly distinguish between cesarean section (CS) births and all other births, which I refer to as natural births.

within 5 years before the survey. The variables of interest include the type of healthcare facility where the birth took place, whether it was by CS or natural birth, complications experienced, the type of medical personnel who provided antenatal care, as well as socioeconomic and demographic controls. Marital status of the expectant mother and households' distance to the nearest hospital are used as exogenous variables which influence choice of place of delivery but have no influence on the method of delivery. Other variables such as education and wealth index are used to control for self-selection.

The capacity of a hospital to perform CS procedures is measured by the number of hospital beds as a proxy. This measure is also used as proxy for the quality of service which influences the selection of health facility. This could be a controversial indicator of quality but there is limited information on other indicators of hospital quality such as personnel and quality of service provided. Data on hospital bed capacity is obtained from administrative records.

The tetrachoric correlation between the dependent variables in the two equations show that there is a statistically significant correlation between delivery at PHCs and CS births. It is plausible to apply a recursive probit model in the estimation. It involves two seemingly unrelated binary equations such that one equation explains the choice of place of delivery which could be PHCs or government hospitals and the second equation indicates whether the birth is by CS or natural birth. The result shows that the likelihood of CS increases by 6.1 percent for births at PHC relative to government hospitals, all things equal. Given the profit motive of private healthcare providers, the result is indicative of some degree of supplier-induced demand.

Generally, the chapter is organized as follows. Section 3.2 contains a brief background of maternal health service provision in Uganda. Section 3.3 presents a review of the literature related to physician induced-demand. In section 3.4, I derive the theoretical model and its prediction. Sections 3.5 and 3.6 describe the data and econometric strategy used in the analysis. Section 3.7 and 3.8 discuss the empirical estimates of the impact of private health facilities on the probability of CS births. The final section (3.9) contains the chapter conclusion.

3.2 Provision of Maternal Health Service in Uganda

The healthcare system in Uganda is organized according to the level of service offered, starting with the most comprehensive to basic primary healthcare services. In the hierarchical structure, the National Referral Hospitals are at the top, followed by Regional and District referral Hospitals, Health Center IV (sub-district hospital), Health Center III, II and I. The Ministry of Health (2010) report indicates that the government owns 2,242 health centers and 59 hospitals. On the other hand, 613 health centers and 46 hospitals are owned by not-for-profit private providers.

Private-for-profit health facilities include 269 health centers and 8 hospitals. In the year 2000, there were 57 government owned hospitals, 44 not-for-profit hospitals and 3 private hospitals. This indicates that there has been a 166 percent increase in the number of private hospitals over the ten year period. On the other hand, the number of not-for profit private and government hospitals increased by a modest 4.5 and 3.5 percent, respectively. The increase in the number of private hospitals indicates the possibility that profit motive could be the driving force behind the level of provision of some healthcare services, including CS births. This calls for deeper analysis since healthcare is associated with market failures.

The not-for-profit private hospitals are operated by NGOs or faith-based organizations and they charge higher fees for services in comparison to free or subsidized government hospitals, however, the private-for-profit hospitals charge the highest fee-for-service. Quality of healthcare services varies between rural and urban areas but is similar in government and private hospitals (Wane and Martin, 2013).

Maternal mortality rate (MMR) is still very high in Uganda in comparison to the OECD average. The 2011 Uganda DHS estimated 438 maternal deaths per 100,000 live births for the seven-year period preceding the survey. The MMR is influenced by a number of factors including the healthcare system and healthcare seeking behaviors. The ability of hospitals to provide cesarean sections can save mothers from risky situations but may also lead to adverse outcomes if it is not clinically required.

Gynecologists in Ugandan government hospitals are paid employees and do not directly benefit from fees charged by the hospitals, hence they have little incentive to induce demand for avoidable CS. This is in sharp contrast with physicians in private hospitals whose wages depend on the services they provide and hospital revenue and hence have incentive to induce demand.

As pertains to the place of delivery, according to 2011 Uganda DHS data, 57 percent of births took place at health facilities, including 44 percent in public-sector health facilities and 13 percent in private-sector health facilities. The mode of delivery has also been changing and births by cesarean section increased from 2.5 percent in 1995 to 5.4 percent in 2011. The 2011 Uganda DHS report shows that 68 percent of mothers who delivered through CS stayed at health facilities for three or more days in comparison with natural births. Therefore, CS births exert pressure on limited resources in hospitals and on the caregivers and may impose additional burdens on healthcare systems.

3.3 Literature Review

The contribution of this study to the literature is both theoretical and empirical. The main theoretical contribution is the explicit link of the profit maximization objective of PHCs with the utility maximization objective of expectant mothers. The theoretical model shows that the information asymmetry between expectant mothers and physicians is the driving force of induced demand when expectant mothers are faced with a choice of mode of delivery (CS or natural birth). The derivation shows that physicians can induce the demand for CS if the cost of CS is equivalent to the perceived benefit from the expectant mothers' perspective. On the empirical side, this is the first study which examines physician induced-demand using data from an African country. The results show that the probability of a CS birth increases when the place of delivery is a private hospital/clinic. The following are some related previous studies.

Dranove (1988) showed that medically uninformed patients are more susceptible to physician induced demand than informed ones. He used a game-theoretic formulation in which physician induces demand and if the patient accepts, the physician receives a fee for service, otherwise an adverse health condition persists without the most effective intervention. The fee depends on the cost of the service, the diagnostic ability of the physician and the severity of the patient's condition. I apply a similar approach in modeling the behavior of expectant mothers when faced with physicians' suggestion of a cesarean section birth.

Another related study is Hay and Leahy (1982), which show that physicians provide higher quantity of medical services than what is optimal to less informed patients. While the possibility of physician induced-demand exists in the healthcare sector, Arrow (1963) and De Jaegher and Jegers (2000) noted that physicians are guided by the patient's welfare unlike salesmen for other types of goods and services. The degree of physician induced-demand may depend on the type of

hospital for which physicians work, subject to professional ethics. According to Epstein and Nicholson (2009), physicians obtain more knowledge on how to practice from fellow physicians and from the hospital where they work. This implies that physicians in private practices might create demand for some services in order to meet the profit objective of the private hospitals.

In an empirical study, Tussing and Wojtowycz (1986) used national survey data to examine physician induced-demand in Ireland. Their findings indicate that the higher the physicians-to-population ratio, the higher the frequency of return visits recommended by physicians. This is because a high number of physicians in an area depresses physicians' income. Induced-demand is then used to increase the volume of services and total income in fee-for-service healthcare systems.

Fuchs (1978) applied multivariate analysis to US data and found that a 10 percent increase in the supply of physicians in an area is associated with a 3 percent increase in surgeries. Similarly, Cromwell and Mitchell (1986) used a simultaneous equation model to estimate physician demand and fees for surgery. They found a positive relationship between the number of physicians per capita and the number of surgeries, especially in large metropolitan areas.

Birch (1988) and Grytten and Sorensen (2001) showed that the higher the number of dentists per capita, the greater the number of recommended dental visits in an area. Nguyen and Derrick (1997) examined physicians' response to Medicare fee reductions due to the Omnibus Budget Reconciliation Act of 1989. They analyzed data from Part B Medicare Annual Data provider files for 1989 and 1990 using a fixed-effects model. The results indicate that physicians who were negatively affected by the Act increased the volume of services to compensate for lost revenue.

Delattre and Dormont (2003) used panel data of 4,500 self-employed French physicians observed over the period 1979-1993 to study induced-demand for medical services. They observed that the physicians experienced a decrease in number of consultations due to an increase in the physicians-to-population ratio. Using generalized method of moment estimators, they found that physicians counterbalanced the decrease in consultations by increasing the volume of healthcare services provided at each consultation. It is therefore probable that an increase in the number of privately owned hospitals could lead to an increase in CS births.

A few empirical works focused on the impact of physician induced demand for CS. A notable one is Gruber and Owings (1996). They used state and time variation in fertility rates to identify the effect of physicians induced-demand for CS. Their logistic regression results indicate that a 10 percent drop in the fertility rate was associated with 0.6 percent increase in the probability of CS birth rates. They concluded that the drop in fertility rates resulted in fewer patients for gynecologists, hence the need to induce demand for lucrative CS.

In a follow up study, Gruber et al. (1999) used a logistic model to examine the impact of Medicaid fee differentials on the CS birth rate over the period 1988-1992. They found that there was lower fee differential for CS and natural delivery under Medicaid in comparison with private insurance. The higher difference between fees for CS and natural delivery under private insurance schemes explained the difference in CS rates between the two sets of patients (by insurance type). This shows that the ability to charge higher fees for CS than regulated rates may motivate physicians to recommend CS births instead of natural birth

Declercq et al. (2013), in "The Listening to Mothers III Survey and Report" found that 63 percent of respondents reported that the decision to have a CS was made by a doctor. For mothers with a repeat CS, decisions on 22 percent of planned CS were made by physicians. This suggest

that in the US, physician have great influence in determining the method of birth and can induce demand for CS. In a related study, Brown (1996) used data from US military hospitals to study the impact of time and day of the week on CS birth rates. With the aid of a logistic regression model, he showed that CS birth is more common during weekends than weekdays. Since physicians in military hospitals do not charge fee for service, the increase in CS rates during weekends is explained by physicians' need for leisure rather than financial gains. He argued that prolonged natural delivery create a higher opportunity cost in terms of leisure. Since leisure and working hours are substitutes, induced-demand for CS could be higher when physicians' compensation depends on the service provided in a PHC.

Stafford et al. (1993) studied the trend of CS in California between 1983 and 1990. They used California discharge abstract data on hospital deliveries and analyzed time trends by indication, age, race, and payment source. Their results show a statistically significant difference in CS rates by payment source. Privately insured expectant mothers were found to have the highest CS birth rates relative to Medicare patients. Since insurance claims and fee for service ensures revenue flow for physicians in private practice, it potentially influences the degree of induced-demand for CS.

The rate of CS is also impacted by socioeconomic factors such as income and peer influence. Leone et al. (2008) used a random intercept logistic model and found that in Egypt, Morocco, Bangladesh, Colombia and Dominican Republic, women of higher socio-economic background, who had better access to antenatal services, are the most likely to undergo cesarean section births. They also observed that women who exchange reproductive health information with friends and family are less likely to experience CS. This probably indicates that well informed expectant mothers are less susceptible to physician induced-demand. Thus it is important to consider education

level and decision making power about health as explanatory variables. Fortunately, these variables are captured in the Uganda DHS dataset and are used in the empirical analysis. It is noted that physicians in private practice sometimes face risks of claims against malpractice. CS could be a form defensive medicine (medical decision making which involves treatment that is not necessarily the best option but serves mainly to protect the physician/hospital against lawsuits by dissatisfied patients). In such a scenario, physician induced-demand for CS would be motivated by risk aversion rather than by profit.

Dubay et al. (1999) used a fixed effects estimator to study the impact of malpractice claims risk on CS rates using US national birth certificate data for the 1990 -1992 period. They found that defensive medicine by obstetricians led to an increase in CS birth rates. Localio et al. (1993) exploited New York State hospital data to examine the relationship between the likelihood of malpractice claims and CS rates. After controlling for the clinical risk of CS delivery, socioeconomic factors, and physician and hospital characteristics, they found that CS rates were positively related with physician malpractice premiums.

Baldwin et al. (1995) and Sloan et al. (1997), however, found no significant impact of risk of malpractice claims on the obstetric services including CS rates. Thus, defensive medicine as a basis for induced demand for CS have mixed findings. In Uganda, defensive medicine may not be as prevalent as in developed market economies because a very small proportion of patients are aware of their rights (Kagoya et al. 2013).

There are a few empirical studies which found no evidence of physician induced-demand for CS. Rossiter and Wilensky (1987) examined the extent of physician-initiated expenditures as a way of identifying physician induced-demand. After controlling for insurance and other factors,

they did not find evidence of physician induced expenditures. They concluded that medical services are recommended for the health needs of the patients rather than for the financial benefit of the physicians. Tussing and Wojtowycz (1992) used a 1986 dataset of 68,847 obstetric deliveries in New York State excluding New York City to study the economic and non-economic factors which influence CS birth rates. Using probit regressions, they found no impact regarding the density of gynecologist and CS delivery in New York State. They showed that county cesarean section rates are influenced by the probability that a given delivery required a CS procedure.

In conclusion, the debate about the existence and the degree of physician induced-demand remains unsettled. Empirical results from previous studies largely depend on the type of data and identification strategy used. The lack of theoretical and empirical study of physician induced - demand in Sub-Saharan Africa, amidst weak regulation in the health systems raises interest to analyze the phenomenon. This study attempts to fill the gap by applying robust econometric strategy and data from Uganda; a developing country characterized by increases in the number of private hospitals amidst inadequate monitoring by the government.

3.4 Theoretical Model

In this section, I develop a model to link the behavior of physicians in PHC with the behavior of the expectant mothers. The model closely follows Hay and Leahy (1982) and Dranove (1988) but with new innovations and predictions. From the onset, it is important to note that most private hospitals in Uganda are set up by physicians. This implies that the profit objective of the PHCs is the same as the income maximization objective of the physicians. This follows Currie and MacLeod (2008) argument that the incentives of hospitals are not different from the incentives of physicians.

In building the model, I assume that the PHCs aim at profit maximization and they operate in a monopolistically competitive market. On the other hand, the expectant mothers aim at minimization of adverse health outcomes subject to household wealth (Y). The ability of the healthcare facilities to perform CS procedures depends on the quality (F) of the healthcare facilities, the skill (D) of healthcare workers, and the diagnostic as well as surgical tools at their disposal. Let the bounded diagnostic skill (D) of the healthcare workers be denoted by:

$$D \in (\underline{D}, \overline{D}) \tag{3.1}$$

Where $\underline{D}$ and $\overline{D}$ are the lowest and the highest healthcare skill levels, respectively. As in a standard agency problem, it is assumed that the physicians have superior information about delivery due to their training and experience. The expectant mothers are assumed to have medical information (H) about their health status and the likelihood of safe natural delivery. H is gained from medical history, education, social interactions, experience and antenatal care. It is assumed to be bounded such that:

$$H \in (\underline{H}, \overline{H}) : \overline{H} \leq \underline{D} \tag{3.2}$$

Where $\underline{H}$ and $\overline{H}$ are lowest and the highest maternal health knowledge possessed by the expectant mothers, respectively. The inequality in equation (3.2) indicates information asymmetry in which the most informed expectant mother is at best as informed as the least skilled maternal healthcare workers. Physicians have the potential to induce demand for CS based on their judgment about the benefit of CS birth, given the severity (z) of the medical condition of the expectant mother and the unborn child.

The physician would also consider fee-for-service (P) to be charged, given medical knowledge (H) of the expectant mother about the likelihood of safe delivery. To minimize reputation damage, the physician would consider proposing CS to expectant mothers at the margin of

natural delivery as well the cost of the CS. Over time, PHCs review their practice and adjust the frequency (Q) of induced CS, such that their reputation is not damaged and the PHC meets the profit objective. It is assumed that the gynecologists gain utility from controlling severity (z) of conditions faced by expectant mothers, quality (F)of the hospital as well as their own altruism (θ) for expectant mothers denoted as :

$$\mu(-z, F, \theta) \tag{3.3}$$

Utility is assumed be increasing in all the arguments in equation (3.3). Physician also gains utility from income or the profit (π) derived from induced-demand for CS. The profit is defined as the difference between total revenue derived from induced-demand for CS and the total cost of the service, $C(Q, \theta, F)$. Hence, the profit is symbolically defined as:

$$\pi = Q.P(Q, H, F) - C(Q, \theta, F) \tag{3.4}$$

The total utility of the physician who owns a private hospital/clinic is the sum of professional satisfaction and profit, denoted as:

$$U^{PHC} = \mu(-z, F, \theta) + Q.P(Q, H, F) - C(Q, \theta, F) \tag{3.5}$$

Per the Hippocratic Oath and ethical rules, $\mu(-z, F, \theta)$ is assumed to be independent of fee-for-service and the quantity of service provided. It follows that the maximization of the physician's utility with respect to induced demand for CS is identical to the profit maximization problem of the private healthcare facilities. Taking the first order condition for physician's utility maximization with respect to Q yields:

$$\frac{\partial U^{PHC}}{\partial Q} = P(Q, H, F) + Q\frac{\partial P(Q,H,F)}{\partial Q} - \frac{\partial C(Q,\theta,F)}{\partial Q} = 0 \tag{3.6}$$

Hence $P(.)\left(\frac{\partial P(Q,H,F)}{\partial Q}\frac{Q}{P} + 1\right) = \frac{\partial C(Q,\theta,F)}{\partial Q}$. Or compactly, $P(.)\left(\frac{1}{\varepsilon} + 1\right) = MC(.)$[5] (3.7)

[5] ε is the price elasticity of demand.

Equation (3.7) indicates the profit maximizing condition of the private healthcare facilities. To analyze the effect of information asymmetry on the degree of induced demand for CS, a comparative static analysis of equation (3.6) using the implicit function theorem yields:

$$\frac{dQ}{dH} = -\left(\frac{\frac{\partial^2 P(Q,H,F)}{\partial Q \partial H} + \frac{\partial P(Q,H,F)}{\partial H}}{\frac{\partial^2 P(Q,H,F)}{\partial Q^2} Q + 2\frac{\partial P(Q,H,F)}{\partial Q} - \frac{\partial C(Q,\theta,F)}{\partial Q^2}}\right) < 0 \tag{3.8}$$

The denominator of equation (3.8) is the second order condition for profit maximization and is negative on the assumption that a unique solution exist. The numerator is also negative since more informed patients (high H) reduce the likelihood of induced-demand for CS. Thus, $\frac{\partial^2 P(Q,H,F)}{\partial Q \partial H} < 0$ and $\frac{\partial P(Q,H,F)}{\partial H} < 0$, which makes equation (3.8) negative. Therefore, the expectant mothers with better maternal health information (H) are less likely to face physician induced-demand for CS births. This shows that, on average, physicians can induce demand in the presence of information asymmetry.

To link the behavior of physicians/healthcare providers with the behavior of the expectant mothers, I borrow a few ideas from Dranove (1988). In a static game theoretic framework, the expectant mothers or their caretakers have two strategies; either consent to or reject the induced-demand for CS. This is done after weighing the cost and benefit of each of the strategies. The payoff (utility) depends on the chosen strategy. If the expectant mother accepts to undergo the demand-induced CS, the payoff is specified as:

$$U^{Wc} = E(M_C) + V_C(Y - P) \tag{3.9}$$

Where $E(M_C)$ is defined as the expected health status of the unborn child, which is unknown before birth, but if it were known to be adverse, clinically required CS would be performed. The term $V_C(Y - P)$ defines the utility the expectant mother gains from residual wealth $(Y - P)$ after CS is performed at fee-for-service(P).

Without CS, the health condition of the expectant mother could deteriorate. The health condition,M_W, is assumed to be a function of the severity (z) prior to birth such that:

$$M_W = -\delta(z): \delta'(z) > 0 \tag{3.10}$$

If the expectant mother rejects the gynecologist's suggestion for CS birth, her payoff is denoted as:

$$U^W = -\delta(z) + E(M_C) + V(Y) \tag{3.11}$$

Where $V(Y)$ represents the utility derived from keeping full wealth without going through cesarean section birth. To decide on the optimal strategy, the expectant mother forms a belief about the severity of her condition given the medical advice and medical knowledge *H*. The belief follows a normal density function $f(z|H,\theta)$. The expected payoff from rejecting induced-demand for CS is stylized as:

$$-\int_{-\infty}^{\infty} \delta(z)\ f(z|H,\theta)dz\ + E(M_C) + V(Y) \tag{3.12}$$

Induced-demand for CS would be accepted if and only if the expected payoff of rejecting CS is less than the expected utility of undergoing CS. That is to say:

$$-\int_{-\infty}^{\infty} \delta(z)\ f(z|H,\theta)dz\ + E(M_C) + V(Y) \leq E(M_C\ )\ +\ V_C(Y-P) \tag{3.13}$$

Departing from Dranove (1988) from here onwards, I assume that in the worst case scenario, the expected health condition of the unborn child is ignored to save the expectant mother's life. Then equation (3.13) reduces to:

$$-\int_{-\infty}^{\infty} \delta(z)\ f(z|H,\theta)dz\ + V(Y) \leq\ V_C(Y-P\ ) \tag{3.14}$$

The preceding equation can be inverted to solve for the price the expectant mother would be willing to pay as $\left(Y - {V_C}^{-1}\left(-\int_{-\infty}^{\infty} \delta(z)\ f(z|H,\theta)dz\ + V(Y)\right)\right)\ \leq P$. When CS is accepted,

$$\left(Y - {V_C}^{-1}\left(-\int_{-\infty}^{\infty} \delta(z)\ f(z|H,\theta)dz\ + V(Y)\right)\right) =\ P \tag{3.15}$$

Equation (3.15) is interpreted as a condition in which the price (P) that the expectant mother is willing to pay implicitly depends on the expected utility gained from relieving severe health conditions during natural births and household income. It also implicitly defines the supplier induced-demand for cesarean sections as a function of Y, z, H and θ. Substituting equation (3.15) into equation (3.7) yields:

$$\left(Y - {V_C}^{-1}\left(-\int_{-\infty}^{\infty}\delta(z)\ f(z|H,\theta)dz\ + V(Y)\right)\right)\left(\frac{1}{\varepsilon}+1\right) = MC(.) \tag{3.16}$$

Equation (3.16) links the profit maximization condition of PHCs with the utility maximization condition of the expectant mothers. It implies that the marginal revenue of a PHC from induced demand for CS depends on expected health benefits as perceived by expectant mothers and household wealth (Y) and price elasticity of demand. This implies that expectant mothers who appear to be wealthy are more likely to face physician induced-demand. Severity (z) of medical condition of the expectant is predicted to increase the likelihood of accepting CS while maternal healthcare knowledge (H) possessed by the expectant mothers is expected to reduce the likelihood of accepting it.

The impact of the gynecologists' concern (θ) for expectant mothers may increase or decrease the likelihood of CS, hence the sign is unknown a priori and it depends on adherence to professional ethics and altruism. From equations (3.15) and (3.16), an estimable equation for the likelihood of CS can be specified as a linear function of Y, z, H , type of hospital (PHC), socioeconomic and demographic characteristics(X) and a stochastic term η_i.Symbolically;

$$CS_i = \alpha + \beta_1 PHC + \beta_2 Y_i + \beta_3 H_i + \beta_4 z_i + \Gamma X_i + \eta_i \tag{3.17}$$

3.5 Data

The dataset for the empirical analysis comes from the 2011 Uganda Demographic and Health Survey (UDHS). It is a large cross sectional dataset collected by the Uganda Bureau of Statistics on behalf of Macro International and USAID. It contains data on demographic characteristics, healthcare services, antenatal care, births, postnatal care, maternal, infant and child mortality among others. It is a nationally representative data obtained through multistage cluster sampling. The country is divided into clusters and then clusters are randomly selected to ensure representativeness. Thereafter, households in clusters are randomly sampled for interviews. A total of 18,674 women aged 15-49, and 2,295 men aged 15-54 were interviewed. The unit of observation in this study are women aged between 15-49 years and those who have had at least one birth in the 5 year period preceding the survey.

The dataset contains information on method of delivery, which can either be CS or natural birth. This is the dependent variable of interest. As a dummy variable, CS births are coded one while natural births are coded zero. The independent variable of interest is the place of delivery, which can be a private or government hospital/clinic. It is a dummy variable equal to one if the place of delivery is a PHC and zero if it is a publicly owned hospital.

PHCs aim at profit maximization but government hospitals aim at improvement of social welfare. It is hypothesized that the difference in goals is associated with differences in the likelihood of CS birth. It is plausible that distance to hospitals influences the choice of hospital but does not influence the choice of the method of delivery. In this way it is exogenous and can meet exclusion restrictions for identification of the parameters. Data on distance was computed using global positioning system (GPS) data obtained from the Uganda DHS. During The Uganda DHS data collection, the latitude and longitudes of each sampled cluster is recorded and the data is

published with the main survey report. To construct distance, I obtained latitudes and longitudes of all hospitals in Uganda and then used ArcGIS to compute distance to the nearest hospital. It is assumed that households choose the nearest hospitals to reduce transportation costs and other inconveniences. If the difference is insignificant, then the quality and cost of maternal healthcare services will have more influence than distance. Table 6 indicates that there is statistically significant differences in mean distance for women who delivered at PHCs in comparison with government hospitals.

The decision-making power of the expectant mothers about health issues is included to capture their likely response to gynecologists' recommendation of unexpected CS birth. An expectant mother who makes health decisions alone is more susceptible to inducement than the one who makes health decisions in consultation with the spouse. Decision making on health issues may also depend on culture, financial resources and position in the household (Stephenson et.al. 2006 and Duong et al. 2004). The Uganda DHS dataset contains a categorical variable which indicate the person who makes the health decision for the sampled individuals. The decisions involve when and where to seek medical care. This can be the individual, spouse, jointly or someone else. It potentially affects the likelihood of accepting or rejecting unexpected CS birth.

The dataset also contains information on antenatal visits during which expectant mothers obtain advice about the likelihood of safe delivery. The type of health professional who provided antenatal care (*ANC*) is also contained in the dataset. This includes physicians, nurses or midwives. Due to skill levels (*D*), information acquired from physicians (*ANC-doctor*) is superior to that obtained from nurses or midwives. Previous studies show that ANC influences the choice of place of delivery and the method of birth (Mishra and Rutherford, 2008). A dummy variable is constructed to indicate the type of personnel who provided the last ANC service.

A proxy measure of hospital quality is also included as a control. It is assumed that the quality of hospital influences the expectant mothers' choice as well the ability of the hospital to perform CS procedures. It is difficult to objectively measure quality as it depends on experiences and perception of the healthcare services provided. Inclusion of the variable is guided by previous literature such as Thaddeus and Maine (1994), and Mesko et al. (2003). The number of hospital beds is used as proxy. Data on the number of hospital beds for each district is obtained from administrative records of Uganda's Ministry of Health. A dummy variable to capture complications experienced during child birth is also included in the model since it increases the likelihood of clinically necessary CS. The Uganda DHS dataset contain information on complications which expectant mothers were informed about during ANC visits and complications during the time of birth.

Data on demographic and socioeconomic characteristics of the households and expectant mothers are also used in the analysis. For instance, the age of expectant mothers influences the likelihood of CS. Burgard (2004) and Reynolds et al. (2006) discuss how an increase in maternal age increases risks at child birth. Age also indicates experience in child birth and utilization of healthcare services as explained in Navaneetham and Dharmalingam (2002). It is assumed that older expectant mothers would be more confident to reject physician suggestion of unnecessary CS births. In the dataset, age is grouped into categories of 15-19, 20-29, 30-39, 40-44 and 45-49 years. When a household is expecting a child, expenditure towards healthcare increases tremendously. The cost may include transportation, medication and supplies, and healthcare fee-for-service among others. Therefore, household's wealth (Y) may influence the choice of place of delivery and the method of delivery. It also influences the response to physician induced-demand for CS. Poor households are less likely to utilize PHCs or afford to pay for CS in private hospitals.

In the Uganda DHS dataset, wealth index is used as a cumulative measure of a household's possessions and hence wealth. It is calculated using principal component analysis on the basis of household assets, housing conditions as well type and access to water. The index is divided into quintiles with the first quintile consisting of the poorest households and the last quintile comprising of the richest. Household wealth influences elective CS (Hannah, 2004, Glei et. al., 2003, and Stephenson and Tsui, 2002). Inclusion of wealth index helps to capture self-selected CS as well as the likelihood of yielding to induced-demand.

Marital status also influences the choice of place of delivery through health decision making power and ability to pay for CS procedures. In contrast to married expectant mothers, single or divorced expectant mothers may face greater financial constraints though they might exercise greater autonomy on health decision making (Duong et al. 2004). A categorical variable is constructed to indicate the marital status of the mothers.

Descriptive statistics of the variables are presented in Table 6. After dropping all home births, the sample decreased to 4,421 observations of which 1,079 occurred at PHCs while 3,342 were at public-sector hospitals. The sample indicates that 10 percent of all births were through CS. About 11 percent of births at PHCs were through CS but the rate is 10 percent at government owned hospitals. The difference in proportion of deliveries by CS at PHC and government hospitals is insignificant before controlling for socioeconomic characteristics. The data also indicate that decision making about women's health issues were mainly made by the expectant mothers (38.7 percent) and also jointly with the spouse (37.7 percent) for the overall sample. The pattern is similar for the PHC and government hospital sub-samples. For expectant mothers from households in the top wealth quintile, 43.6 percent delivered their babies at PHCs while 28 percent gave birth in public sector hospitals, therefore, wealth influences the choice of place of delivery.

3.6 Econometric Strategy

The choice between natural birth and CS birth is a binary decision and hence most previous studies applied binary choice models. In a study of physician induced-demand, Hay and Leahy (1982) used the Linear Probability Model (OLS), Cromwell and Mitchell (1986) used a two stage least squares method (2SLS), Gruber and Owings (1996), Gruber et al. (1999) and Grant (2009) used logistic regressions. In this study, I apply a bivariate probit method and compare the results with probit, OLS, instrumental variable probit and multilevel probit estimates. The rationale for using the bivariate probit model is hinged on the sequence of choice. First, the expectant mother decides on whether to deliver from a PHC or a government hospital. At the hospital, delivery is either by CS or natural mode. It is plausible that the choice of type of hospital and the method of delivery are correlated. Indeed, the dataset shows that the tetrachoric correlation between the decisions to deliver at a PHC and delivery through CS is 0.23 with a standard error of 0.031. This indicates that CS and delivery at private healthcare facilities are not statistically independent. It then follows that estimation using a bivariate probit regression is more efficient than equation by equation estimation. This is because correlation between the dummy variables may introduce endogeneity in OLS or univariate probit. However, the recursive structure of bivariate probit and other exogenous variables improves model identification as discussed in Jones (2007).

Using a latent variable approach, the unobservable utility associated with choice of type of healthcare facility for delivery is influenced by observables (X_1) including the stochastic disturbance term $\epsilon_1$as part of the data generating process. It is specified as:

$$y_1^* = X_1\beta_1 + \epsilon_1 \tag{3.17}$$

The choice of place of delivery is observable from data, and coded one if birth took place at a $PHC(y_1)$ but zero if birth was at a publicly owned hospital/clinic as shown in the equation below.

$$y_1 = \begin{cases} 1 \; if \; y_1^* > 0 \\ 0 \; if \; y_1^* \leq 0 \end{cases} \tag{3.18}$$

The decision on method of delivery is made at the healthcare facility. Birth is either by natural mode or by CS. The latent variable for birth by CS (y_2) depends on observable covariates (X_2), the place of delivery (y_1) in addition to the stochastic disturbance term ϵ_2 as part of the data generating process and is symbolically denoted as:

$$y_2^* = X_2\beta_2 + \lambda y_1 + \epsilon_2 \tag{3.19}$$

Information on the method of delivery (natural or CS) is observable and defined as:

$$y_2 = \begin{cases} 1 \; if \; y_2^* > 0 \\ 0 \; if \; y_2^* \leq 0 \end{cases} \tag{3.20}$$

With the assumption that ϵ_1 and that ϵ_2 are normally distributed, the joint distribution of the disturbance term is denoted as:

$$\left[\binom{\epsilon_1}{\epsilon_2} | X_1, X_1\right] \sim N\left[\binom{0}{0}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right] \tag{3.21}$$

The measure of correlation (ρ) between the stochastic terms ϵ_1 and $\epsilon_2$would be statistically different from zero if the decisions on place of delivery and CS are correlated. As shown in Greene (2012), estimation of this system of equations as a seemingly unrelated bivariate probit is more efficient than single equation estimation. The parameters to be estimated via the likelihood function are specified as:

$$L(\beta_1, \beta_2, \lambda) = \prod\prod pr(y_1 = 1, y_2 = 1|\beta_1, \beta_2, \lambda)^{y_1 y_2} \; pr(y_1 = 0, y_2 = 1|\beta_1, \beta_2, \lambda)^{(1-y_1)y_2} \; \times$$

$$pr(y_1 = 1, y_2 = 0|\beta_1, \beta_2, \lambda)^{y_1(1-y_2)} \, pr(y_1 = 0, y_2 = 0|\beta_1, \beta_2, \lambda)^{(1-y_1)(1-y_2)} \tag{3.22}$$

However, the estimate of main interest is joint and conditional probability of delivery by CS given delivery at a PHC. The joint probability of delivery at a PHC and by CS is defined as:

$$pr(y_1 = 1, y_2 = 1) = \int_{-\infty}^{X_1\beta_1} \int_{-\infty}^{X_2\beta_2 + \lambda y_1} \phi_2(\epsilon_1, \epsilon_2, \rho)\, d\epsilon_2 d\epsilon_1 = \phi_2(X_1\beta_1, \mathrm{X}_2\, \beta_2, \rho) \quad (3.23)$$

The probability of delivery by CS conditional on delivery at a PHC is defined as:

$$pr(CS|PHC) = \frac{pr(CS \cap PHC)}{pr(PHC)} = \frac{\phi_2(X_1\beta_1, \mathrm{X}_2\, \beta_2, \rho)}{\phi(\mathrm{X}_1\, \beta_1)} \quad (3.24)$$

Where $\phi_2$is the bivariate normal density function and $\phi(\mathrm{X}_1\, \beta_1)$ is the marginal probability of delivery at a private hospital. The parameters are identifiable and Wilde (2000) shows that recursive bivariate probit requires no exclusion restrictions if there is sufficient variation in the data provided each equation contains at least one exogenous explanatory variable. Jones (2007) also shows that variation in exogenous variables ensures "identification by functional form." However, this depends on the strong assumption of the bivariate normality of the residuals. To avoid potential endogeneity problems, in the maximum likelihood estimation, the exclusion restriction is met by including distance to hospital and marital status in the choice of place of delivery as defined in equation (3.18) but excluded from equation (3.20).

It is assumed that distance and marital status influences the choice of place of delivery due to cost considerations but have no influence on the method of delivery. Complications during delivery is included in the equation for method of delivery but excluded from the choice of place of delivery due to recursive sequences of events.

3.6.1 Multilevel Mixed Effects Model

It is also plausible that the choice of hospitals and method of delivery have correlated random effects given the sequence of the binary choices. This can be modeled as multi-level or clustered choices and estimated as a combination of fixed and random effects. Multilevel analysis

accounts for variance in the dependent variable that is measured at the lowest unit of analysis since it considers information at all levels (Steenbergen and Jones, 2002). This reduces the likelihood of using incorrect standard errors when making statistical inferences. In this study, an expectant mother can choose between home delivery and hospital delivery, then between private and public hospitals, and finally natural or CS birth. This provides three levels of decisions nested in the choice of the place of delivery. My interest is to estimate the impact of private hospitals on CS. Consequently, the level of choice reduces to two; hospital against home delivery and then private versus government hospitals. Mixed effects models contain both fixed effects and random effects and the maximum likelihood estimation provides both the fixed effects coefficients as well as variances and covariance as shown in equation (3.25).

$$y_{jk} = X_{jk}\beta + Z_{jk}^{2}U_k + Z_{jk}^{3}U_k + \varepsilon_{jk} \tag{3.25}$$

For $i = 1\ldots njk,$ first level observations nested within $j = 1{,}2$ of the second level group which are nested within $k = 1{,}2$ of the third level group. In this case, the level 2 nests hospital and home delivery while the third level nests hospital types (PHCs or government hospitals), respectively. Xjk represents the fixed effects component while $Z_{jk}^{2}U_k$ and $Z_{jk}^{3}U_k$ are the random parts in the second and third level choices and ε_{jk} is the overall error term. A more detailed literature on three level mixed effects probit can be found in Liu and Hedeker (2006).

3.7 Results

In all the estimations, survey sample weights are applied to correct sample bias and ensure representativeness of the observations. Clustered robust standard errors (at the enumeration area level) are estimated to account for heterogeneity of the enumeration areas. Due to missing data on some variables, only 2,465 observations are used in the estimation. The first stage bivariate probit

estimate, which helps to check for identification of parameters is displayed in Table 7. The estimates show that distance influences the choice of place of delivery but does not influence the mode of delivery. This indicates that the exclusion restriction necessary for model identification is satisfied. The Wald χ^2 (47) with p-value of 0.000 indicates that the residuals in equations (17) and (19) are indeed correlated and the bivariate probit model fits the data well. The coefficients are probit indices for equations (3.18) and (3.20), respectively.

The second stage analysis involves obtaining the conditional probability of birth by CS given that birth took place at PHCs. The estimates in terms of average marginal effects are presented in Table 8. For comparison purposes, results from other possible methods of estimation are presented alongside the main one. Column (1) contains OLS estimates, which indicates that there is no statistically significant impact of PHC on the probability of CS. Other plausible specifications, such as Instrumental Variable (IV) probit, is in Column (2), probit estimates are contained in Column (3) and Fixed Effects (FE) results are in Column (4). The coefficient of PHC in Columns (1), (2), (3), and (4) indicate that there is no statistically significant impact of PHC on the likelihood of CS.

However, the bivariate probit estimate in Column (5) indicates that if birth takes place at a PHC rather than at a government hospital, the probability of CS increases by 6.1 percent. Thus, the naive methods which do not consider the recursive sequence of choices and ignore the correlation between the residuals are not suitable for this analysis. The bivariate probit estimates indicate that the likelihood of CS is higher in PHCs in comparison to publicly owned hospitals. Therefore, the profit objectives of PHCs may influence the extent to which CS is recommended given complications and other medical factors which impact the likelihood of an expectant mother delivering through CS.

The results show that physicians in private hospitals in Uganda are likely to induce demand for some services just like their counterparts in developed market economies. For instance, De Regt et al. (1986) reviewed 65,647 deliveries in four Brooklyn hospitals between 1977 and 1982, and found that private physicians performed significantly more cesarean sections than attending physicians. In Uganda, few households have medical insurance, so those who go to private hospitals pay fee-for service. The physicians in the PHCs would know that the patients can afford the costs since they could choose to go to subsidized publicly funded hospital. Though hospitals are responsible for all procedures that take place on its premises, physicians decide on the appropriate procedures. Hence, the positive impact of PHCs on CS is indicative of physician induced-demand. The finding is comparable to Belizan et al. (1999) who show that a greater proportion of CS births in Latin America were performed at private hospitals.

Relating the results to information asymmetry as modeled in the theoretical setup, the impact of health decision making power is weakly significant. Specifically, if a spouse makes most decisions for the expectant mothers, the likelihood of CS decreases by about 1.8 percent. This implies that if health decisions are made by expectant mothers only, the likelihood of CS would increase. It is plausible that expectant mother can be influenced by physicians during childbirth as it is a critical time with a high degree of uncertainty. However, the expectant mother is more informed about her health condition than the spouse. Hence, the estimate could indicate the influence of decision making power rather than information asymmetry. It is only a proxy and should be interpreted with this caveat.

The theoretical model also indicates that household wealth (Y) affects the likelihood of induced-demand for CS. The higher the household wealth, the higher the risk aversion and willingness to accept induced-demand for CS. The marginal effect of the wealth index explains part

of idiosyncratic preference for CS. The result shows that on average, moving from the poorest to other wealth quintiles increases the likelihood of CS. The impact is statistically stronger and larger for an expectant mother in the top wealth quintile. This suggests that wealth significantly affects the likelihood of CS as predicted in the theoretical model. Other covariates such as, parity, age of the mother at child birth, education and pregnancy complications were controlled for and their marginal effects are statically significant with expected signs.

3.7.1 Robustness Check Results

It is possible that the estimates discussed in the preceding section could have been influenced by the model specification. To check for the robustness of the estimates, additional regressions were performed and the results are reported in Table 9. In Column (1) the dummy variable indicting complicated delivery was excluded from the CS equation. The conditional probability of CS given delivery at a PHC remains statistically significant with a slight increase to 6.8 percent. The impact of the wealth index and health decision making remains close to the full model of Table 8.

The estimates in Column (2) in Table 9 are obtained after adding regional dummy indicators as a control to the full model. The impact of PHCs on the conditional probability of delivery by CS remains statistically strong though the magnitude decreases to about 5.4 percent. This indicates some regional differences in CS rates, accessibility to services or some fixed effects. For instance, deliveries in Central and Northern regions increase the likelihood of CS. On the contrary, giving birth in East Central, West Nile and Western regions reduces the probability of CS. Overall, the impact of PHCs, household wealth and health decision making power remains robust.

Column (3) contains the estimates obtained by adding an indicator for antenatal care provided by an obstetrician/gynecologist in both CS and PHC equations. This is meant to capture risks assessed by specialists and subsequent CS births. Antenatal care provided by a doctor increases the likelihood of both delivery at PHCs and CS births. The marginal effect of PHCs on CS births decrease to about 5.1 percent but is still statistically significant at the one percent level.

To check the possibility that a multilevel model could be appropriate, the coefficients are presented in Column (4) of Table 9. The estimate is positive but statistically insignificant. The likelihood ratio (LR) test of the fixed effects regression as an appropriate model against the probit model rejects the null hypothesis. Therefore, multilevel mixed effects probit does not fit the data well. This could be from the fact that 43 percent of births were home deliveries and cesarean sections cannot be performed in such environments.

In all the previous analyses, I used distance to the nearest hospital as one factor which influences the choice of hospital. However, the difference in distance between the nearest government hospital and the nearest private hospital could play a significant role in influencing choices. I used the geographical information system data for sample clusters and hospitals and I constructed the differential distance[6]. The map of Uganda in Figure 5 indicates the location of hospitals and clusters from which samples were drawn.

The OLS, Probit, IV Probit, bivariate probit and mixed effect probit estimates are presented in Columns (1), (2), (3), (4), and (5) of Table 10. The coefficient of the dummy variable for private hospitals are statistically insignificant in Columns (1) ,(2), (3) and (5), which indicates that the specifications do not take care of the recursive structure of events. However, the bivariate probit

[6] Differential Distance is defined as the difference between distance to nearest hospital and nearest private hospital

estimate in Column (4) is positive and statistically significant at the one percent level. From these regressions with varying specifications, the magnitude of the conditional probability of delivery through CS changes slightly but the statistical significance remains unchanged in the bivariate model. The impact of PHCs, wealth and health decision making is fairly stable. This implies that the main result explains the phenomenon and the recursive bivariate model is appropriate for the analysis.

3.8 Discussion

This study sought to test the impact of place of delivery on the likelihood of cesarean section births in Uganda. The estimates show that, on average, the probability of CS is higher in private healthcare facilities. The identification of the impact relied on a seemingly unrelated regression (SUR) of the choice of place of delivery as an endogenous determinant of the method of delivery (CS or natural birth). Distance from hospital and marital status were used as an exclusion restriction since they influence the choice of hospital but not the method of delivery. Overall, the empirical results indicate that place of delivery influences the method of birth.

Privately owned healthcare facilities often operate as a business whilst observing professional ethics. In the case of delivery, the critical situation and uncertainty surrounding safety creates an environment for supplier-induced demand. In Uganda, the inspection and regulation of private hospitals is rather weak. There is absence of standardized rules for reporting the costs of healthcare services. This compounds information asymmetry and the likelihood of induced-demand. It does not necessarily mean that all CS performed at PHCs were due to demand inducement. Some CS could be due to complications, self-request by expectant mothers or repeated CS. Lo (2008) notes that culture influences the method of delivery and some CS are a result of an initial

CS irrespective of the financial gains to gynecologists. In terms of maternal health policy, the results show that there is a need for closer monitoring and regulation of CS in private hospitals in Uganda. As much as physicians have fiduciary responsibility to patients, they might not necessary fulfill their obligations all the time. Principal-agent problems in physician-patient relationships may lead to adverse health outcomes and misallocation of scarce healthcare resources. Smith et al. (1997) advocates for a mechanism to control remuneration of hospitals for additional patients and hospital managements need to exercise control over physicians to reduce principal agent problems. This might reduce supplier-induced demand for healthcare services such as CS procedures.

There are some caveats in regards to the findings. As much as the theoretical model explicitly links the profit motive of physicians in private hospitals with the utility maximization of patients, the empirical results should be interpreted with caution. This is because it was impossible to differentiate the CS which was induced by physicians from the clinically required ones. I relied on the difference in objectives of the private and the public-sector healthcare facilities.

Secondly, there was no data on the cost, yet it is one of the key determinants of accessing service from private hospitals. This study indicates the need for more detailed hospital level data in Uganda. To date, there is no uniform reporting format for private hospitals. The basic information reported to government pertains to healthcare personnel and physical infrastructure. Hospitals could be required to report expectant mothers' preference for cesarean sections as a method of delivery. This could help unravel self-selected cesarean section births vis-a-vis physician induced-demand for CS or those that were unavoidable.

3.9 Conclusion

This study provides a theoretical model which shows an explicit link between the profit incentives of private hospitals with the utility maximization objective of expectant mothers in the presence of information asymmetry. The model shows that physician induced-demand increases with information asymmetry. The study used data from the Uganda Demographic and Health Surveys (2011).

A recursive bivariate probit model and other plausible specifications were used in the estimation. The estimates indicate that the likelihood of cesarean section birth increases for deliveries that takes place at private hospitals. The increase in the number of private hospitals due to economic liberalization of the 1990s seems to influence the degree to which physicians recommend procedures such as CS. Although I was not able to isolate repeat CS, after controlling for complications and wealth, there is still strong evidence that private hospitals are more likely to recommend CS births than government hospitals. Given the difference in the goals (profit versus social welfare) of the private and public hospitals, physician induced-demand for CS could be one of the driving force behind rising CS births in Uganda. Thus there is need for policies to monitor and regulate private hospitals. Regulation can reduce waste of scarce resources and save households from avoidable costs and risks associated with CS births. This, in a way, may improve maternal healthcare in line with the Millennium Development Goal 5.

3.10 References

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Table 6: Summary Statistics by Place of Delivery

Variable	Overall	Private Hospital	GOVT Hospital	Differences
C-section	0.099	0.106	0.097	0.009
	(0.299)	(0.307)	(0.296)	(0.014)
ANC Doctor	0.155	0.209	0.137	0.072***
	(0.361)	(0.407)	(0.344)	(0.011)
Age	27.99	28.27	27.903	0.367
	(6.718)	(6.612)	(6.751)	(0.232)
Insured	0.02	0.04	0.014	0.026***
	(0.14)	(0.197)	(0.119)	(0.006)
Primary Education	0.57	0.505	0.601	-0.096***
	(0.493)	(0.500)	(0.489)	(0.017)
Secondary Education	0.256	0.306	0.239	0.67***
	(0.436)	(0.406)	(0.426)	(0.016)
Higher Education	0.067	0.097	0.055	0.042***
	(0.249)	(0.296)	(0.228)	(0.001)
2nd Wealth Quintile	0.178	0.147	0.186	-0.039***
	(0.378)	(0.355)	(0.389)	(0.013)
3rd Wealth Quintile	0.175	0.151	0.181	0.03**
	(0.380)	(0.358)	(0.385)	(0.013)
4th Wealth Quintile	0.165	0.175	0.161	0.014
	(0.371)	(0.380)	(0.368)	(0.013)
5th Wealth Quintile	0.320	0.436	0.280	0.156***
	(0.466)	(0.496)	(0.280)	(0.015)
Parity	3.61	3.63	3.61	0.02
	(2.26)	(2.29)	(2.25)	(0.08)
Distance	51.59	32.51	57.67	-25.16
	(323.29)	(231.14)	(347.14)	(9.255)
Health Decision(Self)	0.386	0.349	0.398	-0.049**
	(0.487)	(0.477)	(0.489)	(0.017)
Health Decision(Spouse)	0.378	0.411	0.367	0.044**
	(0.484)	(0.492)	(0.482)	(0.017)
Health Decision (SM)	0.003	0.002	0.003	-0.001
	(0.059)	(0.047)	(0.062)	(0.002)
Observations	4421	1079	3342	4420

Notes:
$p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Standard errors are in parentheses. The differences are differences in means of the variables. The means of dummy variables are proportions. GOVT Hospital indicates government owned and operated hospitals/clinics. ANC-doctors is a dummy variable which shows that the last antenatal care before delivery was provided by a physician other than nurses or midwives. Insured indicates whether an expectant mother had medical insurance at the time of giving birth. Health Decision(SM) indicates that someone who is not a family member makes medical decisions.

Table 7: First Stage Bivariate Probit Results

Variable	PHC	C-Section
Private Hospital		1.013
		(0.3861)
Insured	0.040	0.479**
	(0.212)	(0.244)
ANC Doctor	0.196**	
	(0.093)	
Health Decision (joint)	-0.119	0.1362
	(0.101)	(0.110)
Health Decisions (Husband)	0.009	-0.246**
	(0.0926)	(0.108)
Health Someone else	0.172	-0.555
	(0.469)	(0.513)
Age Group (20-29)	0.276**	-0.0367
	(0.135)	(0.164)
Age Group 30-39)	0.313**	0.136
	(0.149)	(0.212)
Age Group 40-44)	0.552***	0.096
	(0.200)	(0.314)
Age Group 45-49)	0.476*	0.380
	(0.267)	(0.392)
2nd Wealth Quintile	0.336	0.309*
	(0.134)	(0.179)
3rd Wealth Quintile	0.287	0.266
	(0.146)	(0.187)
4th Wealth Quintile	0.484	0.408
	(0.02)	(0.190)
5th Wealth Quintile	0.658	0.457
	(0.268)	(0.179)
Distance	-0.007***	
	(0.002)	
Time Fixed Effects	YES	YES
Other Controls y	YES	YES
N	2401	2465
$\rho = 0.302$	Wald χ^2 (43) =6329.54***	

Notes:
p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are in parentheses. ANCdoctor = Antenatal Care provided by a physician. The method of estimation is seemingly unrelated bivariate probit. One equation defines the choice of place of delivery and another defines the method of delivery. The statistically significant ρ indicates that the model assumption of bivariate probit holds.

Table 8: Impact of Hospital Type on the Probability of Cesarean Sections

Variables	(1) OLS	(2) IVProbit	(3) Probit	(4) FE	(5) Biprobit
Private Hospital (PHC)	-0.012	0.141	-0.074	-0.016	0.061***
	(0.016)	(0.123)	(0.099)	(0.021)	(0.015)
Poorer Wealth Index	0.033		0.283	0.005**	0.018**
	(0.020)		(0.186)	(0.025)	(0.009)
Middle Wealth Index	0.006		0.151	-0.001	0.014
	(0.022)		(0.201)	(0.003)	(0.009)
Richer Wealth Index	0.047*		0.323	0.043	0.028**
	(0.025)		(0.200)	(0.031)	(0.013)
Richest Wealth Index	0.018		0.194	0.019	0.037***
	(0.024)		(0.197)	(0.035)	(0.014)
Health decision (joint)	0.034		-0.193*	-0.033	-0.014
	(0.020)		0.117)	0.023)	0.009)
Health Decisions (Husband)	-0.041**		-0.026	-0.035	-0.018
	(0.020)		(0.117)	(0.022)	(0.011)
Health Decisions (Someone else)	-0.114***		-0.576	-0.006	-0.031
	(0.030)		(0.494)	0.055)	(0.022)
Number of Births	-0.015**	-0.014***	-0.092	-0.008	-0.005
	(0.005)	(0.005)	(0.034)	(0.006)	(0.003)
Complicated Delivery	0.037***	0.221***	0.034***	0.064***	0.014***
	(0.012)	(0.007)	(0.006)	(0.045)	(0.007)
Time Fixed Effects	YES	YES	YES	YES	YES
Other Controls	YES	YES	YES	YES	YES
N	2403	2401	2401	2406	2406
R^2 Pseudo R^2	0.111		0.144	0.285	
χ^2 for Wald test		163***	156.98***	6329	4958

Notes:
*p < 0.1; ** p < 0.05; *** p < 0.01. Clustered robust standard errors are in parentheses. CS denotes birth through cesarean section while PHC indicates delivery at a private sector hospital. Other controls include pregnancy complications, long labor period, distance to hospital, education, antenatal care by physicians and age. The estimates in Columns (1), (2), (3), (4) and (5) are obtained from OLS, Instrumental Variable (IV) Probit, Probit, Fixed Effects and bivariate probit regressions, respectively. All estimates in Columns (1)-(4) are average marginal effects. The estimates in column (5) indicates the probability of CS birth conditional on delivery in a private hospital.

Table 9: Robustness Check showing probability of CS conditional on PHC

Variable	(1)	(2)	(3)	(4)
Private Hospital(PHC)	0.068***	0.054 ***	0.051***	0.093
	(0.019)	(0.015)	(0.017)	(0.277)
Poorer Wealth Index	0.012	.019*	0.0208*	0.154
	(0.006)	(0.011)	(0.012)	(0.148)
Richer Wealth Index	0.022	0.021	0.022	0.141
	(0.009)	(0.013)	(0.015)	(0.153)
Richest Wealth Index	0.028	0.026	0.024	0.234
	(0.008)	(0.014)	(0.016)	(0.149)
Health decision (joint)	-0.013	-0.0135	-0.0134	-0.221**
	(0.018)	(0.010)	(0.011)	(0.092)
Health Decisions (Husband)	-0.0159	-0.018	-0.019	-0.234**
	(0.008)	(0.010)	(0.011)	(0.094)
Health Decisions (Someone else)	-0.027	0.028	-0.0354	-0.143
	(0.016)	(0.024)	(0.024)	(0.545)
Number of Births	-0.005	-0.009**	-0.01***	-0.100***
	(0.005)	(0.004)	(0.004)	(0.027)
Complicated Delivery		0.016***	.017***	0.204***
		(0.005)	(0.006)	(0.022)
Central Region 1		0.008***	0.008	
		(0.002)	(0.003)	
Central Region 2		0.041***	0.039***	
		(0.011)	(0.012)	
East Central		-0.054***	-0.053	
		(0.006)	(0.007)	
Northern Region		0.0285***	0.026**	
		(0.012)	(0.012)	
West Nile Region		-0.0399***	-0.040	
		(0.005)	(0.995)	
Western Region		-0.0418**	-0.0418***	
		(0.004)	(0.004)	
ANCdoctor			0.021**	
			(0.0101)	
Time Fixed Effects	YES	YES	YES	YES
Other Controls	YES	YES	YES	YES
N	2414	2406	2406	2425
χ^2 for Wald test	3102.34***	2410.9***	2833.7***	
LR test Fixed Effects vs Probit regression				27.35***

Notes: Clustered robust standard errors are in parenthesis. * $p < 0.1$; **$p < 0.05$ ***$p < 0.01$ respectively. Estimates in Columns (1) - (3) are from bivariate probit and Column (4) is from multilevel mixed effects (ME) probit. The bivariate equations contain place of delivery (PHC) and method of delivery (CS) as dependent variables.

Table 10: Robustness Check with Differential Distance

Variable	(1) (OLS)	(2) (Probit)	(3) (IVprobit)	(4) (Biprobit)	(5) (MEprobit)
Private Hospital (PHC)	-0.010	-0.011	0.101	0.056***	0.090
	(0.016)	(.015)	(0.101)	(0.016)	(0.277)
Poorer Wealth Index	0.035*	0.046*		0.022	0.146
	(.020)	(0.024)		(0.01)	(0.149)
Middle Wealth Index	0.006	0.014		0.008	-0.07
	(0.022)	(0.024)		(0.009)	(0.161)
Richer Wealth Index	0.047*	0.052*		0.021*	0.138
	(0.025)	(0.027)		(0.013)	(0.153)
Richest Wealth Index	0.019	0.032		0.013	0.222
	(0.024)	(0.024)		(0.013)	(0.150)
Health decision (joint)	-0.034	-0.036*		-0.014	-0.220***
	(0.020)	(0.019)		(0.010)	(0.093)
Health Decisions (Husband)	-0.04**	-0.041**		-0.017**	-0.232**
	(0.019)	(0.019)		(0.010)	(0.095)
Health Decisions (Someone else)	-0.114***	-0.068		-0.051	-0.147
	(0.029)	(0.056)		(0.0163)	(0.544)
Number of Births	-0.014	0.014**	-0.014***	-0.008**	-0.101**
	(0.005)	(0.005)	(0.005)	(0.003)	(0.027)
Complicated Delivery	0.057***	0.0375***		.016	0.202
	(0.011)	(0.006)	(0.007)	(0.005)	(0.022)
Time Fixed Effects	YES	YES	YES	YES	YES
Regional Fixed Effects	YES	YES	YES	YES	YES
Other Controls	YES	YES	YES	YES	YES
N	2403	2398	2398	2403	2398
χ^2 for Wald test		135.70***	150***	4.22***	141.67***
R^2	0.111				

Notes:

*p < 0.1; **p < 0.05; ***p < 0.01. Clustered robust standard errors are in parenthesis. All parameter estimates are average marginal effects. Methods of estimation by column: (1) OLS, (2) Probit, (3) IV probit, (4) Bivariate Probit, and (5) Multilevel probit mixed effects. Other controls include: pregnancy complications, long labor period, distance to hospital, education, antenatal care by physicians, and age. The first stage bivariate probit index shows that delivery at private hospitals is positively influenced by the difference between the distance to nearest nearest public and private hospital. The distance does not influence the likelihood of cesarean section birth.

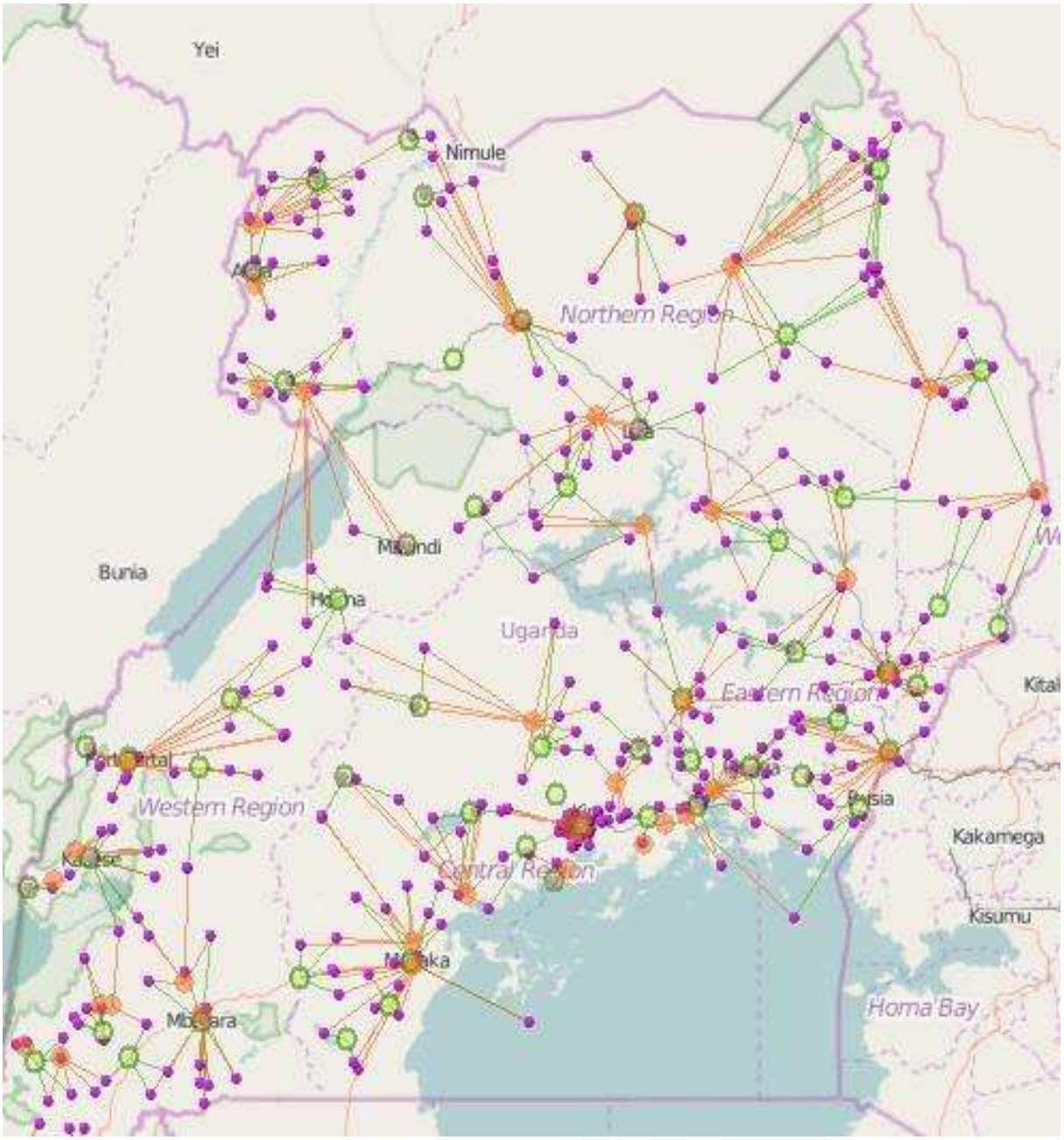

Figure 5: Hospital Locations and Survey Clusters

Green lines indicate the shortest distance from a sampled cluster to a government hospital (green circle). Brown lines indicate the shortest distance to the nearest private hospitals (brown circle). Purple dots indicate clusters from which households were sampled by the Uganda Bureau of Statistics but were "displaced" by some factors to protect the confidentiality of respondents. Technical assistance in creating this map was provided by Mr. Richard McKenzie, a GIS specialist at the USF Library.

Chapter 4: Agricultural Extension and Household Food Consumption

4.1 Introduction

The first Millennium Development Goal (MDG1) set a target of reducing extreme poverty and hunger by one half of its 1990 level by the year 2015. Progress towards the achievement of MDG1 is measured using indicators such as the proportion of population living on less than one US dollar a day, the poverty gap ratio, the share of the poorest quintile in national income or consumption, the prevalence of underweight children and the proportion of population that is undernourished. Undernourishment is measured by a distribution function of dietary energy consumption per person as defined by the Food and Agriculture Organization (FAO). However, nourishment requires some minimum level of food intake, which in turn depends on food availability. On the other hand, data from the 2005/06 Uganda National Household Survey (UNHS) show that the average calorific intake was 1,970 calories per person per day. This is short of the recommended minimum calorific requirement of 2,200 calories. According to the 2014 Uganda National Population and Housing Census report, 11.8 percent of the population have less than two meals per day (UBOS, 2016). This represents about 4.5 million persons. The World Food Program (WFP) also notes that between 2009 and 2010, 48 percent of Ugandans were energy deficient, 14 percent of children were stunted and 20 percent had lower than normal food intake (WFP, 2013). Other indicators of poor nutrition in Uganda are the 5 percent of rural households who are food insecure, 31 percent were highly vulnerable, and 19 percent moderately vulnerable (WFP, 2005). Therefore an inadequate food supply is still a problem in many households in Uganda.

On the other hand, a number studies have shown that household nutrition influences education outcomes, health status, human capital accumulation, labor productivity, and welfare (Hoddinott et al.,2008, Chen and Zhou, 2007, Behrman et al. , 2004, Alderman et al. 2012, and Victora et al., 2008). Programs which can reduce the vulnerability of households can improve food security and welfare. Fanzo and Pronyk (2011) suggest that intervention in agricultural production can increase food availability and intake. In Uganda, the National Agricultural Advisory Services (NAADS) was established in 2001 as a strategy to promote new farming technologies through a farmer demanded agricultural extension model. The goals of the NAADS program include the promotion of food security, nutrition and household income. Participating households select to receive desired farm extension services, inputs and advice on marketing the farm outputs.

This study examines the impact of NAADS on household food intake in Uganda. Previous studies such as Benin et al. (2011), Friis-Hansen et al. (2004), Okoboi et al. (2013), and Diiro and Sam (2015) examined the impact of NAADS on technology adoption, farm output, farm revenue, and synergy with other agricultural service providers. To my knowledge, this the first study which examines the impact of NAADS on household food consumption and provides new results and extends the growing literature on the impact of agricultural extension in Uganda.

In the analysis, a dummy variable (MEAL) is created such that it is equal to one if a household always has at least two meals in a day, but zero otherwise. This measure of food availability is built on the rationale that hunger can be objectively measured as suggested by Radmer et al. (1992) and Kendall et al. (1995). Whereas many studies use anthropometric measures as indicators of food security, the measures can be influenced by diseases and other factors even if food is available. On the other hand, the frequency of food intake is indicative of a household's food supply which influences nutrition and welfare. Furthermore, the WFP (2013) and UBOS (2016)

consider Ugandan households which have less than two meals a day as being vulnerable to food insecurity. The main empirical methods employed in the study are a linear probability model (OLS) and fixed effects (FE) regressions. This enables interpretation of the estimates as causal effects. The dataset used in the study comes from two waves of the Uganda National Household Survey (UNHS) which was conducted by the Uganda Bureau of Statistics in 1999/2000 and 2005/2006. The NAADS program was established in 2001, consequently, I use the 1999/2000 survey as the baseline data while the 2005/2006 survey as the post intervention observations. To explore the diverse channels of the impact of NAADS on food availability, sub samples on the basis of gender, rural/urban residence, regions and age groups are used in the analysis.

The estimates show that NAADS participation increases the probability of having at least two meals per day by 6.6 percent in the OLS model and 7.1 percent in the FE model. The impact is stronger in female-headed households (the FE model indicates that NAADS increases the probability of $MEAL$ by 12.3 percent). To check for the robustness of the estimates, I apply alternative model specifications. Since the frequency of $MEAL$ is count data, I employ a negative binomial regression (NB) which nests a Poisson model as the baseline model. In all the sub-sample groups, the NB regressions show that NAADS training increases the incidence rate ratio (IRR) of meals in participating households.

Due to non-random assignment of households to the NAADS program, self-selection could influence the estimates obtained via OLS and FE. As a remedy, I use propensity score matching (PSM) in which $MEAL$ is the outcome variable and NAADS membership/ or training is the treatment. The Average Treatment Effect on the Treated (ATT) is 0.062 and statistically significant at the 5 percent level in the full sample. This is pretty close to the OLS estimate and shows that NAADS participation increases food consumption by about 6.2 percent, ceteris paribus.

Therefore the finding is stable across model specifications and sample stratifications. The rest of the chapter is organized as follows. Section 4.2 contains a brief background on the NAADS program in Uganda. Section 4.3 is a review of previous studies on the impact of NAADS in Uganda. In section 4.4, I describe the empirical strategy while section 4.5 presents the dataset and key variables. In section 4.6, I discuss the results and robustness checks. The last section is the conclusion.

4.2 Description of NAADS Program

The National Agricultural Advisory Services (NAADS) program was established in Uganda by the NAADS Act (2001) as described in Nahdy (2004). It is a government program under the Ministry of Agriculture, Animal Industry and Fisheries (MAIF). It is one of the seven components of the Plan for Modernization of Agriculture (PMA) which in turn is part of Uganda's Poverty Eradication Action Plan (PEAP).

The main focus of NAADS is the provision of demand driven agricultural extension services. According to NAADS Act (2001), the first objective is "to promote food security, nutrition and household incomes through increased productivity and market oriented farming." Consequently, the mission of NAADS is to scale up the provision of agricultural production information, technology development, identification of farmers needs and ensuring appropriate and affordable extension services. It emphasizes the participation of the poor and women in group decision making process. The program replaced the traditional top-to-bottom approach of agricultural extension service provision. Under the program, farmers request for advisory services and technologies through groups. The program promotes intensive farming, specialization and commercialization of agriculture.

The main point of contact and procurement of agricultural technology takes place at the sub-county level where NAADS coordinators help farmer forums identify service needs and select enterprises as well as establish market linkages. Through focus group discussions, members of the farmer forum articulate their needs and participate in the selection of enterprise/technology and they choose the service providers/suppliers of farm inputs like seeds, livestock, pesticides, fertilizers, and machinery.

The sub-county administrators, farmers forum and service providers ensure implementation of agreed services. Funding is disbursed by the Ministry of Finance and Economic Planning (MFPED) after plans prepared by farmer forums are approved. Monitoring of the of the contracted private service providers is done by the sub-county farmers groups and the NAADS coordinators. This is meant to control quality of service in accordance with NAADS operation guidelines

At district levels, the district NAADS coordinator (DNC), the Chief Administrative Officer (CAO), Chief Finance Officer (CFO), auditors and agricultural scientists are responsible for implementation. The NAADS district farmer forum brings all chairpersons of sub-county groups together and they liaise with district officials to ensure value for money in all procurements and NAADS service provisions. At the national level, NAADS falls under MAIF but is semi-autonomous and managed by a board and a secretariat. The secretariat formulates the implementation manual and monitors district and sub-county performances.

Generally the implementation of NAADS follows a decentralized government structure with the majority of activities concentrated at the district and sub county levels. It is meant to be responsive to the needs of local farmers in a demand-driven setup. It was a complete change from a centralized agricultural extension model. Therefore, it is important to examine the impact of the program on key welfare indicators such as availability of food at the household level.

4.3 Literature Review

There is a growing body of literature on the impact of agricultural programs in Uganda. NAADS in particular has attracted attention due to its bottom-up and demand-driven approach to agricultural extension service provision. It emphasizes farmer participation and service provider competition in agricultural extension. It is a World Bank loan supported program and most studies are concerned with increases in output and income.

Whereas increases in agricultural production and farm income influences food security, adequate food intake is a necessary condition. Studies on household welfare such as Fafchamps et al. (2009), and Kennedy and Peters (1992) show that intra-household bargaining power influences nutritional status. Thus, it is probable that not every household member benefits equally from increased farm output. Tenenbaum (2008) suggests that diversion of food crops for sale is associated with food crises in many developing countries. This is because the head of a household may sell off marketable food crop harvests and leave little for home consumption amidst using the sale revenue to buy items which may not benefit all household members. NAADS also emphasizes commercialization of agriculture which may affect food crop production or the amount of harvest left for domestic consumption. Thus, it is of interest to analyze the impact of NAADS on food consumption in participating households.

This relates directly to MDG1 and Sustainable Development Goals 2 (eliminating hunger). In essence, this study contributes to the literature which analyzes strategies used to promote MDG1 in Uganda. NAADS involves changes in the mode of delivery of agricultural extension services and it gives greater leverage to farmers in choosing the kind of agricultural technology they wish to adopt and the service provider. This is likely to encourage uptake of services and to create ownership of the program among farmers. In this way, it may increase agricultural productivity

and food availability. Thrupp (2000) suggests that agricultural development programs which utilize local experiences and knowledge encourage technology adoption, therefore NAADS can promote food security due to the involvement of farmers in the design and implementation of the program. The major channels through which NAADS could affect food availability are adoption of better farming methods, use of high yielding crop varieties, and control of pests and diseases.

A number of studies show that adoption of new farming technologies or seed varieties is associated with increases in farm output, revenue and food availability. Mitti et al. (1997) find that participatory agricultural extension education and a seed loan scheme achieved wide coverage of farmers and expanded the use of better production systems in drought-prone maize growing areas of Zambia. In contrast, under NAADS, seeds as well as extension education is fully funded by the government. The role of farmers is to articulate their needs, select appropriate technology, and implement chosen animal or crop husbandry. This is equivalent to subsidization of agricultural production. If production is geared towards food crops, the program could improve food availability and household consumption.

However, intra-household inequality, may negatively affect food availability if cash crops are the main produce of the household. Studies such as Fafchamps et al. (2009) and O'Laughlin (2007) have shown that gender inequality is a complex issue in addressing consumption and poverty issues in Africa. An increase in household income might not necessarily lead to improvement in the well-being of all members of the household. Kennedy and Peters (1992) find that in Kenya and Malawi, calorific intake in a household is positively influenced by the proportion of the income controlled by women. Therefore the impact of increased farm output or income may not necessarily mean improvement in welfare due to gender inequality.

In this study, the reported average number of meals in a household is used as an indicator of consumption which may shed light on food availability than fungible indicators such as income or farm output. There are studies which find that adoption of improved seed variety is associated with a reduction of poverty. For example, Kassie et al. (2011) examined the impact of improved groundnut varieties on income and poverty in Uganda. The study used cross-sectional data and propensity score matching methods and found that adopting improved groundnut varieties increases income and reduces poverty.

In a similar study using a different dataset, Kassie et al. (2014) find that adoption of improved maize seed varieties significantly reduced the likelihood of chronic and transitory food insecurity in Tanzania. Asfaw et al. (2012) studied the impact of adoption of improved pigeon pea technologies on poverty in Tanzania. They found that adoption of improved pigeon pea seed variety was associated with an increase in household consumption expenditures. This strand of literature indicates that improved seed varieties for food crops such as peas, maize and groundnuts can increase food availability. The NAADS program, which provides extension services and inputs for both cash and food crops, could have a similar impact since seeds are part of the technologies to be chosen by farmer groups.

Other studies such as Abdoulaye and Sanders (2005), Duflo et al. (2008), Teklewold et al. (2013), Khan et al. (2014), Thuo et al. (2014), and Abdulai and Huffman (2014) conclude that adoption of modern agricultural technology and fertilizers is associated with increased farm returns and improvement in household welfare. It is probable that NAADS, which emphasizes new technology adoption, can have a positive and significant impact on output and farm revenue income.

The preceding analysis shows that adoption of improved seed varieties and agricultural extension services can lead to higher farm yields and income. A few studies evaluated the impact of the NAADS program in Uganda. Oleru et al. (2005) used randomly selected NAADS and non-NAADS sub-counties in Northwestern Uganda to examine the adoption of new faming technologies. They found that in areas where NAADS was operational, farmers had better knowledge of animal and crop husbandry than in non-NAADS areas. In contrast, Benin et al. (2007) used a nationally representative dataset and found that NAADS participation is associated with mixed perception about food availability and nutritional quality of food. About 41-58 percent of NAADS participants reported improved welfare status but about 27 percent indicated that they were worse off than before the NAADS program was put in place. The same study showed that about 15 percent of NAADS participants reported no change in their welfare.

The mixed results show that the impact of NAADS on welfare indicators is somewhat ambiguous. One issue with the Benin et al. (2007) study is the use of households' perceptions about the present and past situations which depends on recall and can be influenced by other circumstances other than NAADS participation. I posit that the evaluation of welfare on the basis of regular events such as the frequency of meals may provide additional insight into the program impact.

In a follow-up study, Benin et al. (2011) used survey data, propensity score matching (PSM), and difference in difference methods to evaluate the impact of NAADS on household income. The study found weak and mixed impacts of NAADS on farm yield and farm revenue. The sign and statistical significance were unstable across sample and sub-sample groupings. Their results could have been affected by sample size which was relatively small (400 observations). As a possible remedy, this study utilized a large nationally representative data set (the Uganda National

Household Survey). Amidst the unstable estimates, they also found that NAADS program participation was associated with increased commercialization of farming which seemed to benefit male headed large household more than female headed households and crop farmers. This could negatively influence food availability in male headed households with intra household inequality.

A few studies show that NAADS did not have a statistically significant impact on farm output or household welfare. For instance, Okoboi et al. (2013) used UNHS data and differences-in-difference regressions and found no statistically significant difference in crop yields and farm output. This is in contrast with earlier studies such as Benin et al. (2011) and Diiro and Sam (2015) which showed that NAADS had a positive impact on farm output. This suggests that the impact of NAADS remains unclear depending on methodology and sample used.

The insignificant impact found in the study of Okoboi et al. (2013) could be due to the use of the 2005/06 and 2009 UNHS data. The period of their analysis covers the second phase of the NAADS program which was affected by a number of institutional problems. One particular problem is elite capture. This is documented in Feder et al. (2010) who found that educated and wealthier farmers were favored in selection of farming technology and inputs. In such scenarios, the program would not benefit the poor and consequently the impact on poverty could be negligible.

The literature reviewed suggest that changes in agricultural extension services can influence technology adoption, farm output and income. Studies which evaluated the impact of NAADS on welfare indicators showed mixed conclusions due to sample used and method of estimation. This study seeks to estimate the direct impact of NAADS on food consumption, an indicator of food security.

4.4 Econometric Strategy

The empirical analysis follows a difference-in-difference set up and a linear probability model (LPM). Since the data points are for two periods, the fixed effects estimator is identical to the difference-in-difference estimator. I exploit the variation in NAADS participation across households and time. This enables me to identify the causal impact of the program with the assumption of exogeneity of the NAADS program. I expect that households who received training or agricultural extension services under the NAADS program to have high farm yield. It is then plausible that such households would have more frequent food intake than those who did not participate in the program. The dependent variable of interest is the average frequency of meals in a household per day. Since meal frequency is count data and is a bounded number, the dependent variable is redefined to make analysis insightful. I created a dummy variable equal to one if a household always has at least two meal per day, otherwise the variable is equal to zero.

The benchmark of two meals a day is based on the World Food Program report which indicates that most Ugandan households normally have at least two meals in a day (WFP, 2013). The Uganda Bureau of Statistics also considers households which have less than 2 meals a day as having insufficient food intake (UBOS, 2016). Secondly, many Ugandan rural households do without breakfast but most strive to have at least lunch or dinner or both as shown in Acham et al. (2012).

For clarity the unit of analysis are households and the estimable equation is specified as:

$$y_{ist} = \beta_0 + \beta_1 NAADS + \sum_{k=1}^{K} \alpha_k X_{kist} + d_s + \upsilon_t + d_s * \upsilon_t + \varepsilon_{ist} \quad (4.1)$$

Where y_{ist} is equal to one if household i in district s at time t had at least two meals in a day but zero otherwise. NAADS is a dummy variable equal to one if a household was trained by NAADS

officials or was visited by NAADS extension workers but zero otherwise. The coefficient of interest is β_1 and it measures the impact of agricultural extension on the likelihood of having at least two meals per day. X is a vector of controls which includes household characteristics such as household head's age, gender, education, household size, size of farmland owned, farm income, farm input purchases, type of cooking fuel and type of residence (urban/rural). My choice of the controls is motivated by previous research on nutrition such as Harnack et al. (1998), Maxwell et al. (1998), Ouedraogo (2006), and Hammons and Fiese (2011).

The stochastic term as part of the data generating process is represented by ε_{ist}. I also include district fixed effects (d_s) and time fixed effects (υ_t) in the model. The parameters are estimated using Ordinary Least Squares (OLS) with clustered robust errors. The use of OLS (LPM) is sometimes criticized for a number of weakness but it gives very good estimates of marginal effects (Angrist and Pischke, 2008).

4.5 Data

The data used in this study comes from the Uganda National Household Survey (UNHS) which was conducted by the Uganda Bureau of Statistics in 1999/2000 and 2005/2006. The 1999/2000 UNHS covered a sample of 10,700 households which were observed between August 1999 and July 2000. The UNHS 2005/06 was conducted from May 2005 to April 2006 and covered about 7,400 households. The 1999/2000 and the 2005/2006 UNHS does not have a panel structure but are appended together as repeated cross sections. The dataset contains information on socioeconomic characteristics of households, enterprises, and agriculture as well as community level data. The questionnaires for each survey were continually expanded to cover new issues and development programs and hence suitable for program evaluation.

The surveys are designed in such a way that the data is nationally representative. The dataset contains sample weights which are useful in correcting standard errors as discussed in Kott (1991). The first stage sampling frame for the surveys were obtained from a preceding national census. In the socioeconomic and agricultural module of the UNHS, for each district, the first stage of sampling involves a random draw of parishes within a district. The second stage involves a random selection of villages from chosen parishes. The final stage involves a random selection of households to whom a detailed questionnaire is administered. Each district is also stratified into rural and urban groups to make the sample representative. In the sampling design, a household is defined as a group of people who normally live and eat together. This may consist of the head of the household, spouse and children. Households are the units of analysis for this study, hence some individual level variables which influence welfare are aggregated to the household level. These include income, loans and farmland owned as individuals.

The dependent variable of interest is a measure of food availability and specifically, the average number of meals a household always have per day. While chronic hunger is on the decline in Sub-Saharan Africa, food insecurity and low intake is still a challenge in Uganda (Vella et al. 1992 and Nakabo-Ssewanyana, 2003). For this reason, I use availability of food as a measure of food security. To facilitate intuitive interpretation of the impact of NAADS, a binary variable is constructed to indicate whether the levels of food intake is below or meets the minimum threshold of two meals per day. The major explanatory variable is participation in the NAADS program. Data on participation in NAADS is contained in the data set as dummy variables and frequency of visits by extension workers.

During the survey, the field interviewers elicited responses on the number of times an agricultural extended worker visited the household, household's membership of a NAADS farmers group and their participation in making agricultural technology selection and procurement decisions. This is the treatment variable whose effect on household food availability is tested. A number of control variables such as household size, land tenure system, age and gender of household head, income, and education, among others are extracted from the survey data and included in the analysis. A description of how the variables are measured is contained in Table 11.

Summary statistics of the variables are displayed in Table 12 and it checks for differences in means of the dependent and control variables. The sample is divided into NAADS and non-NAADS sub-samples. The mean number of meals per day is 2.38 and 1.69 among the NAADS and non-NAADS households respectively. The difference in the mean number of meals is statistically significant and indicates that NAADS might have impacted food availability. The mean daily food expenditure is about 9,990 Uganda shilling (UGX) for non-NAADS households but it is about UGX 14,000 for NAADS households. This could be due to the differences in farm revenue as NAADS households have a mean farm revenue of UGX 200,000 compared to UGX 35,000 for non-NAADS participants.

The mean expenses on farm inputs such as fertilizers, seeds and the number of farm workers are also statistically different between the sub samples. This could be due to adoption of better technologies such as improved seed varieties and intense farming methods. In the regression analyses, the independent variables with statistically significant differences in means are controlled for.

4.6 Results

Table 13 presents the estimates of the effect of the NAADS program on food availability with a modification in equation 4.1 that excludes d_s , v_t , and $d_t * v_t$. This is the linear probability model (OLS) and the estimate of interest is β_1. It indicates the change in probability of having at least two meals in a day, conditional on receiving agricultural extension service through the NAADS program. In all the estimations, sample weights are applied to ensure representativeness of the results. Clustered robust standard errors are used to correct for possible heteroscedasticity. The results in Columns (1), (2), (3), (4), and (5) are obtained from different sub-sample groups.

Column (1) of Table 13 contains OLS estimates from the full sample and it shows that participation in NAADS is associated with a 6.8 percent increase in the probability of a household having at least two meals per day. The estimate is statistically different from zero and the overall goodness of fit with R-squared of 0.32 is good for cross sectional data. Other farm related controls such as utilization of improved seed varieties, farm labor and farm revenue also increase the probability of having at least two meals a day.

The estimates in Column (2) are obtained from a sample with male headed households only. The estimate of β_1 is 0.081 which shows that in male headed households, participation in the NAADS program increases the probability of having two meals a day by 8.1 percent. The magnitude is higher compared to the full sample which suggests that gender plays a role in the effectiveness of the program. The estimate from the female headed household sub-sample shows that the program does not have a statistically significant impact on food consumption and is not reported.

In Column (3) I present estimates from the rural household sub-sample. This is to test the impact of NAADS in the targeted rural areas. Although some Ugandan households practice urban agriculture as reported in Maxwell et al. (1998), on the other hand, Mukwaya et al. (2010) suggest that Uganda has a low urbanization rate of 13 percent. This implies that NAADS participation would be more beneficial to the rural households than urban dwellers. Therefore, it is informative to consider the rural sub-sample separately. The OLS estimate in Column (3) shows that NAADS is associated with a 6.5 percent increase in the probability that a household had at least two meals a day. The estimate is statistically significant at the one percent level. This suggests that supporting rural households with agricultural extension services can improve food availability, even at a subsistence farming level as discussed in Aliber and Hart (2009).

The estimate from the urban households is statistically insignificant and is not reported. The statistically insignificant estimate is plausible since most urban households derive their livelihood from paid employment or retail business. The estimates in Column (4) are for households headed by a person aged 60 years or older. This is meant to test if the program effective among an older and possibly vulnerable age group. The estimate indicates NAADS program increases the probability of food availability by 14 percent if the age of the household head is greater than or equal to 60 years. This is plausible since most retired household heads engage in agriculture and could give more time to farming than working-age population who are attracted to white collar jobs.

The results displayed in Table 14 are obtained from regionally stratified sub-samples. This is meant to test regional variation in the impact of NAADS on food availability. The estimates are obtained from OLS regressions of equation 1 but without d_s , υ_t , and $d_t * \upsilon_t$ terms. The results indicate that NAADS extension service is associated with 9.8 and 9.6 percent increases in the

probability of a household having at least two meals per day in Central and Eastern regions respectively. There is no statistically significant impact in Northern and Western regions. The insignificant estimate for Northern Uganda could be attributed to civil war which affected agricultural production over the period when data was collected (Tusiime et al. 2013). The insignificant impact in the Western region could be explained by the fact that it is the region with lowest level of poverty (Appleton, 2003). Hence, participation in NAADS may not change the frequency of meals if households are already food secure.

The estimates displayed in Table 15 are obtained from district fixed effects regressions. It is necessary to apply a fixed effects (FE) regression because there could have been changes over time and within districts which affected food availability to the households. This is premised on the fact that implementation of NAADS varied across districts. Applying fixed effects regressions also accounts for unobserved district characteristics which influence agriculture and food availability.

The estimator absorbs ancillary district specific intercepts and computes clustered robust standard errors. Column (1) of Table 15 contains estimates from the full sample and shows that NAADS is associated with a 7.1 percent increase in the probability of having at least two meals per day. The estimates displayed in Column (2) are obtained from the subsample of only female headed households. The result show that in female headed households, participation in NAADS program increases the probability of food consumption by 12.3 percent. This is large compared to all the other specifications and indicates that women play a significant role in promoting household welfare and food security (Valdivia, 2001, Ajani et al. 2009, and Hyder et al. 2007).

Columns (3) and (4) of Table 15 are estimates for male headed households and rural households as separate sub-samples respectively. In the two sub-samples, NAADS increases the likelihood of food consumption by 6.2 and 6.9 percent respectively. Column (5) contains estimates from the sub-sample for elderly household heads. However the estimate is statistically insignificant.

Table 16 repeats the FE analysis but with samples stratified by regions. The evidence suggests that NAADS increases the likelihood of a household having at least two meals per day by 8.9 percent in the Central region but insignificant for Eastern and Northern regions. Overall, the FE estimates show that the NAADS program positively influences household food consumption in the participating households. The R-squared for the FE estimates are higher in comparison to the naive OLS model results.

4.6.1 Robustness Check

To check for the robustness of the OLS and FE estimates, I perform additional analysis using negative binomial (NB) regressions and propensity score matching (PSM). The NB analysis is premised on the fact that the frequency of meals is measured as count data and the distribution is skewed to the right as illustrated in Figure 6. This could affect the results and statistical inference in OLS regressions which assumes normal distributions. The estimates from the NB regressions are based on the density function:

$$f(y_i|x_i) = \frac{\Gamma(y_i+\alpha^{-1})}{y_i!\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu_i}\right)^{\alpha^{-1}}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu_i}\right)^{y_i}, y_i = 0,1,2,3,\ldots \quad (4.2)$$

Where y_i denotes the number of meals a household has per day, α is the dispersion parameter, and μ_i is the mean.

The maximum likelihood estimator computes the condition mean, $\mathbb{E}[Y|X] = \exp(X'\hat{\beta})$, from which a column vector of coefficients is obtained. District and time trends are controlled for and the results are presented in Table 17. The estimates are the incidence rate ratio (IRR), which is the relative difference in the frequency of meals conditional on NAADS program and other controls. For the full sample, NAADS increases the incidence of meals in a household by 1.05 times relative to the households which did not benefit from the program. The IRR is 1.09 and 1.07 for the male headed households and rural households respectively. The estimates are statistically significant at the one percent level and the likelihood ratio test indicates that the model fits the data well. Overall, the NB regressions show that NAADS positively influences the average frequency of meals in households which participated in the program.

Although the UNHS dataset was obtained through random sampling, the assignment of households to the NAADS program was not. Households who were willing to form farmer groups self-selected themselves into the program. This could make the OLS and FE estimates biased and inconsistent. As a remedy, I extend the analysis to include Propensity Score Matching (PSM). Assuming selection on observables, households can be paired based on similar propensity scores. The PSM method summarizes the pre-treatment observable characteristics of each subject into a single index variable, and then uses the propensity score to match similar individuals (Rosenbaum and Rubin, 1983). The PSM is the probability of assignment to treatment conditional on observable characteristics such that $pr(NAADS = 1|X) = F(.)$, where $F(.)$ is a cumulative density function. For this analysis, the measure of interest is the average treatment effect on the treated (ATT) defined as: $\mathbb{E}(M_i^1 | NAADS = 1; X) - \mathbb{E}(M_i^0 | NAADS = 1; X)$. (4.3)

Where M is a dummy variable which indicate that a household had at least two meals per day. The superscripts 1 and 0 denote the treated and control groups respectively.

The ATT estimator relies on the overlap assumption, which requires that each unit of observation has a positive probability of being treated (NAADS) or untreated. If the assumption is violated, the ATT estimate would be spurious. The assumption is checked by plotting the probability of getting treated or untreated. The kernel density plots in Figure 7 show that the overlap assumption is not violated. The ATT estimate from the PSM regression using common support is displayed in Table 18. The pseudo R-squared after matching are also very low. The p-values for the likelihood ratio test of joint significance of the independent variables indicates that there is no systematic difference in the distribution of independent variables between the treated and untreated groups after matching.

From the full sample, the ATT is 0.062 which indicates that participation in NAADS increases the probability of a household having at least two meals per day by 6.2 percent. In the rural sub-sample, the ATT is 0.06 and statistically significant at the 5 percent level. The magnitude of the ATT is comparable with the average marginal effects presented in Table 13 and fixed effects estimates in Table 15. However, the ATT is statistically insignificant for the urban and female headed households. The overall impact of the program is positive in all the specifications and close to the OLS and FE specifications.

Therefore, NAADS participation increases the frequency food consumption in Uganda. Since the results are robust to specification changes and sub-sample groups, they suggest that agricultural extension services can be an effective strategy to reduce food insecurity in Uganda. The plausible mechanism is via adoption of better farming technologies and farm inputs which influences farm productivity and hence food availability.

4.7 Conclusion

This study examined the impact of agricultural extension services on household welfare measured by the average frequency of meals in households in Uganda. Data for the analysis was obtained from the Uganda National Household Surveys which were conducted in 1999/2000 and 2005/2006. A linear probability model and fixed effects estimators are the major methods of estimation. The results show that agricultural extension service under the NAADS program increases the probability of a household having at least two meals in a day. Since the frequency of meals is count data, a negative binomial regression is used as an additional method of analysis. The negative binomial regression results indicate that NAADS increases the incidence of meals in the participating households, all else constant. Due to the non-experimental nature of the data used in the analysis, a propensity score-matching model was used to control for self-selection bias. After matching the households on the basis of similar propensity scores, the average treatment effect for the treated shows that NAADS increases food intake.

In all the analyses, the sample was stratified by gender, rural-urban residence, regional and age groupings. The linear probability model estimates are statistically significant in the gender, rural and age stratified sub-samples. In terms of region, the program seems more effective in the Eastern and Central regions. The statistically insignificant impact in the Northern region could be attributed to war which affected agriculture (McElroy et al. 2012). The fixed effects estimator, which exploits district fixed effects and district time trends, shows that participation in the NAADS program increases the probability of frequent meals by about 7 percent in all the sub-samples. But the results from regionally stratified data indicate that NAADS has a statistically significant impact in the Central and Western regions.

Overall, the findings in this study show that agricultural extension services and involvement of farmers in the selection of agricultural production technologies can be a strategy for food security and poverty reduction in developing countries. A mechanism which encourages participation of rural households to demand and utilize agricultural extension services may encourage adoption of modern farming techniques. The positive impact of improved seed varieties indicates that extension services, which includes provision of farm inputs, can be used to combat food insecurity.

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Table 11: Description of Variables

Variable	Description
Meals	Daily average number of meals reported by a household
Conflict Area	A dummy variable equal to 1 if was affected by civil strife
Food Expenses	Food expenditure measured in Uganda Shillings
Hhsize	Number of people who usually live in a household.
Hhage	Age of household head
Hhgender	Gender of household head (Male=1, Female=0)
Disability	Does household head have any disability? (Yes=1, No=0
Literacy	Ability to read and write (Yes=1, No=0)
Marital Status	Is household married? (Married, Separated, Divorced, Single, Widowed)
House Tenure	Type of house tenure(Owned/free or rented)
Cooking fuel	What household uses for cooking (Charcoal, electricity, gas, firewood)
Devt program	Did the household benefit from other development program (Yes=1, N0=0)
Migrant	Did the household migrate to the current location (Yes=1, No=0)
Income	Total Household income in Uganda Shillings
Farm Labor	Number of people who work on the household farmland
Farm revenue	Total revenue from sale of farm products
Farm Input Value	Amount of money spent of farm implements, fertilizers, seeds
Improved Seeds	Planting of high yield maize variety (Yes=1, No=0)

Table 12: Summary Statistics Showing Differences in Means

Variable	NT. Obs	NT. Mean(X)	T. Obs	T. Mean (Y)	Differences (Y-X)
Meal frequency	9991	1.69	177	2.38	0.689**
Conflict Area	10824	0.09	177	0.07	-0.03
Food expense	10152	9983.63	177	14000	3500***
Hhsize	9873	5.26	176	6.14	0.875***
Hhage	10159	43.05	177	44.51	1.47
Hhgender	10824	0.696	177	0.791	0.095***
devt program	10824	0.06	177	0.03	0.03
Migrant	10824	0.66	177	0.94	0.283***
Income	10277	1,400,000	166	1,500,000	74,000
Farm labor	7978	4.67	176	10.68	6.017***
Farm revenue	8689	35,000	177	200,000	170,000***
Farm Input Values	7773	30,000	156	71,000	4,1000**
Improved Seeds	10824	0.10	177	0.73	0.633***

Notes:
* p<0.1, **p<0.05, *** p<0.001. Obs is the number of observations. NT denotes households which were not recipients of extension services under the NAADS program while T are NAADS participants. Y= Mean from NAADS households. X= Mean from non-NAADS households. For dummy variables, the means or differences indicate proportions. Devt program indicates other development programs other than NAADS which provide agricultural extension services to households. This may include interventions implemented by non-governmental organizations

Table 13: The Impact of NAADS on having at least 2 Meals per Day

VARIABLES	(1)	(2)	(3)	(4)
NAADS	0.066**	0.081***	0.065**	0.14***
	(0.028)	(0.092)	(0.031)	(0.037)
Improved Seeds	0.094***	0.105***	0.101***	0.028
	(0.019)	(0.024)	(0.021)	(0.037)
Owned/Free House	0.153***	0.150***	0.167***	0.219*
	(0.032)	(0.038)	(0.033)	(0.117)
Charcoal[a]	0.122***	0.134***	0.187***	0.171**
	(0.033)	(0.039)	(0.034)	(0.078)
Electricity[a]	0.149***	0.264*	0.671***	
	(0.055)	(0.134)	(0.079)	
Literate[b]	0.108***	0.102***	0.113***	0.079
	(0.0176)	(0.0193)	(0.0168)	(0.0492)
Disability	-0.068**	-0.083**	-0.064*	-0.063
	(0.033)	(0.033)	(0.033)	(0.035)
Farm Labor	0.025***	0.023***	0.025***	0.032***
	(0.004)	(0.004)	(0.004)	(0.005)
Hhage	-0.001***	-0.001***	-0.001***	-0.001
	(0.0003)	(0.0004)	(0.0003)	(0.002)
hhsize	0.009***	0.011***	0.008***	0.002
	(0.002)	(0.002)	(0.002)	(0.004)
Constant	0.494***	0.528***	0.491***	0.640***
	(0.0484)	(0.0514)	(0.0484)	(0.167)
Other Controls[c]	YES	YES	YES	YES
R-squared	0.324	0.326	0.324	0.368
Observations	6653	5217	6269	1334

Notes:

Robust standard errors in parentheses. *** p <0.01, ** p <0.05, * p <0.1. OLS is the method of estimation with the dependent variable defined as a dummy variable. (1) Full sample, (2) Male headed households, (3) rural households, (4) household head aged 18-60 years and (5) household aged 60+ years. The estimated coefficient of NAADS in the female headed household and urban household sub-samples are statistically insignificant and are not reported here. The estimates are average marginal effects. [a]Used for cooking in the household relative to firewood as base case. [b] Can the head of household read and write? It is a dummy variable used as proxy for education. [c]Farm revenue, household income, main source of water for domestic use, farm input expenses

Table 14: The Impact of NAADS on having at least 2 Meals per Day by Region

VARIABLES	Central	East	North	West
NAADS	0.098***	0.096**	0.104	0.050
	(0.027)	(0.035)	(0.083)	(0.067)
Improved Seeds	0.052	0.117***	0.129**	-0.006
	(0.039)	(0.036)	(0.054)	(0.033)
Polygamous	-0.018	-0.091***	-0.150***	-0.161***
	(0.022)	(0.028)	(0.050)	(0.038)
Never Married	-0.384***	-0.157***	-0.238***	-0.199***
	(0.121)	(0.054)	(0.081)	(0.026)
Owned/Free House	-0.002	0.132***	0.198**	0.171***
	(0.019)	(0.042)	(0.070)	(0.059)
Charcoal[a]	0.034	0.080**	0.108	0.168**
	(0.046)	(0.038)	(0.065)	(0.073)
Electricity[a]	0.109**	-0.430	0.113**	0.151***
	(0.037)	(0.310)	(0.052)	(0.040)
Literate[b]	-0.007	0.101***	0.140***	0.153***
	(0.035)	(0.012)	(0.030)	(0.033)
Farm Labor	-0.006	0.024***	0.013***	0.036***
	(0.006)	(0.004)	(0.004)	(0.0034)
Hhage	-0.0014	-0.0016***	-0.0014*	-0.001
	(0.001)	(0.001)	(0.0008)	(0.0008)
Hhsize	-0.000	0.007**	0.004	0.010**
	(0.003)	(0.003)	(0.006)	(0.004)
Constant	0.007***	0.584***	0.546***	0.328***
	(0.098)	(0.060)	(0.086)	(0.0575)
Other Controls[c]	YES	YES	YES	YES
R-Squared	0.080	0.264	0.183	0.518
Number of Observations	317	2,215	1,500	2,605

Notes:
Robust standard errors in parentheses. *** p <0.01, ** p <0.05, * p <0.1. OLS is the method of estimation with the dependent variable defined as a dummy variable. The estimates are average marginal effects. [a]Used for cooking in the household relative to firewood as the base case.[b] Can the head of household read and write ? It is a dummy variable used as a proxy for education.[c] Farm revenue, household income, main source of water for domestic use, and farm input

Table 15: The Impact of NAADS on having at least 2 Meals per Day (FE)

VARIABLES	(1)	(2)	(3)	(4)	(5)
NAADS	0.071***	0.123**	0.062***	0.069***	0.045
	(0.021)	(0.049)	(0.023)	(0.021)	(0.063)
Improved Seeds	-0.007	0.002	0.002	-0.003	-0.130**
	(0.017)	(0.022)	(0.022)	(0.017)	(0.049)
Farm Labor	0.001	0.002	0.002	0.002	-0.005
	(0.002)	(0.001)	(0.001)	(0.002)	(0.02)
Migration	-0.03*	-0.042**	-0.042**	-0.026	-0.106**
	(0.016)	(0.020)	(0.019)	(0.016)	(0.041)
Hhage	-0.001***	-0.001***	-0.001***	-0.001***	-0.001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.002)
Hhsize	0.008***	0.008***	0.008***	0.007***	0.012***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)
Constant	-0.077***	-0.075**	0.563***	0.006	0.647***
	(0.028)	(0.034)	(0.021)	(0.027)	(0.146)
Year Fixed Effects	YES	YES	YES	YES	YES
District Fixed Effects	YES	YES	YES	YES	YES
District Time Trends	YES	YES	YES	YES	YES
Other controls	YES	YES	YES	YES	YES
R-squared	0.469	0.515	0.473	0.468	0.554
Number of Observations	6,653	1,436	5,217	6,269	1,161

Notes:

*** p <0.01, ** p <0.05, * p <0.1. Clustered robust standard errors in parentheses. The results in the columns are for different sub-samples. Column (1) is the full sample, Column (2) consists of male headed households, Column (3) is for female headed households, Column (4) is for rural households, and Column (5) is the sample for households whose head is aged 60 years and above. The dependent variable is defined as a dummy variable indicating a household always has at least 2 meals per day. The estimates are average marginal effects. Other controls includes marital status, education, farm revenue, household income, type of fuel used for cooking, and main source of water for domestic use.

Table 16: Fixed Effects Regressions by Region

VARIABLES	Central	Eastern	Northern	Western
NAADS	0.089***	0.0148	0.147	0.076*
	(0.025)	(0.015)	(0.120)	(0.038)
Improved Seeds	0.045	-0.044**	-0.0036	-0.0312
	(0.043)	(0.019)	(0.045)	(0.03)
Farm labor	-0.009	0.001	0.007**	-0.004
	(0.007)	(0.003)	(0.003)	(0.003)
Migrant	0.003	-0.022	-0.067*	0.005
	(0.0349)	(0.0207)	(0.0367)	(0.0321)
Hhage	-0.002	-0.001***	-0.002*	-0.000
	(0.001)	(0.000)	(0.001)	(0.001)
hhsize	-0.001	0.0105***	0.005	0.009**
	(0.003)	(0.003)	(0.006)	(0.003)
Constant	0.030***	0.240***	0.582***	0.614***
	(0.0846)	(0.0375)	(0.0709)	(0.0364)
Other Controls	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES
District Fixed Effects	YES	YES	YES	YES
District Time Trends	YES	YES	YES	YES
R-squared	0.162	0.378	0.278	0.631
Number of Observations	317	2,215	1,500	2,605

Notes:
*** p <0.01, ** p <0.05, * p <0.1. Clustered robust standard errors in parentheses. Sample weights are applied in all the estimations. The dependent variable is defined as a dummy variable. The estimates are average marginal effects. Other controls includes marital status, education, farm revenue, household income, type of fuel used for cooking, and main source of water for domestic use.

Table 17: Robustness Check Using Negative Binomial Regression

VARIABLES	(1)	(2)	(3)	(4)	(5)
NAADS	1.05**	1.09***	1.073***	1.08*	0.118
	(0.023)	(0.023)	(0.019)	(0.052)	(0.221)
Year Fixed Effects	YES	YES	YES	YES	YES
District Fixed Effects	YES	YES	YES	YES	YES
District Time Trends	YES	YES	YES	YES	YES
Other Controls	YES	YES	YES	YES	YES
Number of Observations	6,632	5,201	6,240	5,318	1,314

Notes:
*** p <0.01, ** p <0.05, * p <0.1. Clustered robust standard errors in parentheses. The coefficients are incidence rate ratios (IRR). The IRR indicates the number of times a household which benefited from NAADS service is more likely to have a meal in a day compared to non-NAADS beneficiaries, holding other variables constant. Other controls includes marital status, education, farm revenue, household income, type of fuel used for cooking, and main source of water for domestic use. Column (1) is the full sample, Column (2) is for male headed household, and Column (3) is a sub-sample for rural areas. Columns (4) and (5) are for household heads aged 18-60 and 60+ respectively.

Table 18: Robustness Check Using Propensity Score Matching

Variables	(1)	(2)	(3)	(4)	(5)
NAADS (ATT)	0.062***	0.054**	0.06**	0.084	0.075
	(0.024)	(0.026)	(0.025)	(0.06)	(0.026)
Matched Observations (N)	1,645	1,228	1,489	402	150
Pseudo R-squared after matching	0.004	0.004	0.005	0.004	0.009
χ^2 p-values after matching	0.983	0.421	0.80	0.976	0.86

Notes.
***p <0.01, ** p <0.05, * p <0.1. Standard errors in parentheses. The coefficients are Average Treatment Effect on the Treated (ATT) and indicates the difference in the probability of a household having at least 2 meals per day conditional on NAADS. The propensity score was estimated using logit and on common supports. The pseudo R-squared after matching indicates how much the variation in NAADS participation can be attributed to observables. The p-values for the likelihood-ratio test checks whether the observed difference in model fit for the treated and untreated is statistically significant. All regressions include district fixed effects and controls as described in Table 11. The sample consist of observations contained in the 2005/2006 survey only.

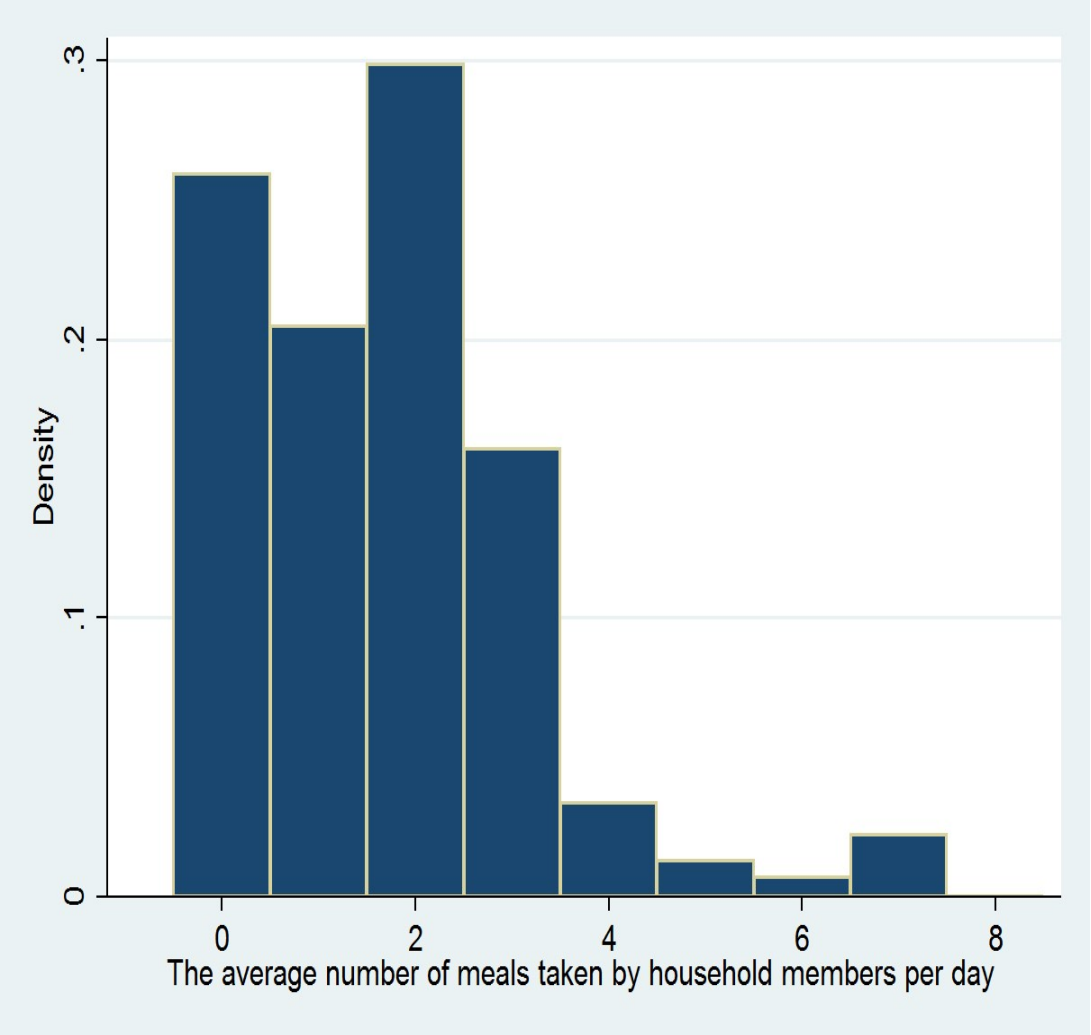

Figure 6: Daily Food Consumption

Source: author's computation

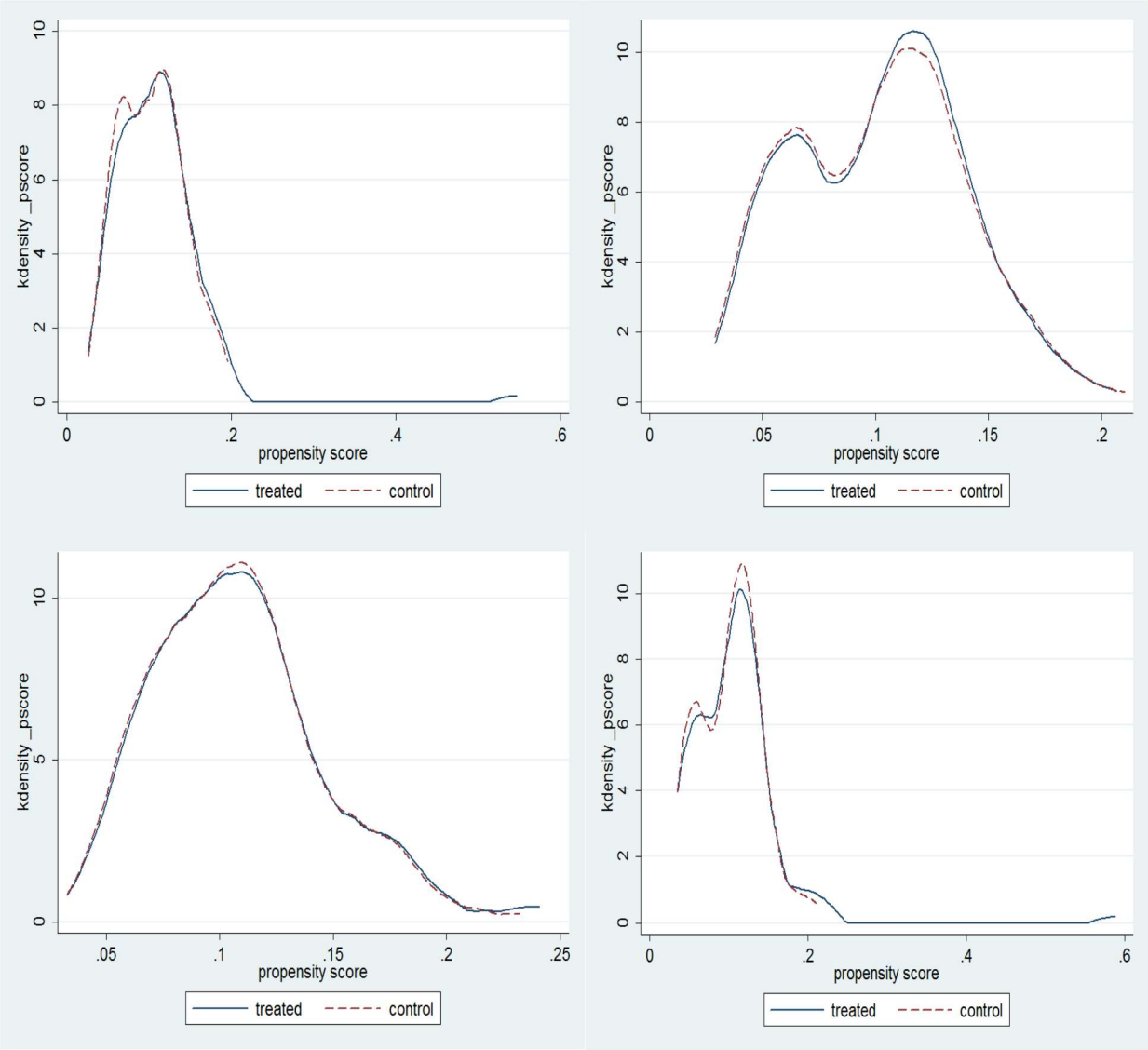

Figure 7: Probability Plots to Check Overlap Assumption

Notes:
The kernel density plots are used to check whether the overlap assumption for propensity score matching is satisfied or violated. The overlap assumption is satisfied if the likelihood of finding observations in both the control and the treatment groups given all possible combinations of covariates values. A violation of the overlap assumption would make it difficult to account for the effects of unobserved outcomes. The figures above show the overlap assumption is not violated as the propensity scores are between zero and one and the kernel density overlaps most of the time.

Chapter 5: Synthesis and General Conclusions

5.1 Conclusions

The dissertation examined three health and development issues related to the Millennium Development Goals/ Sustainable Development Goals. The dissertation is motivated by the persistent poor health and development indicators in Sub-Saharan Africa. A number of strategies have been applied to help African countries achieve economic growth so that they can address development bottlenecks. The strategies include Structural Adjustment Program (SAP), the Highly Indebted Poor Countries (HIPC) Initiative, and project tied loans.

In the first essay, I examined the impact of the HIPC Initiative on under-five mortality rate in Sub-Saharan Africa. The findings indicate that countries which participated in the HIPC Initiative experienced a statistically significant reduction in under-five mortality rate. This is explained by the conditionality of the Initiative which required that for a country to benefit, it must come up with strategies to reduce poverty and improve social service provision. It is probable that the conditionality led to improvement in healthcare service provision and hence impacted the cause of child mortality.

The requirement to allocate more resources to social services, including the health sector could have mediated the observed changes in child mortality rate in the participating countries. From this essay, one can conclude that the debt relief effort spearheaded by the World Bank, IMF, African Development, and the Jubilee 2000 coalition led to some improvements in health outcomes in SSA. This indicates debt relief and/ or development aid with conditionality can yield

positive outcomes. This is in sharp contrast with arguments that conditionality is bad. Aid without conditionality and monitoring breeds inefficiencies and corruption. Therefore, international development organizations and industrialized countries can help Sub-Saharan Africa achieve the sustainable development goals through tied aid which improves social service provision and poverty reduction.

Due to the poor economic performance of many developing countries in the 1980s, the IMF designed and implemented the Structural Adjustment Program (SAP). The program involved liberalization of many sectors of the economy and a reduction in the roles of governments. In Uganda, social services such as healthcare, which used to be provided by the government and not-for-profit organizations was liberalized. As a result many private hospitals and clinics were established as for-profit businesses, notwithstanding the fact that provision of healthcare services involves a high degree of information asymmetry. As a consequence, poor regulation of a liberalized healthcare sector could propagate supplier-induced demand for some services. A notable case is the increase in the rate of cesarean section births. Given information asymmetry and complications associated with child delivery, profit oriented hospitals may find it lucrative to recommend it to expectant mothers. This is the research problem analyzed in the second essay. I examined the impact of private hospitals on the likelihood of cesarean sections in Uganda. Using a bivariate probit method, the impact of place of delivery is identified. This is the first study which empirically examined the phenomenon of physician induced-demand in an African country. The results indicate the need for closer monitoring of private hospitals so that expectant mothers are protected from physician induced-demand. Patients also need to be educated about their rights so that they can make informed decisions. This can protect expectant mothers from maternal health problems associated with cesarean section births.

The third essay examined the impact of agricultural extension services on household food consumption. The National Agricultural Advisory Services (NAADS) is a World Bank funded project which provides demand-driven agricultural extension services and farm inputs in Uganda. It is a change from the top-to-bottom agricultural extension service model. The program aimed at increasing agricultural productivity and improving household income and food security. The program required farmer group formation as a means of accessing the service. As a consequence, some households formed groups and received agricultural extension services while others did not benefit. This creates a good condition for evaluating the effectiveness of the program. The impact of the program on household food consumption is directly related to the Millennium Development Goal number 1 and the Sustainable Development Goal number 2.

Previous studies examined the impact of NAADS on technology adoption, farm output, farm income and a composite measure of poverty. However, I consider the impact of NAADS on food consumption as an end in itself. This is because increases in farm output and income may not translate into improvement in household welfare due to intra-household inequality in decision making and resource allocation. On the other hand, food consumption is relatively uniform within a household and hence a more direct measure of the impact of NAADS on one indicator of welfare. The findings indicate that membership and training under NAADS improves food availability and consumption. Thus, it helps in reducing hunger and hence promotes achievement of MDG 1/ SDG 2. The main takeaway from this chapter is that demand driven agricultural extension services can be an effective strategy in fighting hunger and rural poverty. Therefore, decentralized and participatory agricultural extension services should be promoted.

5.2 Future Research

Given the findings from these three essays, future studies could focus on related issues such as debt sustainability in countries which benefited from the HIPC initiative. This is because the initiative was a temporary measure to reduce debt obligations but it also opened new avenues to borrow funds at concessional rates. As much as concessional loans carry low interest rates, some HIPCs contracted huge loans after receiving debt relief. As a result, the total debt stock may pile up again, leading to a vicious cycle of indebtedness, high debt servicing, crowding out of public good provision, poor health services, adverse health outcomes, low labor productivity, low economic growth and the need to borrow more, ad infinitum. Thus, it may be informative to analyze the impact of the HIPC Initiative on debt sustainability.

From the essay on physician induced-demand for cesarean section births in Uganda, future research may consider the impact of insurance on cesarean section birth rates. The increase in the number of private hospitals/clinics in Uganda has created a market for health insurance and the Uganda government has proposed a national health insurance scheme which shall require contributions from individuals employed in the formal sector. Physician induced-demand might impose a financial burden on the scheme. A study which analyzes the utilization of healthcare services financed by private insurance may produce evidence which can be used to plug loopholes in the proposed national health insurance scheme.

Future studies on food security and agricultural extension could consider demonstration effects. The households which did not receive training but live in the neighborhoods of farmers who were trained by extension workers could have an incentive to adopt new farming methods. A random sample of such households and those who lived far from trained farmers can be used to estimate demonstration effects on farm productivity and household welfare.

About the Author

John B. Oryema is a Ugandan national. After completing high school from Northern Uganda, he was admitted to Makerere University Kampala on a national merit government scholarship to pursue the Bachelor's degree program. As Uganda's premier University, getting admitted to Makerere on state scholarship is an achievement in itself as there were only 2,000 slots for the whole country. At Makerere, John majored in Economics and emerged as the University wide valedictorian for earning the highest CGPA in the graduating class of March 2003. In 2006, he earned his MSc in Public Policy from University College London where he studied with funding from the UK Commonwealth Scholarship Commission. He returned to Uganda in 2006 and joined Makerere University where he taught introductory econometrics, mathematical economics, rural finance and public sector economics. While teaching at Makerere University, John studied and earned the MA in Economics administered by the Collaborative Master's Program for Anglophone Africa under the auspices of AERC based in Nairobi, Kenya. In 2011 he was admitted to the PhD in Economics program at the University of South Florida with a Graduate Student Assistantship. While pursuing the PhD program, John taught microeconomic and macroeconomic principles to undergraduates at USF. This dissertation is a culmination of his journey in pursuit of knowledge. His areas of specialization are Applied Microeconomics, Health Economics, Development Economics and Applied Econometrics. He looks forward to a career in economic research, consulting, policy analysis and training the next generation of economists.