EFFECT OF HOUSEHOLD POVERTY ON WOMEN'S FERTILITY AND CHILD NUTRITIONAL STATUS IN UGANDA

LILLIAN NAMUBIRU

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university

Signature…………………………………

Date………………………………………

Lillian Namubiru

This thesis has been submitted for examination with our approval as university supervisors

Signature…………………………………

Date………………………………………

Professor Jane Kabubo-Mariara

School of Economics

University of Nairobi

Signature…………………………………

Date………………………………………

Dr. Djesika Amendah

African Population Health and Research Center

Nairobi Kenya

DEDICATION

This thesis is dedicated to the Almighty God, the source of my strength and wisdom, and also to my father, mother, sisters, brothers, teachers and friends.

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ABSTRACT

This thesis investigates the effect of poverty on health status in Uganda. First, we test for the effect of poverty on fertility, second for the effect of poverty on child nutritional status, and finally, whether the effect of poverty on child nutritional status varies by gender of household head. Poverty is proxied by wealth index of a household. Fertility, a proxy of women's reproductive health is measured by the number of children ever born (CEB), while child nutritional status, an indicator of child health, is measured by the children's height-for-age Z-scores (HAZ) and the probability of a child being stunted.

The thesis uses two nationally representative data sets, the Uganda Demographic and Health Survey (UDHS) for 2006, and the Uganda National Household Survey (UNHS) for 2005/2006. Various estimation methods are employed. The Ordinary Least Squares (OLS) and Zero-Inflated-Poisson (ZIP) models are used for a reduced form fertility model. To account for possible endogeneity of wealth index, the Instrumental Variable (IV) methods are used, while the Control Function Approach (CFA) is used to account for potential heterogeneity in the wealth-fertility relationship. Testing for the effect of wealth index on child nutritional status is done using OLS and Probit models. To control for possible endogeneity of wealth index in the child nutrition model, the IV and IVProbit models were used for HAZ and the probability of a child being stunted respectively. The CFA is employed to account for potential heterogeneity in the wealth-child nutritional status relationship. In addition, the OLS, IV and CFA models are used when investigating whether the effect of wealth index on child nutritional status varies by gender of household head.

The findings of the thesis indicate that wealth index is inversely correlated with fertility, but positively affects child nutritional status. The use of professional care at birth improves child nutrition. The IV results suggest that wealth index may not be endogenous in both the fertility and child nutritional status models. The CFA results indicate the presence of heterogeneity arising from unobservable determinants of fertility that may be correlated with wealth index. A similar result is found in the wealth-child nutritional status relationship. Results further suggest that wealth index is positively associated with child nutritional status in both male and female-headed households. Another important finding is that using professional care at birth decreases the likelihood of malnutrition more significantly in female-headed households than in male-headed ones. We uncover no endogeneity and

heterogeneity issues in the wealth-child nutritional status relationship for both male and female-headed households.

The findings of this thesis suggest that improvement in wealth status and higher female education are likely to lower fertility and improve child nutritional status. The use of professional care at birth, which may be a proxy of accessibility of healthcare services, should also be promoted in different parts of the country in order to lower malnutrition in children. However, there is need to eliminate the differences that prevail in the usage of professional care at birth in male and female-headed households.

ACRONYMS

2SLS	Two-Stage-Least Squares
AERC	African Economic Research Consortium
APHRC	African Population Health and Research Center
APORDE	African Programme on Rethinking Development Economics
CEB	Child ever born to a woman
CFA	Control Function Approach
DHS	Demographic and Health Survey
DW	Durbin-Wu-Hausman
EPRC	Economic Policy Research Center
ERP	Economic Recovery Programme
FHHs	Female-Headed Households
GDP	Gross Domestic Product
GNI	Gross National Income
GoU	Government of Uganda
HAZ	Height-for-age Z-scores
HSSP	Health Sector Strategic Plan
IV	Instrumental Variable
IVProbit	Instrumental Variable Probit
KM	kilometers
MDGs	Millennium Development Goals
ME	Marginal effects
MFPED	Ministry of Finance Planning and Economic Development
MHHs	Male-Headed Households
NGO	Non Governmental Organization
NHIS	National Health Insurance Scheme
OLS	Ordinary Least Squares
PEAP	Poverty Eradication Action Plan
UBOS	Uganda Bureau of Statistics
UDHS	Uganda Demographic and Health Survey
UN	United Nations
UNHS	Uganda National Household Survey
UPPAP	Uganda Participatory Poverty Assessment Project
USE	Universal Secondary Education
WAZ	Weight-for-age Z-scores
WHO	World Health Organization
WHZ	Weight-for-height Z-scores
ZIP	Zero-Inflated-Poisson

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CHAPTER ONE: BACKGROUND AND CONTEXT

1.0 Introduction

All over the world, countries aim at economic growth and development. Extensive research has highlighted main factors in economic growth and development. Among them are "investments in human capital (health and education), choices over family size and birth rates, interactions between human capital and physical capital" (Becker et al., 1994). The United Nations (UN) acknowledges that much of the Millennium Development Goals (MDGs) agreed upon by countries in 1990s should be attained by 2015. Globally, the proportion of people living in extreme poverty (i.e. those living on less than 1 dollar a day) has been halved before 2015. Reducing the percentage of undernourished people in the world may be attainable by 2015. Improving maternal health through reducing maternal mortality by 75 percent and providing universal access to maternal reproductive health still falls short of its target. Another health related MDG is that of reducing child mortality by two thirds. Presently, a lot of effort is needed to meet child mortality targets especially in the poorest regions in the world (United Nations, 2013). Mild to severe malnutrition has been considered to cause 13 to 66 percent of deaths among children in developing countries (Pelletier et al., 1995).

Like in most African countries, there has been stagnation or reversal in the progress to achieving these MDGs in Uganda (Republic of Uganda, 2013) making it unlikely that Uganda will meet the international deadline of 2015. Nevertheless, with continued health sector investments by the Government of Uganda (GoU) together with its development partners such as the NGOs and the private sector, it can be anticipated that health status outcomes will improve in the country.

1.1 Overview of Uganda's Economy

Uganda is an East African country with a population of about 35.4 million persons (Uganda Bureau of Statistics, 2013). Its gross domestic product (GDP) was 21,483 millions of US dollars in 2013 which classifies it among the poor countries (World Bank, 2014b). In addition, the country ranks 161 out of 186 countries in the human development index which classifies countries based on not only gross national income (GNI) per capita, but also on social indicators such as education and life expectancy at birth. With this ranking, Uganda lies among the low human development countries (United Nations Development Programme, 2013). The country became independent in 1962 and adopted a mixed economic system with the government taking a lead in major economic activities, while the private sector was sanctioned by the constitution (Bigsten and Kayizzi-Mugerwa, 1999). Between 1960s and mid 1970s, the economy was flourishing and had the most effective public service systems in Sub-Saharan Africa (EPRC, 2010).

However, during the late 1970s and early 1980s, the Ugandan economy experienced a breakdown resulting from poor economic policies which failed to sustain the post independence growth. The economy suffered a lot of mismanagement in key sectors and the situation was worsened by political instabilities that occurred in the same period. In 1987, the Economic Recovery Programme (ERP) was adopted (Bigsten and Kayizzi-Mugerwa, 1999) to improve economic performance and stability. The ERP recognized that private sector especially through foreign direct investments would take a lead in economic growth. The government was therefore to provide an enabling environment for the private sector to boost development. In the 1990s, the economy was liberalized to aid maximization of economic growth and efficiency in all sectors (Okidi et al., 2005).

The economic situation and political turmoil of the 1970s and early 1980s negatively impacted all sectors of the economy but particularly the health sector (EPRC, 2010; Lawson, 2004). Indicators of health status such as mortality, malaria and malnutrition prevalence worsened (Bigsten and Kayizzi-Mugerwa, 1999). To date, the health sector in Uganda is affected by inadequate numbers and distribution of professional workers, which in turn hinders effective service delivery (Republic of Uganda, 2010c).

The Government of Uganda (GoU) with its aim of promoting economic growth and development of the country recognized the importance of the link between health and poverty, and in 1997, the Poverty Eradication Action Plan (PEAP) was adopted. The PEAP framework acted as a guideline for the country's development (Republic of Uganda, 2004). In 1998, the Uganda Participatory Poverty Assessment Project (UPPAP) which aimed at involving the poor and their voices represented at policy level was introduced. The UPPAP agenda led to the revision of the PEAP of 1997 thus giving rise to the PEAP of 2000 (Bahiigwa, 2003). Further revisions were done leading to PEAP for the period 2004/05 to 2007/08. As part of its five pillars, the PEAP for 2004/05 to 2007/08 emphasized provision of better health and education as means of reducing poverty in Uganda (Republic of Uganda, 2004).

In addition, the GoU introduced health sector specific policies for improving people's health status, such as the first National Health Policy (NHP) which guided the health sector between 1999 and 2009. This policy aimed at improving the provision of health services in a cost-effective way to the population (Republic of Uganda, 1999). To guide the health sector during the period 2010/11 to 2019/20, the GoU has introduced the second National Health Policy (Republic of Uganda, 2010b). The second NHP focuses on health promotion, early diagnosis, prevention and treatment of disease. This second policy also aims at efficient delivery of the Uganda National Minimum Health Care Package (Republic of Uganda, 2010d); which addresses the major causes of disease burden. The package is also a key reference in determining the allocation of public funds and other essential inputs. Although this package is for the whole population, it mainly focuses on the poor, women and children (Republic of Uganda, 1999). The Poverty Eradication Action Plan (PEAP) has now been replaced by the National Development Plan (NDP). The NDP covers the period 2010/11 to 2014/15 with the aim of transforming Uganda from a peasant to a modern economy within 30 years. To attain this goal, as was with the PEAP, the NDP maintains the poverty reduction vision through its objective of raising the per capita incomes in the country. In addition, the NDP focuses on developing the quality of human resources through better health status and education of individuals (Republic of Uganda, 2010c).

1.2 The Concept of Health Status: Reproductive and Child Health

The concept of health status is a broad one which encompasses fertility, nutritional status, morbidity, disability and mortality (Claeson et al., 2001). This thesis focuses on fertility which is one of the indicators of the reproductive health status of women (Ajakaiye and Mwabu, 2007; Greene and Merrick, 2005), and child nutritional status an indicator of child health (Kabubo-Mariara et al., 2009b; Abalo, 2009; Bahiigwa and Younger, 2005).

Fertility rates are measured by current and cumulative fertility rates. Current fertility indicators include: (i) age-specific fertility rate (ASFRs) which is fertility rate per 1,000 women of a particular age category, (ii) the general fertility rate indicates the number of live births per 1,000 women, (iii) crude birth rate referring to the number of live births per 1,000 population (Uganda Bureau of Statistics and Macro International Inc., 2007), and (iv) total fertility rate which is the number of children a woman would have if she were to go through her reproductive cycle and bears children when subjected to current ASFRs (World Bank, 2014a). Cumulative fertility rates, mainly number of children ever born - refers to the average number of children born alive to women in a particular age group (Uganda Bureau of Statistics and Macro International Inc., 2007). Other indicators of women's reproductive health include family planning, maternal mortality ratio and morbidity (Ajakaiye and Mwabu, 2007; Greene and Merrick, 2005).

Indicators of nutritional status of an individual can be considered to be inputs such as nutrient intake and outputs in form of anthropometric measures. Both inputs and outputs characterize the individual's health production function. Nutrient intakes are proxies for energy intakes which affect individual's wealth/income through productivity. Anthropometrics such as height, weight and body mass index are used to measure nutritional status of individuals (Strauss and Thomas, 1998). Specific to child nutritional status, studies have focused on anthropometric measures with emphasis on Z-scores of height-for-age, weight-for-height and weight-for-age (Kabubo-Mariara et al., 2009b; Ssewanyana, 2003; Sahn and Alderman, 1997; Haddad and Hoddinott, 1994; Baye and Fambon, 2009; Abalo, 2009). Height-for-age (HAZ) is a reflection of long-term or cumulative growth deficiencies of a child. A child is said to be stunted or chronically malnourished if his/her height-for-age Z-scores fall below -2 standard deviations from the median of the reference population. Weight-for-height (WHZ) measures the weight (body mass) of children relative to their height or length. Children are said to be too thin or to suffer from wasting if their weight-for-height Z-scores fall below -2 standard deviations from the median of the reference population. Weight-for-age (WAZ) indicator captures both acute and chronic malnutrition in children. Children whose weight-for-age Z-scores fall below -2 standard deviations from the median of the reference population are said to be underweight (Uganda Bureau of Statistics and Macro International Inc., 2007). Weight-for-height and weight-for-age are short term indicators of child nutritional status; because weight varies with either dietary intake or sickness in a short period of time (Baye and Fambon, 2009; Abalo, 2009).

Thus, fertility and child nutritional status reflect health status of households which in turn greatly affect their productivity and income levels (Republic of Uganda, 2004; Strauss and Thomas, 1998; Ribero and Nuñez, 1999), and have implications for national poverty and wealth.

Fertility in Uganda

In Uganda, the total fertility rate (TFR) declined steadily over the past two decades although it remains high. The TFR was 7.1 in 1988 (Uganda Bureau of Statistics, 2007), 6.9 children in 1995 and 2000/2001, 6.7 in 2006 (Uganda Bureau of Statistics and Macro International

Inc., 2007) and 6.2 children in 2011 (Uganda Bureau of Statistics and ICF International Inc., 2012). Considering fertility rates by wealth status in 2006, women from the lowest wealth quintile had a total fertility rate of 8.0 children compared to 4.3 children for those from the richest quintile (Uganda Bureau of Statistics and Macro International Inc., 2007). For poor households, such a large number of children increases poverty in the next generation because assets are subject to greater sub division across generations (Republic of Uganda, 2004). High fertility rates combined with low birth spacing are among the major reasons why infant mortality rates have remained high in Uganda (Tashobya and Ogwal, 2004; Republic of Uganda, 2003). Although fertility is declining in Uganda, compared with the East African countries, Uganda's fertility rate is the highest. For instance, TFR in Rwanda was 6.1 in 2005 and 5.5 in 2007/08, while in Tanzania it was 5.7 in 2004 and 5.4 in 2010. In Kenya it was 4.9 in 2003 and 4.6 in 2008/09 (see Uganda Bureau of Statistics and Macro International Inc., 2007; Uganda Bureau of Statistics and ICF International Inc., 2012).

Child Nutritional Status in Uganda

Child nutritional status indicators in Uganda are dire and have remained so over the last decade: 38 and 39 percent of the children were stunted in 1995 and 2001 respectively. Those proportions only fell by 1 percent to 38 percent in 2006, and by 5 percent to 33 percent in 2011 (Uganda Bureau of Statistics and Macro International Inc., 2007; Uganda Bureau of Statistics and ICF International Inc., 2012). Poor nutrition is a result of low incomes, unequal bargaining power within the household, and the heavy burden on women's time and poor health (Republic of Uganda, 2004). Other causes of poor nutrition include: sicknesses like malaria and infectious diseases, low quality food, and poor feeding practices (Uganda Bureau of Statistics and Macro International Inc., 2007; United Nations Children's Fund, 2009). Malnutrition is an underlying cause of 60 percent of child mortality in Uganda (Republic of Uganda, 2009). Although the prevalence of underweight children in Uganda has fallen over the years, the current prevalence is still high. Among the children under five years, 23, 16 and 14 percent were underweight in 2000/2001, 2006 and 2011 respectively (Uganda Bureau of Statistics and Macro International Inc., 2007).

It has been argued that child malnutrition is a major challenge to the growth and development for several reasons: First, malnutrition affects long-term physical growth and development of children. This in turn may lead to high levels of chronic illness and disability in adult life, or even death (Kabubo-Mariara et al., 2009b). Poor nutrition in the early stages of life negatively impacts the cognitive development; and socioeconomic outcomes of individuals in their adulthood (Harttgen et al., 2012; Ampaabeng and Tan, 2012).

1.3 Poverty in Uganda

Poverty can be defined as the incapability of individuals to meet the basic needs of life. Poverty also covers powerlessness of individuals in the sense of insecurity and exploitation by service providers. Poverty makes people vulnerable to natural and economic shocks, and isolated from the larger society and other socioeconomic infrastructure (Okidi and Mugambe, 2002). Poverty in Uganda covers mainly three aspects i.e. low incomes, limited human development and limited empowerment (Republic of Uganda, 2004). Income poverty shows the percentage of people living below the poverty line defined as the cost of meeting the basic calorie and non-food needs by households. Income poverty declined in Uganda from 56.4 percent in 1992/93 to 31.1 percent in 2005/06 (Ssewanyana, 2009), and to 24.5 percent in 2009/10 (Republic of Uganda, 2010e).

In the absence of income or expenditure data, poverty can be measured by wealth status comprising of household assets such as durable consumer goods (bicycle, refrigerator, television and car), and dwelling characteristics such as floor material, source of drinking water, toilet facilities, and other wealth indictors. These household assets and characteristics are used to construct a wealth index. This index in turn indicates the socio-economic status of household members (Uganda Bureau of Statistics and Macro International Inc., 2007). Many studies on poverty have used the wealth index as an alternative measure of welfare. These studies argue that wealth index is as dependable as the traditional measures of consumption expenditure (Filmer and Pritchett, 2001; Kabubo-Mariara et al., 2012; Sahn and Stifel, 2000; 2003).

Various groups in Uganda are affected by poverty differently depending on area of residence or household headship. For instance, 27.2 percent of the population in rural areas is poor compared to only 9.1 percent in urban areas. To appreciate the magnitude of rural poverty, it is important to note that out of approximately 7.5 million poor Ugandans, 7.1 million live in rural areas. In other words, 85 percent of rural residents comprise 94.4 percent of the nationally poor Ugandans, compared to only 15 percent urban residents with 5.6 percent of the nationally poor (Republic of Uganda, 2010e). The high proportion of rural households living in poverty is related to the fact that they are more likely to be engaged in subsistence agriculture and have little production left for marketing. Thus incomes stagnate in rural areas thereby hindering wealth creation and sustainable poverty reduction (Ssewanyana, 2010). Conversely, service and industrial sectors mostly located in the urban areas have grown in the recent decades, lifting urban residents out of poverty.

Female-headed households (FHHs) are another group at higher risk of poverty because they are likely to have only one income earner. In rural areas where physical aptitude is important for subsistence agriculture, female-headed households may be disadvantaged. While conventional wisdom suggests that female-headed households are poorer than male-headed ones, research findings are mixed in Uganda. For example, 39 percent of female-headed households in 1999 were poor compared to 33 percent male-headed households (MHHs). In 2003, equal proportions (39 percent) of female and male headed households were poor (Republic of Uganda, 2004). However, recent literature indicates that FHHs in Uganda are in much worse poverty than MHHs (Ssewanyana, 2009).

1.4 Statement of the Research Problem

Poverty and health status are important measures of personal wellbeing that can influence each other. On the one hand, higher incomes and wealth enable individuals to purchase more of goods and services that are associated with good health, such as food, access to safe and clean water, sanitation and quality health care services (Fuchs, 2004; Bloom and Canning, 2000). On the other hand, healthy individuals are likely to be more productive, earn more and are less likely to be poor than sick individuals (Okidi and Mugambe, 2002). Therefore understanding how poverty and health are related is important for policy interventions intended to improve people’s wellbeing (Buddelmeyer and Cai, 2009).

This thesis addresses the issue of poverty and health in Uganda. Wealth index is used to measure household level poverty status, while women’s fertility and children nutritional status are used to proxy reproductive and child health respectively.

The quantity-quality of children model postulates that lower fertility rates may allow parents to give more care time to each child, and also commit resources to their children’s human capital development (health and education) plus other necessities of life (Schultz, 2007). At national level, lower fertility as a return on women’s human capital may promote economic growth and development (Schultz and Mwabu, 2003). However, poverty limits fertility decline (Schultz, 2005).

Assessing the effect of poverty on fertility is fraught with methodological issues such as measurement of poverty, possibility of reverse causality between poverty and fertility, and heterogeneity that may arise from unobservable determinants of fertility. Perhaps this is one of the reasons why there is a dearth of knowledge on the health status-poverty nexus in Uganda. For instance, only two recent studies address fertility in Uganda: Bbaale and Mpuga (2011) explained fertility in Uganda, but did not test for the effect of poverty. They treated fertility as a continuous rather than a count variable. A previous study by Schoumaker (2004) focused on fertility-poverty relationship, but did not control for endogeneity of wealth index and possible heterogeneity in the relationship. This thesis contributes to the literature through addressing these research gaps by analyzing the effect of poverty on fertility. The thesis uses the Zero-Inflated-Poisson (ZIP) model to estimate fertility as a count variable, and controls for potential endogeneity of poverty, and also heterogeneity that may arise from unobserved determinants of fertility which may be correlated with wealth index.

Furthermore, poverty worsens nutritional status (Lawson, 2004). A well-nourished population (children and adults) is a key ingredient for growth and development (Republic of Uganda, 2010c; Food and Agriculture Organization, 2004). However, for a country to realize these long term development benefits, investment in nutrition must start in the early stages of life and should be sustained there after (Boyden and Dercon, 2012; Commission on Growth and Development, 2008).

Assessing the effect of poverty on child nutritional presents similar methodological issues as those described above. Consequently, among the studies that have examined child nutrition in Uganda (Mackinnon, 1995; Ssewanyana, 2003; Lawson, 2004; Bahiigwa and Younger, 2005; Ssewanyana and Kasirye, 2012; Harttgen et al., 2012; Bbaale, 2014), none has comprehensively accounted for all the methodological issues. For instance, some focused only on height-for-age Z-scores (Mackinnon, 1995; Ssewanyana, 2003; Lawson, 2004; Bahiigwa and Younger, 2005; Ssewanyana and Kasirye, 2012) while others only on the probability of a child being stunted (Harttgen et al., 2012; Bbaale, 2014). Some studies failed to control for possible endogeneity of welfare measures (Mackinnon, 1995; Ssewanyana and Kasirye, 2012), while others did not control for the effect of unobservables that may be correlated with both child nutrition and poverty (Ssewanyana, 2003; Lawson, 2004; Bahiigwa and Younger, 2005). This thesis further contributes to the literature by addressing these research gaps, focusing on both height-for-age Z-scores and the probability of a child being stunted. The study tests for the effect of poverty on child nutritional status, and also controls for potential endogeneity of poverty and heterogeneity in the child nutrition-poverty relationship.

In order to address the effect of poverty on child nutritional status, it is important to target the poor. Recently, female-headed households have been affected by worsened poverty compared to male-headed households (Ssewanyana, 2009; Staten et al., 1998; Kennedy and Haddad, 1994; Chant, 2009). However, little is known on whether the effect of poverty on child nutritional status varies in male versus female-headed households in Uganda. In Uganda, only Appleton (1996) examined whether the differences in child nutrition by gender of household head were significant, but did not specifically test for the effect of poverty on child nutrition. This thesis further contributes to the literature by investigating whether the effect of poverty on child nutritional status varies in male and female-headed households.

1.5 Objectives of the Study

The general objective of this thesis is to investigate the effect of poverty on health status in Uganda.

The specific objectives are:

i. To investigate the effect of poverty on fertility.
ii. To investigate the effect of poverty on child nutritional status.
iii. To investigate whether the effect of poverty on child nutritional status varies by gender of household head.
iv. To draw policy recommendations for reducing fertility and improving child nutritional status in Uganda.

1.6 Justification of the Study

Improved health status is a very important aspect related to economic growth of a country. Thus understanding how health status is related to poverty is crucial for policy design. The output of this thesis will therefore benefit researchers, policy makers and other stakeholders. In particular, the Government of Uganda can use the findings of this thesis to design specific policies for improving the health status (fertility and child nutrition) of individuals. In addition, since lower fertility and better child nutrition positively impact individual incomes and productivity, the findings of the thesis can contribute towards pro-poor growth policies.

In turn these policies would help to alleviate poverty in Uganda. The thesis makes an important contribution to literature by addressing research gaps in the health status-poverty nexus with particular reference to fertility, child nutritional status and how they are affected by household poverty/wealth status.

1.7 Organization of the Thesis

The rest of this thesis is organized as follows: Chapter two presents the literature review, while chapter three presents the methodology - conceptual framework, theoretical framework and empirical model, data types and sources. The results for the effect of poverty on fertility are presented and discussed in chapter four. Chapter five presents and discusses the results for the effect of poverty on child nutritional status. The results for the effect of poverty on child nutritional status by gender of household heads are presented and discussed in chapter six. Chapter seven presents summary, conclusions and policy implications of this thesis. The chapter further discusses limitations of the study and areas for further research.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of the theoretical literature on the health production function, and empirical studies relating poverty and health status of individuals as well as studies exploring other correlates of health status. The theoretical literature consists of various economic models/theories/schools of thought that can be employed to analyze the effect of poverty on health. The empirical literature first, presents the various studies that have examined the relationship between health status and wealth but using measures different from those in this thesis. Second, we discuss literature relating poverty and fertility, followed by studies explaining the poverty-child nutritional status nexus. Finally, literature focusing on child nutritional status, poverty and gender of household head is reviewed. In each of the cases, we point out the key findings and policy recommendations. The thesis also discusses limitations of each study where they arise and elucidates how this thesis attempts to fill up the identified research gaps.

2.1 Theoretical Literature

Health status of individuals has been explained by the human capital theory (Becker, 2007; Grossman, 2000; Becker, 1962). Human capital is defined as a total amount of those intangible resources that may be inherited or acquired through investing in people (Becker, 1962; 1974). Such investment in people can take the form of use of health services, education, on-the-job training, or migration to better paying jobs (Schultz, 1961). Human capital increases people's productivity, incomes and thus lowers poverty (Becker, 1962; Mushkin, 1962; Ben-Porath, 1967). Individuals produce their own health (Mwabu, 2007) with inputs such as health care, balanced diet, education and one's behaviour/lifestyle - e.g. physical exercises, smoking and alcohol consumption (Grossman, 1972; 2000).

Becker (1960) presented the quantity-quality theory of fertility and postulated that families choose both the quantity and quality of children they would like to have. He argued that due to the increasing cost of raising children in society, most parents especially the richer tend to have fewer children than their poorer counterparts. He defined the cost of children in terms of amount of care time and money to be spent on them e.g. on their health, education, food, clothing, etc. Becker further argued that parents attain satisfaction/utility as they spend on their children. In turn, when incomes increase most parents increase expenditure on their children; this higher income positively impacts quality and quantity although the responsiveness of number of children is often lower than their quality. He suggested that on the one hand, the quality of children may be affected by tastes of parents, family income and price of goods like food, education, health, clothing, etc. On other hand, the quantity of children would be determined by ability of parents to give birth which is usually outside their control. He argued that in communities where the knowledge and use of contraception is high, the fertility rates would be lower than in communities where such knowledge/use is limited.

Rosenzweig and Schultz (1983) examined the determinants of birth weight - a measure of child health outcomes in the United States. The authors discussed health production functions using structural models; and argued that the choice of inputs in the individual/household health production function is influenced by biological/technical factors, income and prices. The Rosenzweig-Schultz model takes into consideration various aspects like health production, household production and consumption, and demand for health and health care services (Mwabu, 2007).

This thesis follows the human capital theory, and employs it to analyze the effect of poverty on health status in Uganda.

2.2 Empirical Literature

Various studies have explored the link between health and wealth, using different measures of each. Smith (1999), focused on the causal link between chronic illness and wealth measured by net and business equity, real estates, vehicles and financial assets. The study found that chronic illness negatively affected wealth and that an increase in wealth lowered chances of reporting chronic illness especially among children and young adults. Cantarero and Pascual (2005) examined the effect of socioeconomic status (gender, age, educational level, marital status, income, household size and social relationships) on self-assessed health in Spain. The study used ordered probit models with panel data from the European community. The results showed that being wealthy increased the probability of reporting very good health. In another study, Weil (2005) focused on the impact of differences in health status on variations in GDP per capita for rich and poor countries. Health status was approximated by the average adult height for men, adult survival rate and age of menarche for women. The study concluded that removing health variations would reduce differences in GDP per capita. In a study that linked poverty to several measures of stress-related health status in Australia, Saunders (1998) concluded that the poor are more stressed than their richer counterparts. This implied that financial stresses associated with being poor had an independent effect on emotional health.

In the next three sub sections, we discuss empirical literature focused on fertility and poverty, child nutritional status and poverty, and child nutritional status, poverty and gender of household head.

2.2.1 Fertility and Poverty

In this sub-section, we mainly review the study objectives, estimation methods, key findings and limitations of studies explaining the poverty-fertility relationship in developed and developing countries.

Among the studies explaining fertility in Uganda, Bbaale and Mpuga (2011) examined the determinants of fertility using ordinary least squares (OLS), while Schoumaker (2004) analyzed the relationship between poverty and fertility using Poisson regressions. Furthermore, Hannon (2008) examined the determinants of regional fertility in Uganda using UDHS data of 2006 and multiple linear regressions. Bbaale and Mpuga (2011) found that post-primary female education lowers fertility, although the authors did not focus on the effect of poverty on fertility, nor did they treat fertility as a count variable. Schoumaker (2004) found that the poorest women had higher fertility rates, married younger and used less contraception. Hannon (2008) found that education and wealth index were inversely correlated with fertility, while use of contraception increased the number of children born by a woman. The study suggested that improvement in education and reduction in poverty would lower fertility in Uganda. Bbaale and Mpuga (2011); Schoumaker (2004) and Hannon (2008) used data from the Demographic and Health Survey. None of these studies did account for the possible endogeneity and heterogeneity that can arise while investigating the effect of poverty on fertility.

Rutaremwa (2013) explored factors influencing pregnancies and fertility among adolescents in Uganda using data of the UDHS 2011 and logistic regressions. Like earlier reviewed studies, Rutaremwa (2013) did not account for potential endogeneity of wealth index. The study found marital status to highly affect the probability of having children, and that of being pregnant. The author recommended that sensitizing adolescents on behaviour change would lower teenage pregnancies and fertility. In another study, Bauer et al. (2006) focused on determinants of desired fertility in a rural area of Uganda using OLS method and cross-sectional data. The high risk of diseases and participation in clan activities were found to increase desired number of children born to a woman. Bauer et al. (2006) study was not nationally representative.

Schultz and Mwabu (2003) investigated the causes and consequences of fertility in contemporary Kenya. They used household survey data of 1994 and 1997 and the instrumental variable (IV) method to control for the potential endogeneity of log consumption per adult in the fertility model. The results showed that log consumption per adult was endogenous to fertility, thus validating the use of IV method to provide accurate fertility estimates. The study also indicated that income of a family originating from returns on physical assets like land increased fertility while income from returns on human capital of women, lowered fertility. Schultz and Mwabu (2003) suggested the use of less costly family planning methods and investment in education as policies to lower fertility. Though the study controlled for possible simultaneity between log consumption per adult and fertility, it did not account for heterogeneity - the effects of neglected non-linear interactions of unobserved factors with fertility covariates (see Mwabu, 2009).

A couple of fertility studies used data from the Ghana Living Standards Survey (Ahene-Codjoe, 2007, Bhasin et al., 2010). While Ahene-Codjoe (2007) investigated whether fertility declined over time using the Oaxaca-Ransom (1994) decomposition method, Bhasin et al. (2010) used the IV method and the control function approach (CFA) methods to examine the determinants of fertility, incomes and poverty of households in Ghana. Ahene-Codjoe (2007) found that expenditure per adult had greater impact on fertility decline than education. On the contrary, Bhasin et al. (2010) found that fertility was positively correlated with log of consumption expenditure per adult. Fertility was also positively correlated with contraceptive use, but was negatively affected by education of the woman and her husband. The authors further found that log of consumption expenditure per adult is endogenous to fertility, and there was evidence of heterogeneity in the fertility-log of consumption expenditure per adult relationship. Bhasin et al. (2010) recommended the need to educate the public about proper use of contraception, improve access to and utilization of reproductive health services; and to reduce poverty in the country by implementing poverty alleviation projects. As a limitation, Ahene-Codjoe (2007) did not account for the potential endogeneity of expenditure per adult, and for heterogeneity that may arise from unobservable factors correlated with fertility and its determinants. Using the decomposition and the OLS methods, Ahene-Codjoe (2007) and Bhasin et al. (2010) respectively failed to treat fertility as a count variable, and to control for excess zeros that may characterize fertility data.

Moultrie and Timæus (2001) used data from the South Africa project for statistics on Living Standards and Development Study, and descriptive methods to examine the differences in lifetime fertility among black women. The results indicated that increased education, higher income and living with relatives lowered fertility. The study did not account for endogeneity of income and heterogeneity that may occur from unobservable determinants of fertility.

While examining the effect of religion on fertility in France, Baundin (2008) used data from *Enquête Mode de Vie des Français*, 2007 and the Zero-Inflated-Poisson (ZIP) and IV models. The results showed evidence of endogeneity of female income in the fertility model. In addition, incomes of females were inversely correlated with their fertility, yet males' income increased the number of children a spouse would have. The results further indicated that a person who practiced her religion had higher fertility than her non-practicing counterpart. Like several other studies, Baundin (2008) did not account for heterogeneity between fertility and its covariates.

Aldieri and Vinci (2011) investigated the correlation between education and fertility in Italy, using data from the European Union Statistics on Income and Living Conditions for the period 2004-2007. Poisson and ZIP models were estimated. Education was found to be inversely correlated with fertility, while yearly family income, good health and government transfers increased fertility. In a related study, Islam and Nesa (2009) used data from the Bangladesh Demographic Health Survey to investigate the role of education in fertility transition while controlling for other factors like wealth status, area of residence and region. Poisson regression methods were used. The study found that educated and wealthy women had lower fertility rates relative to their illiterate and poor counterparts. The study recommended compulsory higher education for women as a policy to lower fertility. Similarly, Sackey (2005) explored the effect of female education on fertility and labour force participation using the IV method of estimation and data from the Ghana used data from the Ghana Living Standards Survey Sackey (2005) found that education positively affected female labour participation, and had an inverse correlation with fertility, while increased real household assets increased fertility, and child survival was exogenous to fertility. None of the three studies (Aldieri and Vinci, 2011; Islam and Nesa, 2009; Sackey, 2005) controlled for potential endogeneity of wealth status/income/real household assets, and heterogeneity that may occur due to unobservables that impact fertility and but could also affect wealth status/income/ real household assets.

Weerasinghe and Parr (2002) explored the effect of household wealth on marital fertility in Sri Lanka using the Demographic and Health Survey data and logistic models. The results indicated that increased wealth and female labour participation lowered fertility. In an earlier study, Schultz (1994) examined the impact of welfare benefits on marital status and fertility in the United States using census data of 1980 together with OLS and Tobit models. The study controlled for wage opportunities faced by different women and their potential spouses. The results showed that increased female wages lowered fertility, but fertility increased with male wages. Weerasinghe and Parr (2002) and Schultz (1994) did not control for endogeneity of wealth status and welfare measures, and heterogeneity respectively.

Strulik and Sikandar (2002) estimated the income-fertility nexus by applying a nonparametric method of Kernel regression using data sets collected by Robert Barro and Jong-Wha Lee for 109 countries. For this dataset see (Barro and Lee, 1950-2010). The results revealed that there is a critical level of per capita income beyond which fertility falls exponentially as income increased. The study did not account for potential endogeneity of per capita income, and heterogeneity that may be due to unobservables affecting both fertility and per capita income.

Several studies focused on fertility without necessarily examining the effect of wealth on fertility (Brand and Davis, 2011; Breierova and Duflo, 2003; Carranza, 2012).

Using data from the National Longitudinal Survey of Youth in the United States, Brand and Davis (2011) investigated the effects of timely college attendance and completion on women's fertility. Multilevel Poisson and discrete-time models were used. The study found that fertility reduced with increased timely college attendance and completion. More still, as the socioeconomic status of women improved, their desire for college education increased and in turn fertility declined. In a related study, Breierova and Duflo (2003) used the IV method to investigate the impact of education on fertility and child mortality in Indonesia. Their study was based on data from the intercensal survey linked with administrative data on number of schools. The results showed that female education had greater impact on fertility and age at marriage than male education. Dissimilar from this thesis, Brand and Davis (2011), and Breierova and Duflo (2003) did not test for the effect of poverty on fertility.

Carranza (2012) examined the effect of property inheritance and expropriation on fertility behaviour and son preference among Muslim couples in Indonesia using Demographic and Health Survey data. The study employed the difference-in-difference estimation approach. The results indicated that relative to non-Muslims, Muslims had higher fertility rates, and greater preference for sons than daughters. The study recommended that Muslim rules on property inheritance should be extended to daughters as well in order to lower fertility; however, Carranza (2012) failed to treat fertility as a count variable.

2.2.2 Child Nutritional Status and Poverty

This section reviews literature on child nutritional status including studies that focused on the effect of wealth/income, and other key factors impacting child nutrition like children, parental, and community/environment characteristics.

In a study that focused on causes of health inequalities in Uganda, Ssewanyana and Kasirye (2012) explored the determinants of child nutritional status using pooled Demographic and Health Survey data for the period 1995-2006. They concluded that welfare proxied by log of asset index greatly affects the nutrition of children and health inequalities in the country. In addition, maternal education positively impacted child nutrition, while some child characteristics - being a multiple birth and male child, birth order and age, negatively influenced child nutrition. The study further found that community factors - use of modern contraception and source of drinking water (piped, borehole and unprotected spring water) positively affected child nutritional status. The study also found absence of non-linearities between child nutritional status and wealth after interacting sex of a child and mother's education with log of asset index. However, the study did not control for the possible endogeneity of wealth/income in the child nutrition models.

Ssewanyana (2003) and Lawson (2004) used the instrumental variable methods to control for potential endogeneity of income in the child nutrition model. Ssewanyana (2003) studied the determinants of food security and child nutrition among the urban poor in Uganda using cross sectional data collected from Kampala district, while Lawson (2004) examined the importance of income and other factors in determining children's health using the 1999 Uganda National Household Survey data. Both studies concluded that increasing income would improve the nutritional status of children. Similar to Ssewanyana and Kasirye (2012), Ssewanyana (2003) and Lawson (2004) also found that child characteristics - age of a child, birth order, multiple birth children and being a male child negatively affected child nutrition.

Household and parental characteristics such as maternal education and height lowered child malnutrition. Ssewanyana (2003) showed that community factors - distance to public clinic and food prices negatively impacted child nutrition. These studies however, did not analyze the probability of a child being stunted, though they examined height-for-age Z-scores. The study by Ssewanyana (2003) was not nationally representative as it covered only Kampala district.

Other studies in Uganda which were not nationally representative include those by Vella et al. (1992); Wamani et al. (2005) and Kikafunda et al. (1998). The studies investigated determinants of child nutrition in North-West, Western and Central Uganda respectively using cross sectional data collected from each study region. Using stepwise multiple regressions, Vella et al. (1992) found that use of unprotected water sources, breast feeding and age of a child were inversely correlated with child nutritional status, while parental education greatly improved child nutrition. Like the earlier reviewed child nutrition studies in Uganda; Wamani et al. (2005) using logistic models, also showed that mother's education improved child nutrition, age of a child and being a male child were inversely correlated with child nutrition. Similar results were found by Kikafunda et al. (1998) except that the author never included sex of a child in the analysis. Vella et al. (1992) did not include a measure of income/welfare in their analysis, and Wamani et al. (2005) and Kikafunda et al. (1998) did not control for its possible endogeneity of wealth index/socioeconomic status, and for heterogeneity due to unobserved determinants of child nutritional status.

Mackinnon (1995), focused on the determinants of child mortality and malnutrition in Uganda using the 1992 Integrated Household Survey. The results indicated that post-primary education significantly explained child mortality and height-for-age. However, potential endogeneity of income, and heterogeneity were not controlled for in the child nutrition models. Using two datasets separately i.e. the Uganda Demographic and Health Survey (UDHS), and Uganda National Household Survey (UNHS), Bahiigwa and Younger (2005) studied children's health status in Uganda. First, the authors used pooled UDHS data for the period 1988-2000 and an OLS method to model trends and determinants of child height. Second, they utilized the 1999 UNHS data and an IV model to examine the effect of plan for modernization of agriculture (PMA) on height-for-age. The study concluded that improved welfare and maternal education, and use of health care services like vaccination reduced child malnutrition. The study also showed that child age, civil conflict in some parts of the country and reliance on own production by a household negatively affected child nutrition. In their first objective, Bahiigwa and Younger (2005) did not account for potential endogeneity of wealth index. In addition, for both objectives, heterogeneity in the poverty-child nutrition nexus was not accounted for.

Harttgen et al. (2012), used pooled Demographic Health Survey data and logistic models to explore the relationship between economic growth and the probability of a child being stunted in Africa including Uganda. Their study found that income growth reduced the probability of being under weight and stunted. The study showed that child nutrition is positively affected by mother's education and her nutrition, and wealth index (socio-economic status of a household). The study recommended economic growth as a long run policy and its benefits to be directed to children and the needy in low income countries. In another study, Bbaale (2014) examined the relationship between maternal education and the probability of a child being stunted using UDHS data for 2006 and probit models. The study found that maternal education especially at post-secondary level reduced the likelihood of a child being stunted, while children of working mothers were more likely to be stunted compared to their counterparts of non-working mothers. Turi et al. (2013) examined determinants of underweight, overweight and obesity in women and children in Uganda using data from UDHS of 2011; the OLS and multinomial logit models coupled with Arc GIS statistics. Results indicate that women suffering from obesity and overweight were more likely to bear overweight children, and that being wealthy and residing in urban areas was highly correlated with being overweight. Although both Harttgen et al. (2012); Bbaale (2014) and Turi et al. (2013) tested for the effect of wealth index on child nutrition, they did not account for its potential endogeneity, and heterogeneity that may arise from unobservable determinants of child nutritional status.

Mugo (2012) used data from the Kenya Integrated Household survey 2005/2006, the instrumental variable method and the control function approach to examine the impact of parental socioeconomic status on child nutrition (height-for-age Z-scores and weight-for-age Z-scores). The study found that maternal labour force participation positively but insignificantly affects child nutrition; while maternal education negatively impacts child nutrition. In addition, age of a child negatively affected child nutrition and being married improved child nutrition. Results further showed that maternal labour force participation and maternal education are endogenous to child nutritional status. However, the study did not test for the effect of wealth status/income on child nutritional status.

In an earlier study on Kenya, Kabubo-Mariara et al. (2009b) used a pooled sample of the 1998 and 2003 Demographic and Health Survey data to investigate the determinants of children's nutritional status in Kenya. The study used descriptive analysis, reduced form models, and policy simulations to explore the correlation between child nutritional status and its determinants. The results showed that wealth index is an important determinant of child nutritional status. Similar to various studies, the study indicated that boys suffer more malnutrition than girls and that children of multiple births are more likely to be malnourished than singletons. The results further revealed that maternal education is a key determinant of children's nutritional status. The study recommended improvement in welfare, promotion of post-secondary education for women and provision of basic preventive health care to lower child malnutrition. However, the study did not account for potential endogeneity of wealth index, and the effect of unobservable determinants of child nutrition and wealth index.

Kandala et al. (2008) used geo-additive regressions in Malawi, Tanzania and Zambia to examine geographical and socioeconomic factors affecting child malnutrition. A similar study was carried out in Democratic Republic of Congo by Kandala et al. (2011). Further, Takele (2013) used the Bayesian Semi-parametric regressions in Ethiopia to investigate factors influencing child nutrition. The three studies used data from the Demographic and Health Survey (DHS) and results indicated that child characteristics, maternal education, wealth index and area of residence were important determinants of child health. Kandala et al. (2008; 2011) and Takele (2013) did not account for potential endogeneity of wealth index.

Abalo (2009) correlated the non-monetary wealth and socio-demographic characteristics of households with child nutritional status in Togo using data from the Demographic and Health Survey conducted in 1998. The instrumental variable (IV) and fixed effects methods were used to control for potential endogeneity of wealth index in the child nutrition model. Results indicated that the age of the child, assets/wealth of the household, mother's education and community facilities and infrastructure are important determinants of child nutrition. The study suggests that the composite wealth index may be endogenous to child nutritional status. In a related study, Masiye et al. (2010) used multivariate method and the national cross-sectional survey data of 2006 to examine the determinants of child nutritional status in Zambia. Household expenditure, a proxy of income/poverty was found to be the key determinant of child nutrition. The results further showed that parental education improved child nutrition, and age of children and rural residence negatively affect child nutrition. Potential endogeneity of per capita expenditure was controlled for, and the results suggested that per capita expenditure was actually exogenous. The study recommended giving direct nutritional interventions to disadvantaged groups and areas as a measure of lowering child malnutrition. The two studies (Abalo, 2009; Masiye et al., 2010) did not model the probability of a child being stunted, although they explained height-for-age as a continuous variable.

Babatunde and Martinetti (2010) used the instrumental variable approach and micro-level household survey data to analyze the effect of income (remittances) on food security and child nutritional status in rural Nigeria. The study found that an increase in remittance income increased calorie consumption but had no effect on child nutritional status. The study also found that mother's education, having a toilet and farm size positively affected child nutrition, and older children were more malnourished than their younger counterparts. The study recommended incorporation of remittances into the development policies because remittances are important for food security. The incorporation would allow income from remittances to improve child/household nutritional status; as it appeared that remittances had been only extended to provision of household calorie and not to meeting requirements of child nutrition. The study was not nationally representative as it concentrated on rural areas.

Strauss (1990) analyzed the determinants of child nutrition outcomes (height-for-age and weight-for-height) using household level panel data in rural Côte d'Ivoire. Multivariate analyses are conducted to estimate fixed and random effects models. The study found that mother's age, maternal education, wage rate and being a child of a senior wife positively affected child nutrition. The results also showed that older children, poor quality health services and distant health facilities/schools increased child malnutrition. The study concluded that living standards or welfare and parental education needed to be improved to achieve better child nutrition. The study differs from this thesis as it used land per adult to measure wealth status. Garcia and Alderman (1989) also investigated the patterns and determinants of child nutritional status in rural Pakistan using household data collected by the International Food Policy Research Institute. The IV method was used to control for potential endogeneity of income in the child nutrition model. The results indicated that income per capita positively influenced height-for-age and weight-for-height. The study also found that mother's education and height, breast feeding and giving birth at a hospital improved child nutritional status. Other results showed that age of a child, household size and having illnesses like diarrhoea increased child malnutrition. Thus to improve child nutrition, the study suggested improvement in incomes, mother's education, environmental and sanitation characteristics. A related study by Haddad et al. (2003), explored the response of child nutrition (weight-for-age z-scores) to income growth using household data for 12 countries also using the IV approach. Like most studies on child nutrition, the study found that increased income improved child nutritional status. The results also showed that mother's height and education positively influenced child nutrition. The study recommended that a balanced income growth strategy coupled with provision of direct interventions would reduce child malnutrition. Different from this thesis, Strauss (1990); Garcia and Alderman (1989) and Haddad et al. (2003) did not also explain child nutrition using the probability of a child being stunted. In addition, Strauss (1990); Garcia and Alderman (1989), only focused on rural areas rather the whole country.

Horton (1988) analyzed the impact of birth order on child nutrition in Philippines using household panel survey data. Fixed and pooled regressions were estimated. The results indicated that birth order negatively affected height-for-age, and household assets (wealth) positively impact child nutrition. The results further showed that age of a child was inversely correlated with child nutrition. The study also showed that parental height and having piped water positively impacted children's nutrition. Horton (1988) concluded that the impact of birth order was greater on height-for-age Z-scores than on weight for height Z-scores. The study recommended that family planning would reduce family size, and education would lower inequality in income and human resources. Horton's study neither explained child nutrition using the probability of a child being stunted nor did it control for the possible endogeneity of assets/wealth/income.

2.2.3 Child Nutritional Status, Poverty and Gender of Household Head

Literature tend to associate female-headed households (FHHs) with high poverty levels; or to take FHHs as pointers of poverty especially in developing countries (Buvinić and Gupta, 1997; Rajaram, 2009). In turn, this perception has resulted in research on the impact of gender of household head on child nutritional status; but focusing specifically on comparison between FHHs and male-headed households (MHHs).

The literature on the link between gender of household head and nutritional status of children has shown inconsistent results from different parts of the world, probably because of different approaches used (Buvinić and Gupta, 1997; Engle, 1997).

On the one hand, various studies have shown that nutritional status for children from FHHs may be better than their counterparts from MHHs. Bomela (2007) for instance, examined the relative effect of household characteristics on child nutrition in South Africa using data from the Living Standards and Measurement Survey. The study concluded that chronic malnutrition is higher in MHHs than FHHs. The results also showed that child nutrition is directly affected by household socioeconomic status measured by housing types (formal and informal dwellings) which were considered to be good proxies of economic status of a household. Bomela (2007) further showed that a child's age, being a male child and large sized households negatively affected child nutrition. This study suggested regular and continual national nutritional surveillance of all households to lower malnutrition in children. Despite the fact that Bomela (2007) included a proxy variable for poverty/expenditure and categorized it as socioeconomic status, the study did not take into account the possibility that this socioeconomic status variable could be potentially endogenous in the child nutrition model. The study also did not account for possible heterogeneity that may occur from unobservable factors affecting socioeconomic status but may also impact child nutrition.

Rogers (1991) investigated whether FHHs and MHHs had different expenditure preferences on basic needs which in turn would affect children's nutritional status in Dominica Republic. Multivariate analysis and data from income, expenditure and food consumption household survey of 1986 were employed. The study found that child nutritional status in FHHs was equal or even better than in MHHs. The study showed that relative to MHHs, FHHs depended more on income transfers than their own earnings for survival. The gender of the household head impacted child nutrition through differences in the characteristics of each type of household, e.g. those related to food expenditure and diet. The study therefore recommended that knowing the characteristics of FHHs and how they impact nutrition of children will improve child health. However, the study did not include an income variable in the child nutritional status models. The study instead assumed that the income effect would be captured through protein and calorie intakes.

In a related study, Kennedy and Peters (1992) examined the impact of gender of household head on nutritional status of children, using data on income and consumption from Kenya and Malawi. They found that despite the low income levels in FHHs, the nutritional status of children is better than that of children in MHHs where the income levels are higher. The study also found that child nutritional status was impacted by the interaction between income and gender of household head rather than just one of them. The results further showed that income under the control of women had an impact on caloric intake of the child. The study suggested that investment in children's nutrition through better feeding practices and nurturing behaviour would lower malnutrition. Despite the study's contribution, it did not attempt to control for endogeneity of income, and the effect of unobservables in the child nutrition model.

Kennedy and Haddad (1994) compared household income and child nutritional status (weight-for-age Z-scores) by gender of household head using data from Kenya and Ghana. Specifically, the probability of a child being underweight proxied as equal to 1 if the child's weight-for-age Z-scores fall below -2 standard deviations, and equal to zero otherwise was estimated using Probit models. The results showed that interaction of income and female headship improved child nutrition (in Kenya this result occurred at low income levels while in Ghana only at higher income levels). Child nutritional status in Kenya was found to be equal or even better in FHHs than MHHs (the opposite result was found in Ghana). The study further showed that per capita expenditure and maternal height negatively affected the probability of a child being underweight in Kenya and Ghana. The study found that being a male child was positively correlated with the probability of a child being underweight, but overall boys in FHHs were more likely to be underweight than boys in MHHs in Ghana. Mother's schooling in Ghana lowered the likelihood of a child being underweight. The study recommended that poverty eradication programs and provision of public health services would improve child nutritional status. The study only explained the likelihood of a child being underweight, but not the probability of child being stunted and height-for-age.

Some studies have found that child malnutrition may be higher in FHHs than MHHs. For instance, Onyango et al. (1994) explored the relationship between child nutritional status and gender of household head where they focused on the patterns of family income and decisions made in FHHs versus MHHs, using data collected in 1988 from Busia district in Western Kenya. The study found that children in FHHs were more likely to suffer from stunting (those whose HAZ-scores fall below -2 standard deviations) than in MHHs. However, Onyango et al. (1994) also showed that when measuring child nutritional status by weight-for-age Z-scores, children in FHHs were less likely to have lower weight than in MHHs. They recommended that adequate nutritional intakes and lower disease burden are crucial for improving child nutritional status. Haidar and Kogi-Makau (2009) investigated the nutritional status of preschoolers via the gender of household head using cross sectional data from North Ethiopia. They concluded that although both household types were exposed to similar poverty situations, the proportion of children suffering from chronic malnutrition was larger in FHHs than MHHs. They highlighted improved hygiene and feeding practices as interventions for lowering malnutrition. The studies by Onyango et al. (1994) and Haidar and Kogi-Makau (2009) were not nationally representative and they did not account for possible endogeneity and heterogeneity that might arise from unobserved determinants of child nutritional status.

2.3 Overview of the Literature

This chapter presents a review of theoretical and empirical literature relating to poverty and health status. The theoretical literature mainly discussed the theories, analytical and methodological frameworks that can be used to examine effect of poverty on health. For example, transition from high to low fertility rates and how to improve the health, nutrition and population outcomes of individuals are discussed. Most literature recommends the use of structural models to empirically deal with various estimation issues especially the possibility of reverse causality between health status and welfare. In addition, instrumental variable method is employed to handle estimation issues of endogeneity, and the control function approach to account for heterogeneity.

The empirical literature focused on studies for the effect of poverty on health status. Most studies used health indicators e.g. fertility and child nutrition on the one hand, and on the other hand welfare variables (e.g. asset/wealth index, income and household per capita expenditure) to investigate the link between health and poverty. The empirical literature review, further examined other determinants of health status. Most studies used cross-sectional and panel data sets, as well as various estimation methods - ordinary least squares (OLS), Poisson, Zero-Inflated-Poisson for fertility studies. The OLS, probit, logit, ordered probit model, fixed effect model, simultaneous models and non-parametric method of Kernel regression were used for child nutritional status. To account for potential endogeneity of welfare measure, most studies used the instrumental variable approach, while the control function approach was utilized to account for the effect of unobservables on health status that may also be correlated with welfare. Most of these studies found that household, child and community characteristics were highly correlated with health status. Although various studies suggested presence of endogeneity of welfare measures, and others found evidence of heterogeneity in health status, other studies seem to suggest that welfare indicators are exogenous.

While various studies have examined the causal link between health status and poverty, there are still gaps in the Ugandan literature. Such gaps include not accounting for the effect of poverty on health status; and not controlling for either endogeneity of poverty or heterogeneity in the health status-wealth relationship by some studies. Other studies did not treat fertility as a count variable, while most child nutrition studies did not focus on the probability of a child being stunted. In addition, there is a dearth of knowledge on whether the effect of poverty on child nutritional status varies by gender of household head. This thesis attempts to address these research gaps in the Ugandan context.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter presents the conceptual framework and theoretical model for analyzing the effect of poverty on health status. In this thesis, health status indicators are fertility (a measure of women's reproductive health) and child nutritional status (an indicator of child health). Poverty is proxied by wealth index of a household. The empirical model for estimating first, the effect of wealth index on fertility and second, the effect of wealth index on child nutritional status is also discussed in this chapter. We discuss the estimation issues of potential endogeneity of wealth index, and also heterogeneity that could arise from unobservable determinants of health status (fertility and child nutritional status) that may be correlated with wealth index. Variables used in the analysis, their measurement, data sources and types are also presented in this chapter.

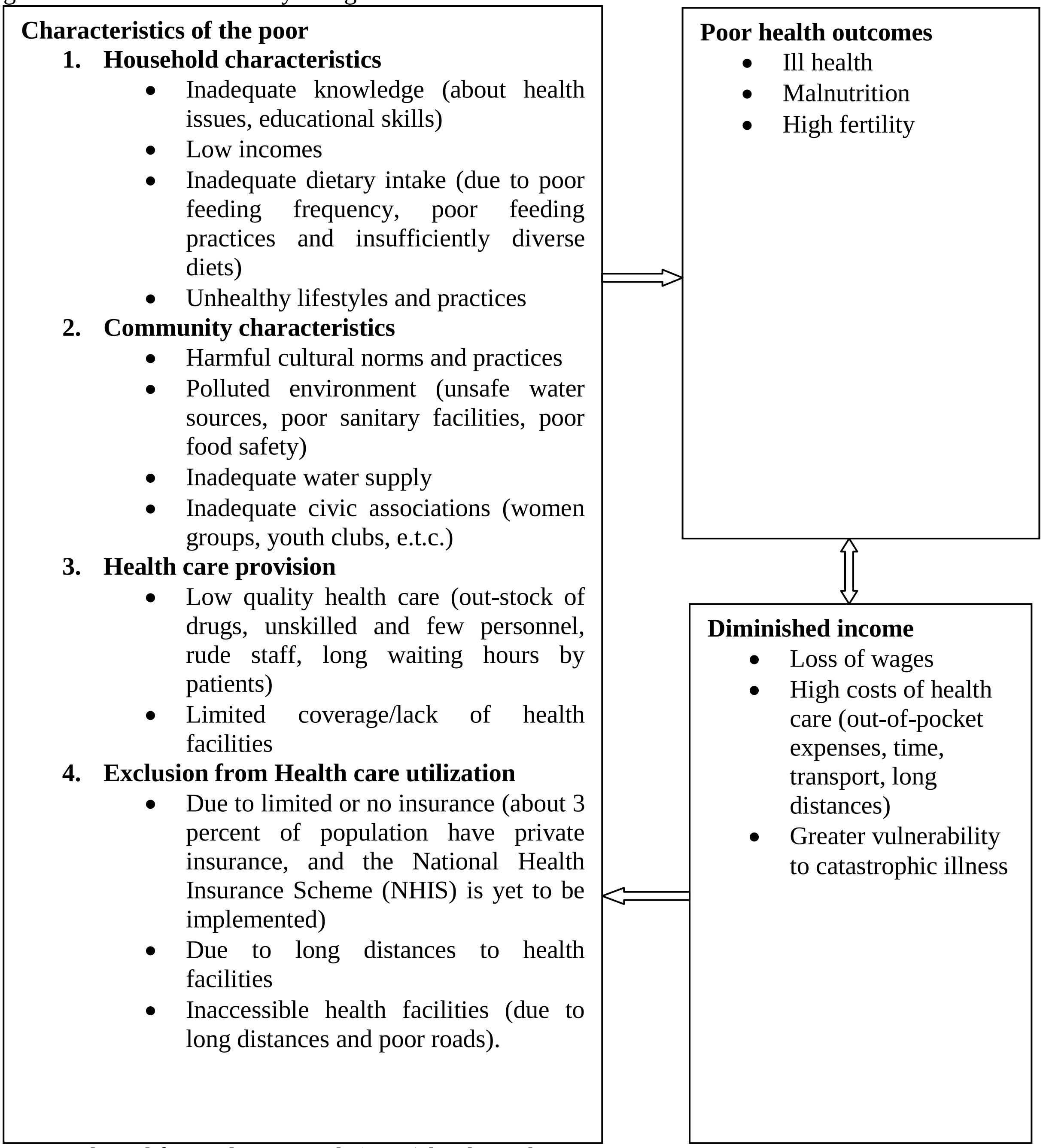
3.1 Conceptual Framework

This framework illustrates the causal links between health status of individual(s) and poverty. This thesis adopts the approach used by Claeson et al. (2001) who have shown that poverty is both a cause and consequence of ill health.

Poverty makes individuals/household to suffer from several deprivations which translate into poor health outcomes (figure 3.1). For instance, poor households/individuals have inadequate housing facilities, nutrient deficiencies and lack of knowledge on how to respond to health problems (Commission on Macroeconomics and Health, 2001). At community level, poverty makes individuals to practice harmful cultural norms, and also encounter challenges such as unclean water supply, inadequate sanitation and poor societal organization, which all may result in poor health outcomes Claeson et al. (2001). In addition, the health status of the poor is adversely affected by the provision of low quality health care services, reduced access to health care centers due to long distances, high transport costs and poor road networks. The health of the poor deteriorates faster than that of their richer counterparts because of exclusion of the poor from using health facilities as they lack insurance coverage and are faced with high out-of-pocket expenses.

In Uganda, the Health Sector Strategic Plan (HSSP) III contends that although public health services are generally free of charge, patients continue to pay fees under-the-counter in public health institutions. In addition, about 5 percent of households in Uganda experience catastrophic health expenditures and 2.3 percent are impoverished due to medical bills (Republic of Uganda, 2010a).

Figure 3.1: Health and Poverty in Uganda



Source: Adapted from Claeson et al. (2001) by the author

Conversely, poor health outcomes lead to loss of income, thus causing poverty. The unhealthy persons tend to be unproductive and may have fewer earning opportunities which in turn lower their income/wealth (Bloom and Canning, 2000). Furthermore, due to being unhealthy, the poor are constrained such that they lack financial ability to pay for health care services, food, clean water, good sanitation and other key inputs to produce good health

Claeson et al. (2001). Some households may sell off even their few productive assets like land in order to cover medical bills, thus forcing them deeper into poverty (Commission on Macroeconomics and Health, 2001).

3.2 Theoretical Framework

Following Rosenzweig and Schultz (1983) and Mwabu (2007), this thesis starts by considering a model with constrained maximization of a utility function based on the following assumptions: The household, run by a household head, has n members and it maximizes utility function (*U*). The utility function depends on consumption, health related goods and health status of all members, such that:

$$U = U(C, Z, H) \tag{1}$$

where C denotes the health neutral goods that have no direct effect on health status of household, i.e. it includes consumption commodities like clothing. Z denotes health related goods or behavior e.g. drinking, smoking, physical exercises, etc. The Z goods yield utility to the household but also affect its health. H denotes health status of the household.

The health status (H) is produced by a household (Mwabu, 2007), and the health production function can be expressed as:

$$H = f(Z, X, \mu) \tag{2}$$

where, X represents health inputs such as medical care services that affect household health directly and only enter the utility function through their effect on health; Z is defined as before; μ represents the component of household health due to unobserved factors like genetics or environmental conditions. These unobserved factors are known by the household but are not in its control. Note that Z and X are inputs that go into the health production function (2) and Z enters the utility function directly.

The household budget constraint for all purchased goods is expressed as follows:

$$M = CP_C + ZP_Z + XP_X \tag{3}$$

Where: M is the exogenous income for the household; P_C is the price of health neutral goods (C); P_Z is the price of health related consumer goods (Z); and P_X is the price of health inputs like medical care services (X) respectively. From equations (1) and (2), the health input (X) is purchased for improving household health, hence X only enters the utility function through H, the household production function for health. The budget constraint in equation (3) can be modified to include non-market goods.

Following Mwabu (2007), and Ajakaiye and Mwabu (2007), the household's reduced demand functions for non-health related goods *C* and health inputs (*Z* and *X*), are obtained by maximizing utility (1) given the health production function (2), and subject to the budget constraint (3). The resulting reduced form health demand functions for *C*, *Z* and *X* are expressed as:

$$C = D_C(P_C, P_Z, P_X, M, \mu) \quad (4.1)$$

$$Z = D_Z(P_C, P_Z, P_X, M, \mu) \quad (4.2)$$

$$X = D_X(P_C, P_Z, P_X, M, \mu) \quad (4.3)$$

The resulting reduced form demand function for the health outcome may similarly be expressed as follows:

$$H = \phi(P_C, P_Z, P_X, M, \mu) \quad (5)$$

From equations (4.1) to (5), the entire set of prices enters the demand function for each and every good.

3.3 Empirical Model

Health Status and Poverty

Health status and poverty may be interrelated or jointly determined. Poor health reduces income earning opportunities for individuals/households thus leading to poverty. Poverty reduces one's ability to purchase health inputs like medical care and nutritious foods which in turn negatively impacts one's health status (Fuchs, 2004). Poverty also makes women unable to access or afford family planning services and this may translate into high fertility and low child spacing (Bbaale and Mpuga, 2011). Conversely, high fertility is likely to lower women's participation in income earning activities since they have to devote more time to child care and other household chores. In turn, women's inability to work, limits their income earning opportunities which may translate into poverty (Schultz and Mwabu, 2003; Chun and Oh, 2002). In addition, the poor are less able to invest in the health of their children. For instance, they are less likely to afford sufficient nutritious food intakes for all their children and thus these children become malnourished (Bloom and Canning, 2000). Due to malnutrition, the cognitive development of children, and their education attainment later in adult life are adversely affected. This deficiency in the growth and development of children may limit their income earning opportunities, and thus these children may remain poor as adults (Kabubo-Mariara et al., 2012; Harttgen et al., 2012).

The general relationship between health status and poverty is summarized following Mwabu (2007), Kabubo-Mariara et al. (2009a) and Bhasin et al. (2010) as follows:

$$H = \delta_h W_1 + \beta M + \varepsilon_1 \tag{6}$$

$$M = \delta_M W + \varepsilon_2 \tag{7}$$

where H is health status of the individual and M is the poverty indicator (wealth index). W_1 is a vector of exogenous variables while W is a vector of variables consisting of W_1 covariates that belong to the health status observed equation and a vector of instrumental variables W_2 that affect poverty (wealth index) without directly impacting health status. δ and β are vectors of parameters to be estimated while the ε_1 and ε_2 are error terms.

Fertility and Poverty

To estimate the effect of poverty on fertility (a proxy for reproductive health of women), first, we assume that wealth index is exogenous in the fertility model and thus equation (6) is estimated using the OLS and Zero-Inflated-Poisson (ZIP) methods. The ZIP model helps to account for two specificities of fertility: first, it is a count variable-discrete, positive with limited range, and second many childless women may be in the dataset which would result into excess zeros. Following Baundin (2008); Cameron and Trivedi (2005), and Erdman et al. (2008), the ZIP model for fertility is specified following a Poisson distribution, with the probability of having $y_i = n$ children ever born expressed as:

$$P_r\left[y_i = n \mid b_i\right] = \frac{e^{-\omega_i}\omega_i^n}{n!}, \; n = 0,1,2,........ \tag{8}$$

where ω_i is mean parameter and b_i are the covariates of fertility in period i (see Erdman et al., 2008). Baundin (2008) argues that individual fertility data often show an excess of zero observations. Therefore it is best to apply count data models that account for those excess zeros while studying fertility. The starting point for estimating count variables is the Poisson model. This model is derived from the Poisson distribution by parameterizing the correlation between the mean ω_i and the independent variables b_i using the exponential mean expressed as:

$$\omega_i = \exp\left(b_i \pi\right) \tag{9}$$

The Poisson model is usually criticized as it assumes that the variance and the mean are equal, yet in reality they are not, i.e. for count data, the variance often exceeds the mean, a term called overdispersion. Compared with the Poisson, the ZIP model allows modeling excess zeros in a dataset, in addition to accounting for overdispersion (Cameron and Trivedi, 2005; Erdman et al., 2008).

In other words, the ZIP model simultaneously estimates the number of children born with a Poisson model, and the choice of not having children using a logit model (Baundin, 2008). The probability that a woman belongs to the group with zero counts $\left(G^0\right)$ is given by a logit model as follows:

$$\Omega_i = \frac{e^{\varphi_i \rho_i}}{1 + e^{\varphi_i \rho_i}} \tag{10}$$

where ρ_i are independent variables that affect the decision to have children and φ_i are parameters to be estimated. A woman belonging to the zero group $\left(G^0 = 1\right)$ has her fertility always equal to zero, while the woman not in the zero group $\left(G^0 = 0\right)$ with the probability equal to $1 - \Omega$, has her fertility distributed following a Poisson distribution.

It is important to note that the assumed ZIP distribution for fertility as a count variable is different from the standard Poisson model, on the one hand with the overall probability for a zero count expressed as follows:

$$P_r\left[y_i = 0 \mid b_i, \rho_i\right] = \Omega_i + \left(1 - \Omega\right) P_r\left[y_i = 0 \mid b_i, G^0 = 1\right] \tag{11}$$

On the other hand the probability for a woman having a positive count is expressed as follows:

$$P_r\left[y_i = n > 0 \mid b_i, \rho_i\right] = \left(1-\Omega_i\right) P_r\left[y_i = n > 0 \mid b_i, G^0 = 0\right] \tag{12}$$

Equations (11) and (12) make up the Zero-Inflated-Poisson model, such that during the estimation process, equation (11) becomes a logit model and (12) is the modified Poisson model (Cameron and Trivedi, 2005). Equation (12) increases the chances of having zero counts relative to a standard Poisson regression model. Since the standard Poisson and ZIP models are not nested, they cannot be used to decide whether the distribution really has excess zeros, thus a Vuong (1989) test is often run to choose between the standard Poisson and the ZIP model.

Child Nutritional Status and Poverty

Equations (6) and (7) are further estimated for child nutritional status. We estimate the effect of wealth index on height-for-age Z-scores (HAZ), and on the probability of a child being stunted. We further test whether the effect of wealth index on child nutritional status varies by gender of household head. First we assume that wealth index is exogenous to child nutritional status, such that we estimate an OLS model to analyze the effect of wealth index on HAZ, and a probit model to test for the effect of wealth index on the probability of a child being stunted.

The probit model is derived and specified following Schmidheiny (2012); Cameron and Trivedi (2005) and Wooldridge (2002). The probability of a child being stunted is a binary response variable denoted as S_i taking on two possible outcomes 0 and 1, and, we specify it as follows:

$$S_i = \begin{cases} 1 \; if \;\; HAZ \;\; is < -2 \; standard \;\; deviations \\ 0 \; otherwise \end{cases} \tag{13}$$

We consider a sample of independently and identically distributed (iid) observations i.e. $i = (1, ..., N)$ of the probability of a child being stunted (S_i) - a dependent dummy variable, and a $\left(K+1\right)$ dimensional vector $r_i^{'}$ of explanatory variables comprising of a constant. The probability that the dependent variable takes on a value 1 is expressed as:

$$P\left(S_i = 1 \mid r_i\right) = F\left(\mho_i\right) = F\left(r_i^{'}\tau\right) \tag{14}$$

where τ is a $(K+1)$ dimensional column vector of parameters and $\mho_i = r_i^{'}\tau$ is a single linear index. The transformation function F maps the single index into $[0,1]$ and satisfies the following in general $F(-\infty)=0$, $F(\infty)=1$, $\partial F(\mho)/\partial\mho > 0$. The probit model assumes that $F(\bullet)$ is a cumulative density function with a standard normal distribution. The response probability is given as:

$$P(S_i = 1 | r_i) = \xi\left[r_i^{'}\tau\right] = \int_{-\infty}^{r_i^{'}\tau} \varphi(t)dt = \int_{-\infty}^{r_i^{'}\tau} \frac{1}{\sqrt{2\Pi}} e - \frac{1}{2}t^2 dt \tag{15}$$

where $\varphi(\bullet)$ is the probability density function (pdf) and $\xi(\bullet)$ is the cumulative density function of the standard normal distribution.

The probit model is derived from a latent variable S^* which is not observed by the researcher but linearly depends on r_i. The latent/unobserved probability of a child being stunted (S^*) model is specified as a function of both explanatory variables (r_i) and the error term (u_i), such that;

$$S_i^* = r_i^{'}\tau + u_i \tag{16}$$

To estimate equation (16), the expected value of the error term given the independent variables is assumed to be zero i.e. $E(u_i)=0$. Linking the observed variable S with the latent variable S^* (Awiti, 2013), implies that the researcher can only observe choice S_i and therefore an individual child is considered stunted when, $S_i = 1$ where the latent variable is positive, and zero otherwise. The resulting probability of child being stunted as an observed binary variable is expressed as: $S_i = 1$ if $S_i^* > 0$ and 0 if $S_i^* \leq 0$.

In this thesis, the probability of a child being stunted is such that $S_i = 1$ implying a child is stunted when his/her HAZ-scores are <-2, and otherwise for a child who is not stunted i.e. $S_i = 0$. The independent variables are assumed to be exogenous and the error term is normally distributed and homoskedastic i.e. $u_i | r_i N \sim (0, \sigma^2)$. The probability of a child being stunted $S_i = 1$ can now be derived from the latent variable and the decision rule as follows:

$$P\left(S_i = 1 | r_i\right) = P\left(s_i^* > 0 | r_i\right) = P\left(r_i^{'}\tau + u_i > 0 | r_i\right) \quad (17.1)$$

$$P\left(S_i = 1 | r_i\right) = P\left(u_i > -r_i^{'}\tau | r_i\right) = 1 - \xi\left(-r_i^{'}\tau | \sigma\right) \quad (17.2)$$

$$P\left(S_i = 1 | r_i\right) = \xi\left(r_i^{'}\tau | \sigma\right) \quad (17.3)$$

Equations (17.1) and (17.2) are simplified to get equation (17.3). Using maximum likelihood method, equation (17.3) - the probit model is estimated as the probability of a child being stunted. The marginal effects are derived as follows:

$$ME = \frac{\partial E(S_i | r_i)}{\partial r_i k} = \frac{\partial\left(S_i = 1 | r_i\right)}{\partial r_i k} = \varphi\left(r_i^{'}\tau\right)\tau k \quad (18)$$

3.3 Estimation Issues

Two issues arise from the estimation of equations (6) and (7) - endogeneity and heterogeneity.

Endogeneity

Endogeneity can be defined as a situation where an independent variable is correlated with the disturbance term of the model, and it may arise from three sources. First, omitted variables where because of data limitations, the researcher may not include the unobserved variables in a regression model. Second, endogeneity may arise from measurement error such that a researcher includes an imperfect measure of variable in the regression model, instead of its true measure (Wooldridge, 2002). Third, endogeneity due to reverse causality - occurs when the explained variable impacts the independent variable, or at least one of the explanatory variables is jointly determined with the dependent variable (Epstein et al., 2009; Centorrino, 2013).

From equation (6), the poverty measure (M) is potentially endogenous to health status (H) though it is treated as a choice variable, it could be affected by health status (see equation 6). In this thesis, endogeneity of poverty could occur because of reverse causality of health status and poverty. On the one hand, household health status may affect poverty as improved health is likely to increase household productivity and in turn raising income thereby reducing poverty. On the other hand, high income gives greater command over health promoting goods (Bloom and Canning, 2000). In the fertility-poverty relationship, endogeneity would arise from the fact that extra children would supplement family labour (especially in agriculture or small-scale labour-intensive production) thereby increasing household income, thus lowering poverty. Alternatively, poverty may arise from reduced income earning opportunities of mothers who now have to devote more time to give care to each additional child (Bhasin et al., 2010). Endogeneity in the child nutritional status-poverty relationship may result from a vicious circle where poor parents' incapacity to provide nutritious and abundant food to their children, may then end up in such children being malnourished. Consequently, chronically malnourished children more frequently suffer from infectious diseases compared to their well-nourished counterparts. In turn, parents' wealth status is lowered since as caregivers they now allocate less time to income generating activities (Masiye et al., 2010).

Due to endogeneity, instrumental variables are used so as to consistently estimate the effect of poverty (M) on health status (H). The instruments should influence poverty without directly affecting health status (Bhasin et al., 2010). In this thesis, we use different instruments for wealth index. For the fertility-poverty relationship, wealth index is instrumented for using time to water source, distance to NGO facility and distance to most common agricultural input market. The instrumental variables for wealth index in child nutritional status model include - distance to feeder roads, distance to telephone facility and time spent to water source. Finally, for the effect of wealth index on child nutritional status by gender of household head, we use distance to telephone facility and time spent to water source.

Heterogeneity

Heterogeneity in the health production function could arise from the presence of exogenous health factors that can be known to the individual but unobserved by the researcher. Bias may arise from unobserved characteristics, preferences and endowments of members of a household that affect the choice of their health inputs, but are also correlated with the health outcome (Kabubo-Mariara et al., 2009a). In this thesis, heterogeneity is likely to arise from first: women/community desire to have large/small families which may only be known to the individual/community but not observed by the researcher (Angeles et al., 2003). Second it could arise from unobserved community characteristics that are correlated with poverty as well as child nutritional status (Kabubo-Mariara et al., 2009b). For instance, cultural beliefs and perceptions in some communities may influence the feeding and nurturing practices of children. Such cultural factors may include food taboos and beliefs on when and how to introduce complementary foods in the diet of children which can translate into malnutrition (Mwangome et al., 2010; Engle 2002), but these beliefs are unobserved by the researcher (Liu et al., 2007). Failure to control for heterogeneity would lead to biased estimates. To account for heterogeneity, the control function approach (CFA) is used. The CFA involves a reduced form health equation expressed as follows:

$$H = \alpha_0 + \delta W_1 + \beta M + \alpha_1 \nu + \lambda(\nu M) + \psi \qquad (19)$$

Where, ν are the fitted residuals from the reduced form OLS poverty model, which is explained by W_1. $\alpha_1 \nu$ captures the non-linear indirect effects of poverty (M) on health status (H), since the residuals (ν) control for the unobserved factors that impact health status (H). νM is the interaction of the fitted residuals of poverty with the actual/observed value of poverty. Introducing the residuals (ν) and the interaction of residuals with the observed poverty (νM) in equation (19), accounts for the effects of unobservable factors that would bias the estimated parameters of the structural model (Ajakaiye and Mwabu, 2007). ψ is a composite error term comprising ε_1 and the predicted ε_2 with the assumption that E(ε_1) = 0 ; δ , β , α and λ are parameters to be estimated. All other variables are as defined before.

The Ordinary Least Squares (OLS) method is used to estimate a reduced form poverty model (i.e. equation 7), where the potentially endogenous explanatory variable poverty (M) is regressed on (W) a vector of all exogenous variables consisting of covariates (W_1) belonging to the health status (H) model, and (W_2) the instrumental variables for poverty. The OLS coefficient estimates from the reduced form poverty regression are used to derive the fitted residuals for (M). The fitted residuals (v) are computed by getting the difference between the observed and the fitted values of poverty. The fitted residuals serve as a control for unobservable variables which are correlated with poverty (Ajakaiye and Mwabu, 2007; Kabubo-Mariara et al., 2009a). The OLS method is also used to estimate equation (19) while accounting for heterogeneity.

In case the unobserved components are not mean-independent of the instrumental variables, more control variables can be included in the health status equation. The addition of more control variables ensures that the conditional expectation of unobserved components, are still linear functions of wealth index residuals. To account for the effects of neglected non-linear interactions of unobserved factors, with correlates of health status, interaction terms (more controls) are introduced (Kabubo-Mariara et al., 2009a). This thesis further accounts for potential heterogeneity by including more control variables i.e. the interaction of the wealth index residuals with each of the woman education dummies, and the interaction of wealth index residuals with current age of a woman. Equation (19) with additional control variables becomes:

$$H = \lambda + \theta W_1 + \phi_0 M + \phi_1 \nu + \phi_2(\nu M) + \phi_3(\nu \Pr im) + \phi_4(\nu Sec) + \phi_5(\nu Post) + \phi_6(\nu Age) + \psi \quad (20)$$

The W_1 covariates for fertility include woman's characteristics (age, education, religion and marital status), area and region of residence. The W_1 explanatory variables for child nutritional status comprise child characteristics (sex of the child, child of multiple birth, birth order, age of a child), maternal and household characteristics (mother's age, sex of household head, size of household, age of household head, mother's education, marital status), professional care at birth as a community characteristic, and area and region of residence. $\nu \Pr im$ is the interaction of wealth index residuals with woman's primary education, $vSec$ is the interaction of wealth index residuals with woman's secondary education, $vPost$ is the interaction of wealth index residuals with woman's post-secondary education and $vAge$ is the interaction of wealth index residuals with the current age of the woman. θ, ϕ_0 to ϕ_5, are parameters to be estimated.

In this thesis, equations (19) and (20) are estimated for fertility and child nutritional status measures of health status. We use the OLS method to estimate equations (19) and (20) for fertility, while the OLS and probit models are estimated for child nutritional status.

3.4 Description and Measurement of Variables

Dependent Variables

Fertility: This thesis measures fertility as the total number of children ever born to a woman in a household following Ainsworth et al. (1996); Lam and Duryea (1999); Kabubo-Mariara et al., (2009a); Bbaale and Mpuga, (2011); Shapiro and Tambashe, (1997); and Schultz, (1997).

Child Nutritional Status: This thesis measures child nutritional status using first height-for-age Z-scores (HAZ) following Ssewanyana (2003); Kabubo-Mariara et al. (2009b); Abalo (2009) and Strauss (1990). Second this thesis uses the probability of a child being stunted as an indicator of child nutritional status following Kabubo-Mariara et al. (2009b) and Harttgen et al. (2012). The height-for-age Z-scores (HAZ) is a long term measure of child nutritional status (Ssewanyana, 2003). The HAZ indicator suggests that stunted children are those who are shorter than expected for their age and gender cohorts in the reference population because of past chronic nutritional deficiencies (Sahn and Stifel, 2002). In other words, a child is said to be stunted or to suffer from chronic malnutrition if his/her height-for-age Z-scores falls below -2 standard deviations from the median of the reference population (Uganda Bureau of Statistics and Macro International Inc., 2007). The Z-score is defined as Z-score $= \frac{T_i - T_{median}}{\sigma_T}$, where T_i is height for child i and T_{median} is the median height for a healthy and well nourished child from a reference population of the same age and gender. σ_T is the standard deviation from the mean of the reference population (Sahn and Stifel, 2002).

Explanatory Variables

Poverty: This thesis measures poverty using the wealth/asset index following Filmer and Pritchett (2001); Schoumaker (2004); Wandel and Holmboe-Ottesen (1992); Fotso and Kuate-Defo (2005) and Stifel et al. (1999). This index has several characteristics - first, the wealth index is a better measure of permanent welfare or economic well-being of a household than income or expenditure. Second, the wealth index serves as an alternative indicator for welfare but not simply a proxy for income/expenditure (Rutstein and Johnson, 2004; Sahn and Stifel, 2000). Third, since this thesis uses data from the Uganda Demographic Health Survey (UDHS) which contains information on household assets/characteristics and not on expenditure or income, the wealth index is the only option to measure welfare (Uganda Bureau of Statistics and Macro International Inc., 2007). In this thesis, the wealth index scores have been adjusted to account for the negative and zero values such that no household has zero assets.

Explanatory Variables for the Fertility Model

The fertility model covariates are mainly women's and household characteristics. The women's characteristics are current age of the woman, education level (primary, secondary, post-secondary and no education as the reference), marital status (currently married, divorced/separated/widowed and never married as the reference) and religion (Catholic, protestant, Muslim and Pentecostals/SDA/others as the reference) which captures the effects of socio-cultural beliefs and customs. The household characteristics are area of residence (rural = 1 and 0 otherwise) and regional dummies (Central, Eastern, Northern and Western as the reference)[1]. Table 3.1 summarizes the variables for the fertility model, their expected signs and literature source.

Table 3.1: Summary of the Variables for the Fertility Model

Description	**Expected sign**	**Literature source**
Explanatory variables		
Wealth index	(-)	Ainsworth et al. (1996); Schoumaker (2004); Weerasinghe and Parr (2002)
Current age of woman	(+)	Ainsworth et al. (1996); Bhasin et al. (2010); Mwabu and Schultz (2003); Baundin (2008)
Current age of woman squared	(-)	Ainsworth et al. (1996); Bhasin et al. (2010); Mwabu and Schultz (2003)
Rural residence = 1 (zero otherwise)	(+)	Ainsworth et al. (1996); Mwabu and Schultz (2003)
Woman's education	(-)	Ainsworth et al. (1996);Lam and Duryea (1999); Bhasin et al. (2010); Mwabu and Schultz (2003); Shapiro and Tambashe (1997)
Regions of the Country (Western = reference category)		Bbaale and Mpuga (2011)
Central	uncertain	
Eastern	uncertain	
Northern	uncertain	
Marital status (Never married= reference category)		Shapiro and Tambashe (1997)
Married	(+)	
Divorced/separated/widowed	(+)	
Religion (Pentecostals/SDA/others = reference)		Schultz (1997); Shapiro and Tambashe (1997); Bbaale and Mpuga (2011)
Catholic	(+)	
Protestant	(+)	
Muslim	(+)	

Source: Author's own construction based on previous literature.

[1] The regional dummies in this thesis are based on the UNHS classification – Central, Eastern, Northern and Western. Note: The UDHS classification has nine regions: Central 1, Central 2, Kampala, East Central, Eastern, North, West Nile, Western and Southwest. The North sub regions were also included in the UDHS to capture internally displaced persons (IDPs) and Karamoja areas.

Explanatory Variables for the Child Nutritional Status Model

The explanatory variables for the child nutritional status model include: Child, maternal, household and community characteristics. The child characteristics are age in months, sex (male = 1 and 0 otherwise), multiple birth child and birth order. The sex variable reflects the gender differences of the children in the sample. The maternal characteristics are mother's age, mother's education, mother's height and marital status. Mother's education depicts the child care practices like breast feeding and hygiene. Mother's height captures the genetic and family background effects that are not reflected by education. The household characteristics are age of household head, sex of household head (male = 1 and 0 otherwise), area of residence (rural = 1 and 0 otherwise) and regional dummies. The headship of a household helps to capture the distribution of resources in the household (Ssewanyana, 2003; Kabubo-Mariara et al., 2009b). The community variables indicate availability of social infrastructure and services in the community. The use of professional care at birth (nurse/midwife) is one of such community variables in the child nutritional status model. Table 3.2 summarizes the variables for the child nutritional status model, their expected signs and literature source.

We used market access proxies as instrumental variables for the potentially endogenous wealth index. The instrumental variables include: distance to NGO health facility, distance to most common agricultural input market, distance to feeder roads, distance to telephone facility and time to water source.

Table 3.2: Summary of the Variables for the Child Nutritional Status Model

Description	**Dependent variables and the expected**		**Literature source**
	Height-for-age Z scores	**Probability of a child being stunted (<-2 = 1, zero otherwise)**	
Wealth index	(+)	(-)	Ssewanyana (2003); Kabubo-Mariara et al. (2009b); Abalo (2009); Bahiigwa and Younger (2005)
Sex of child (Male = 1, zero otherwise)	(-)	(+)	Ssewanyana (2003); Kabubo-Mariara et al. (2009b); Abalo (2009); Harttgen et al. (2012)
Child of multiple birth	(-)	(+)	Ssewanyana (2003); Kabubo-Mariara et al. (2009b); Harttgen et al. (2012)
Birth order	(-)	(+)	Ssewanyana (2003); Kabubo-Mariara et al. (2009b); Horton (1988)
Age of child (months)	(-)	(+)	Ssewanyana (2003); Kabubo-Mariara et al. (2009b); Masiye et al. (2010); Babatunde and Martinetti (2010)
Age of child squared (months)	(+)	(-)	Ssewanyana (2003); Kabubo-Mariara et al. (2009b); Masiye et al. (2010)
Mother's age (years)	(+)	(-)	Kabubo-Mariara et al. (2009b); Abalo (2009)
Mother's age squared (years)	(-)	(+)	Kabubo-Mariara et al. (2009b); Abalo (2009)
Sex of household head (Male =1, zero otherwise)	mixed	Mixed	Kabubo-Mariara et al. (2009b); Rogers (1991); Bomela (2007); Onyango et al. (1994), Appleton (1996); Kennedy and Peters (1992); Kennedy and Haddad (1994)
Household size	(-)	(+)	Kabubo-Mariara et al. (2009b); Babatunde and Martinetti (2010)

Age of household head	(+)	(-)	Kabubo-Mariara et al. (2009b); Harttgen et al. (2012)
Mother's education	(+)	(-)	Ssewanyana (2003); Kabubo-Mariara et al. (2009b); Abalo (2009); Strauss (1990); Babatunde and Martinetti (2010)
Marital status			
Currently married	(+)	(-)	Fuchs (2004); Mboho and Bassey (2013); Mugo (2012)
Divorced/separated/widowed	(+)	(-)	Mboho and Bassey (2013)
Professional care at birth (nurse/midwife)	(+)	(-)	Kabubo-Mariara et al. (2009b); Garcia and Alderman (1989); Shapiro-Mendoza et al. (2004)
Area of residence (rural = 1, zero otherwise)	(-)	(+)	Kabubo-Mariara et al. (2009b); Abalo (2009); Masiye et al. (2010); Mugo (2012)
Regions of the country			Bahiigwa and Younger (2005); Ssewanyana and Kasirye (2012)
Central	uncertain	Uncertain	
Eastern	uncertain	Uncertain	
Northern	uncertain	Uncertain	

Source: Author's own construction based on previous literature.
Note: The regional dummies in this thesis are based on the UNHS classification (see footnote 1).

3.5 Data Type and Sources

We utilize two datasets: the Uganda Demographic and Health survey (UDHS) for 2006; and the Uganda National Household Survey (UNHS) for 2005/2006 to analyze the effect of poverty on fertility, and the effect of poverty on child nutritional status.

The UDHS 2006 is a nationally representative survey which collected demographic and socioeconomic information on 8,531 women aged 15-49 and 2,503 men aged 15-54 as well as 2,687 children of under five years. Specifically, the survey collected detailed information on fertility, family planning, infant, child and maternal mortality, maternal and child health. It also collected information on breastfeeding and nutrition, malaria, and household assets among others. Household assets were used to generate wealth index as a measure of household welfare.

The UNHS 2005/2006 is also a nationally representative survey which covered 7426 households. It included among others a community module which collected information on distance to the most common agricultural input market, distance to NGO health facility, distance to telephone facility and distance to feeder roads which were used as instrumental variables for poverty (Note however that time to water source, also an instrumental variable came from the UDHS 2006 dataset). The UNHS 2005/2006 survey used a two stage sampling design to draw the sample. At the first stage, the probability proportional to size (PPS) design was used to draw the Enumeration Areas (EAs). At the second stage households which are the ultimate sampling units were drawn using simple random sampling. Initially 600 EAs were selected and allocated to each region on the basis of the population size of the region. This selection was followed by drawing an extra 153 EAs from 10 districts using the inter-penetrating sampling method. Since majority of the population in the North was in Internally Displaced People's (IDPs) Camps, the Northern region was treated as a separate selection stratum. From the IDPs, 30 EAs were drawn, making the overall total sample covered by the UNHS 2005/2006 to be 783 EAs (Republic of Uganda, 2006).

The UDHS 2006 covered all districts in the country, where a representative probability sample of 9,864 households was selected. This survey also used a two stage sampling method; at the first stage 321 clusters were selected from a list of clusters sampled in the UNHS of 2005/2006. In addition, the UDHS 2006 included 17 clusters and 30 Internally Displaced People (IDP) camps increasing the number to a total of 368 clusters. The second stage involved selection of households in each cluster based on the complete listing of households (Uganda Bureau of Statistics and Macro International Inc., 2007).

In this thesis, we mainly use data from the UDHS 2006 - women's individual recode, kids' recode and the household cover page files. This information is complemented with data from the community file of the UNHS 2005/2006 mainly the distance variables used as instruments for poverty.

Data Merging Process

The final data sets for analysis were generated through the following data merging process. First for the fertility data set, we got the individual recode's women file and the household cover page file from the UDHS 2006. These two files were combined using unique identifiers as the region, cluster and household number variables. We then merged the newly combined UDHS data files with a UNHS 2005/2006 community file using the enumeration area (ea) code as a unique identifier[2]. Second for the child nutritional status data set, the same merging process mentioned above was followed. However, instead of the individual recode's women file, the kid's recode file was used. The rest of the data files used were the same for both the fertility and child nutritional status models.

[2] The enumeration area (ea) code is found in both the UDHS 2006 household cover page file and also the UNHS 2005/2006 community file. This is the unique identifier for the community variables.

CHAPTER FOUR: FERTILITY AND POVERTY

4.0 Introduction

This chapter presents the descriptive statistics and regression results investigating the effect of poverty on fertility in Uganda. We first discuss the descriptive statistics followed by the regression results for the full sample, and sub-samples distributed by area of residence (urban/rural). These results are then used to draw conclusions and policy implications.

4.1 Descriptive Statistics

Descriptive statistics for the variables used in the analysis are presented in table 4.1. The results indicate that the total number of children ever born to a woman (CEB) or fertility rate in Uganda is 3.54 children. This is consistent with 3.53 CEB indicated in the Uganda Demographic Health Survey (UDHS) report findings of 2006. The 0.01 difference between the national and estimated CEB may be due to slight differences in sample size - after data merging, the number of women fell from 8531 to 8421. It should be noted that the CEB fell slightly from 3.53 in 2006 to 3.42 in 2011 (Uganda Bureau of Statistics and Macro International Inc., 2007; Uganda Bureau of Statistics and ICF International Inc., 2012). This shows only a 0.11 decrease in fertility over a period of five years. This may explain why results seem to depict lower fertility rates in Uganda. The mean wealth index score is 1.74 in terms of household assets ranging from 0.01 to 5.84 and a median of 1.39.

The mean age of a woman in the sample is 28.14 years. In terms of women's education level, 21 percent do not have any formal education, 58 percent have primary education, 17 percent have secondary education and 4 percent possess post-secondary education. These results are comparable with national unweighted education statistics where 21percent of the women have no education, 58 percent have primary education and 22 percent have post-primary education. The national statistics for secondary and post-secondary education are combined into one category (see Uganda Bureau of Statistics and Macro International Inc, 2007). The data further shows that in Uganda, 84 percent of the women reside in rural areas compared to only 16 percent in urban areas. The highest proportion of women in the sample live in the Eastern region (34 percent) followed by the Central region (32 percent).

Marital status is captured by three categories; (1) never married, (2) currently married and (3) divorced/separated/widowed. The majority of the women in the sample (63 percent) are married. The religion variable is analyzed based on four categories; Catholic, Protestant, Muslim and Pentecostals/SDA/other. Majority of the women in the sample are Catholics (45 percent) followed by Protestants (33 percent). The last two categories constitute equal but relatively lower proportions (11 percent).

The last three (3) rows of table 4.1 present proxies of market access: distance to NGO health facility (kilometers), distance to most common agricultural input market (kilometers), and time to water source in minutes (only one way). These proxies are used as instrumental variables for wealth index. On average, distance to NGO health facility is 23.36 km, compared to that to the most common agricultural input markets of 7.94 km while the mean time to the water source is 59.49 minutes. In urban areas (see appendix table A8), the average distance to NGO health facility and to the most common agricultural input market is 26.44 km and 6.47km respectively while the mean time to water source is 26.47 minutes. In rural areas, the mean distances to NGO health facility and to the most common agricultural input market are 22.75 km and 8.23 km respectively, and the average time to water source is 65.79 minutes. The rural/urban results for market access proxies have three implications. First, women in urban areas travel longer distances to NGO health facilities than their rural counterparts. This is perhaps due to the possibility of women in urban areas having several alternative health care facilities closer to them, than the fewer NGO facilities located farther away from them. Second, markets for agricultural inputs are located closer to urban than rural areas because of the fact that most industries that manufacture agricultural inputs are located in urban centers. In turn, rural women travel long distances to the nearest urban center to access these inputs. Third, compared to urban water sources, the rural water sources are more likely to be farther away from the household.

Table 4.1: Descriptive Statistics for Fertility Model Variables

Variable	Observations	Mean	Std. Dev.
Fertility (children ever born)	8421	3.54	3.21
Wealth index	8421	1.74	1.08
Current age of woman	8421	28.14	9.49
Current age of woman squared	8421	882.10	580.96
Rural residence = 1 (zero otherwise)	8421	0.84	0.37
Women's education level			
No education	8421	0.21	0.41
Primary education	8421	0.58	0.49
Secondary education	8421	0.17	0.38
Post-secondary education	8421	0.04	0.19
Regions of the Country			
Central	8416	0.32	0.46
Eastern	8416	0.34	0.47
Northern	8416	0.19	0.39
Western	8416	0.15	0.36
Marital status			

Never married	8421	0.24	0.43
Currently married	8421	0.63	0.48
Divorced/separated/widowed	8421	0.13	0.34
Religion			
Catholic	8415	0.45	0.50
Protestant	8415	0.33	0.47
Muslim	8415	0.11	0.32
Pentecostals/SDA/others	8415	0.11	0.31
Proxies of market access			
Distance to NGO health facility (kilometers)	8412	23.36	36.16
Distance to most common agricultural input market (kilometers)	8412	7.94	14.77
Time to water source (minutes)	7959	59.49	61.91

Source: Author's computation based on a combined dataset of UDHS 2006 and UNHS 2005/06

The results controlling for the regional dummies (not presented), show that compared to the Western region, the mean distance to NGO health facility and to the most common agricultural input market in the Central region are 15.35 km and 10.79 km respectively while the mean time to water source is 58.76 minutes. On average, in the Eastern region, women travel 12.09 km and 6.01 km to NGO health facility and to the most common agricultural input market respectively, and take a mean of 57.50 minutes to the water source compared to the western region. Compared to the Western region, the average distances to NGO health facility and to the most common agricultural input market are 31.83km and 5.83 km respectively, whereas the mean time to water source is 62.98 minutes in the Northern. The results in the Western region indicate an average distance of 54.59 km to NGO health facility and 8.94 km to the most common agricultural input market, while mean time to water source is 61.26 minutes.

The regional differentials in the proxies of market access may be interpreted as follows: Compared to the Western region, the Central and Eastern may have a large number of health facilities. In addition, the two regions are within the proximity of the major referral, public, private and NGO health facilities compared to the Western region. In terms of accessibility to water supply, the Central and Eastern regions are closer to water sources than in Western Uganda. The Northern region, however, compared to Western region, suffered the effects of political instabilities. We speculate that infrastructure like water supply facilities, were destroyed as a result of those instabilities. In turn, this may have made distribution of water sources in the Northern region sparser than in the Western region.

Further, in terms of distance to the most common agricultural input market, the Western region has more agricultural activities than the Central region. For the Northern region, the input promoting and selling project in the most remote areas may have increased accessibility to agricultural inputs compared to the Western region (Nkonya and Kato, 2001).

The rural/urban sub-samples descriptive statistics are presented in appendix table A8. The rural sub-sample is similar to the full sample for most variables (fertility, woman's age and her education, religion and marital status). However, the CEB in rural areas - 3.80 children is slightly higher than that for the full sample - 3.54 children. In addition, the average wealth index in rural areas (1.43) is lower than that for the full sample. Except for time to water source with a mean of 65.79 minutes which is higher than that for the full sample, the means of other proxies of market access in rural areas are close to that of the full sample. Urban sample results are different from the full sample for most variables. For example, in urban areas the average fertility is 2.21children which is lower than the full sample mean. The mean wealth index in urban areas; is 3.31 which is greater than that of the full sample. In addition, the differences in the means for most of the variables in the rural and urban sub-samples are statistically significant.

4.2 Regression Results and Discussion for the Full Sample

This section presents and discusses the regression results on the effect of wealth index on fertility. We base our discussion on the results presented in table 4.2 with models estimated under different assumptions. Fertility with exogenous wealth index is presented in columns (1) and (2). The OLS was run as a benchmark model. Fertility (CEB) is a count variable with positive numbers ranging from 0 to 16. For this reason the Zero-Inflated-Poisson (ZIP) was run to account for the many women with no children (24.65 percent) a common characteristic with national fertility data. Estimating the ZIP model generates two sets of results: first, the Poisson results which show the fertility count model of women with non-zero counts i.e. those who have children and second, the Logit model (see appendix table A2) which determines whether the count (fertility) is zero, or a woman belongs to a group with zero children (Baundin, 2008; StataCorp, 2009).

Columns (3) and (4) of table 4.2 present the instrumental variable model results. The first stage has wealth index as the dependent variable. It tests the impact of the two instrumental variables time to water source (minutes) and distance to NGO health facility (kilometers) on wealth index while controlling for other factors. The second stage model in column (4) tests the effect of wealth index on fertility after controlling for possible endogeneity and other covariates.

The control function approach (CFA) results accounting for heterogeneity that may arise from unobservable determinants of fertility are presented in columns (5), (6) and (7). Column (5) presents fertility model results with wealth index residuals derived from the reduced form wealth index model. Column (6) presents the control function approach model results which include both wealth index residuals and the interaction of residuals and the wealth index. Column (7) presents CFA results with other interaction terms.

Table 4.2 shows that Wald Chi-square, F and LR Chi-square tests for the goodness of fit are all highly significant, implying that all model parameters are jointly different from zero. Thus, all the models fit the data better than the intercept-only model. The R-squared values indicate that the explanatory variables in all models explain between 69 percent and 70 percent of the total variation in fertility rates. The Vuong test[3] is positive and highly significant at 1 percent level suggesting that the ZIP model better estimates fertility than the standard Poisson model (StataCorp, 2009).

First, all results for the logit model (women with zero children) in appendix table A2 have insignificant coefficients except for primary education in the urban sample which is negative and significant at 10 percent level. Secondary and post-secondary results may imply that fewer women in Uganda have obtained post-primary education (see Uganda Bureau of Statistics and Macro International Inc., 2007), yet literature has found post-primary education to lower fertility (Ainsworth et al., 1996; Mwabu and Schultz, 2003; Bbaale and Mpuga, 2011) or even to increase the probability of women not to have children (Baundin, 2008). The results further suggest that one’s religion is an important determinant of the choice to have children (see Baundin, 2008). In addition, results support the view that fertility rates tend to be higher in rural compared to urban areas (see Ainsworth et al., 1996), while for regions of the country, results may imply existence of minor variations in fertility levels.

Second, both the Ordinary Least Square (OLS) and the ZIP[4] models treat wealth index as exogenous and thus they estimate its effect without controlling for possible endogeneity. In these two models, wealth index negatively and significantly affects the fertility of a household implying that on average the higher the wealth, the lower will be the number of children born to women living in the households in our sample. For example in both the OLS

[3] The Vuong test helps to choose between the standard Poisson and the ZIP model which of them best estimates fertility. In addition since both of models are not nested to really know whether the fertility data has many zeros, a Vuong test is necessary (Baundin, 2008).
[4] From this point onward, ZIP in the discussion of results is specifically referring to the Poisson results which capture women with children.

and ZIP models, an increase in wealth index by one unit will reduce fertility by 0.11 and 0.04 children respectively. These results are consistent with the studies by Weerasinghe and Parr (2002) and Gudbrandsen (2010) which concluded that increased levels of wealth help to reduce fertility.

In column (4) where wealth index is instrumented for, the results also indicate that wealth index significantly and negatively affects fertility. The results are consistent with those for the control function approach models but the magnitude of the CFA coefficients especially in columns (6) and (7) are slightly smaller. It should be noted that the magnitude of coefficients for wealth index in both columns (4) and (5) are the same - that is 0.33 - but only have marginal differences in the standard errors (0.151 and 0.150 respectively). Intuitively this effect of wealth index on fertility implies that women from wealthier households have fewer children. This might be interpreted in two different ways. First, wealthier women attach a higher value on the quality of their children compared to the quantity (Becker, 1960). Therefore wealthier mothers would prefer investing more resources in their children for instance through education, than having an additional child who may add more costs to the family (Gauthier et al., 2004). Second, these results of lower fertility for wealthier women may be explained by the fact that they work and their wages would be negatively affected by the reduction in working hours (Schultz, 1994) as children require time for care. In addition, some employers would be reluctant to employ women with young children (Kim and Aassve, 2006).

The results with exogenous wealth index show that current age of a woman positively and significantly affects fertility in Uganda. This implies that the older the woman, the higher the number of children born to her, holding other factors constant. The same result is observed for the other fertility models in table 4.2. The magnitude of current age in the OLS, second stage IV and CFA models is almost twice that of the ZIP model. An increase in the woman's age by 1 year increases fertility by 0.27 children (ZIP model) and about 0.42 children (other models). Age squared is inversely related to fertility. The effect of age and age squared increases fertility at a decreasing rate thus exhibiting an inverted U-shape (Weerasinghe and Parr, 2002; Bhasin et al., 2010). The inverted U-shape may be explained by the fact that in the early years of women's reproductive cycle, they would have more children but their fertility declines with age towards the end of this cycle (American Society for Reproductive

Medicine, 2008). Our results for age and age squared are consistent with the study by Bhasin et al. (2010) which found that mother's age had a significant non-linear effect on fertility.

Concerning women's education, the coefficient on primary education is positive and significant for all fertility models in table 4.2 (except for OLS where the coefficient is positive but insignificant). These results indicate that women with primary education will have 0.03 children more (ZIP model) and 0.14 children more on average for the second stage IV and CFA models than their counterparts with no education. These findings are consistent with Kabubo-Mariara et al. (2009a) who found primary education for the mothers to have a positive and significant effect on fertility.

Women's secondary education has a negative and significant effect on fertility according to the OLS, ZIP and CFA models in columns (1), (2) and (6) of table 4.2. In other words, in these three models, women with secondary education are likely to have 0.50, 0.16 and 0.29 fewer children respectively than those with no education, *ceteris paribus*. Women's post-secondary education coefficients are larger than those for their secondary education. The OLS and ZIP results show that women with post-secondary education are likely to have 1.71 and 0.50 fewer children respectively than their counterparts with no education. The results for the second stage IV, and CFA (column 5) indicate that women with post-secondary education have 1.32 fewer children than their uneducated counterparts. Other CFA results show that women with post-secondary education have 1.35 (column 6) and 1.31 (column 7) fewer children than uneducated women. These findings are consistent with (Shapiro, 2011) who found that women with post-primary education had lower fertility compared to women with no education. This might be explained by the fact that women with higher education levels (secondary and post-secondary) tend to spend more years in school. These extra years in school act as a control mechanism to reduce women's fertility as many tend to postpone age of marriage and child birth (Breierova and Duflo, 2003). It may also be that educated women have knowledge about contraception, child spacing and benefits of having small families which in turn motivates them to lower the number of children they can bear (Gordon et al., 2011; Schultz, 1969).

The marital status results indicate that women who are currently married are likely to have a higher number of children than those who have never married other factors held constant. These results are consistent for all the fertility models. Thus, being currently married increases women's fertility by 1.75 children in the ZIP model, 0.81 children in the second stage IV and CFA models (columns 5 and 7) and 0.80 children in column 6 (CFA). These results support Moultrie and Timæus (2001) who found that unmarried mothers have fewer children than married mothers of the same age. The ZIP model shows positive and highly significant effect of being divorced/separated/widowed on fertility relative to not being married.

Another factor that affects fertility is religion. This is captured by three dummy variables; Catholic, Protestant and Muslim with Pentecostals/SDA/other as the reference category. The results show that compared to being Pentecostals/SDA/other, Catholic women have lower fertility rates, other factors held constant. Relative to being Pentecostals/SDA/other, being Catholic lowers fertility by 0.04 children (ZIP model), 0.13 children (OLS model) and about 0.17 children for other models. Muslim women tend to have more children compared to Pentecostals/SDA/other women with significant results for all models. The size of the coefficient increases as one moves from the OLS to other models (except for ZIP where the coefficient decreases). Carranza (2012) found similar results that Muslim women had more children than non-Muslims. The high fertility of Muslim women could be explained by the fact that the Koran teaches that only the surviving son in the family has the right to inherit property of his late father lest the paternal uncles do so. In turn, women especially those with only female children are motivated to continue child-bearing until when they get a son, thus increasing their fertility (Carranza, 2012). In addition, on average Muslim women marry at a younger age compared to non-Muslim women (Zahangir et al., 2008 , Sarkar, 2009). Earlier age at first marriage is associated with increased number of children a woman is likely to have (Marini, 1981). Consistent with the (Uganda Bureau of Statistics and Macro International Inc., 2007) and Bollen et al. (2001) women residing in rural areas tend to have more children than their urban counterparts. However, the coefficient is only significant for the OLS and ZIP models.

Table 4.2: Fertility Model Results under different Assumptions - Full Sample

Variable	Fertility with Exogenous Wealth Index		Fertility Instrumental Variable Model		Control Function Approach Models		
	(1) Ordinary Least Squares model	(2) ZIP model	(3) First stage wealth index model	(4) Second stage fertility model with instrumented wealth index	(5) Fertility with wealth index residuals	(6) Fertility, wealth index residuals and their interactions with wealth index	(7) Fertility and other interaction terms
Wealth index	-0.1059*** [0.027]	-0.0413*** [0.009]		-0.3349** [0.151]	-0.3349** [0.150]	-0.3073** [0.152]	-0.3151** [0.152]
Current age of woman	0.4079*** [0.017]	0.2652*** [0.006]	0.0243*** [0.007]	0.4196*** [0.018]	0.4196*** [0.018]	0.4192*** [0.018]	0.4201*** [0.018]
Current age of woman squared	-0.0026*** [0.00026]	-0.0031*** [0.00009]	-0.0002** [0.00011]	-0.0028*** [0.00027]	-0.0028*** [0.00027]	-0.0028*** [0 .00027]	-0.0028*** [0.00027]
Woman's education level (No education = reference)							
Primary education	0.0535 [0.053]	0.0284** [0.014]	0.3739*** [0.021]	0.1428* [0.079]	0.1428* [0.079]	0.1370* [0.079]	0.1418* [0.079]
Secondary education	-0.4994*** [0.076]	-0.1615*** [0.026]	0.9956*** [0.029]	-0.272 [0.172]	-0.272 [0.171]	-0.2895* [0.171]	-0.2737 [0.172]
Post-secondary education	-1.7126*** [0.120]	-0.5028*** [0.051]	1.5804*** [0.047]	-1.3238*** [0.271]	-1.3238*** [0.270]	-1.3548*** [0.271]	-1.3138*** [0.272]
Marital status (Never married = reference)							
Currently married	0.8565*** [0.067]	1.7544*** [0.053]	-0.2570*** [0.028]	0.8066*** [0.081]	0.8066*** [0.081]	0.8046*** [0.081]	0.8057*** [0.081]
Divorced/separated/widowed	-0.0335 [0.084]	1.5728*** [0.055]	-0.2646*** [0.035]	-0.1018 [0.097]	-0.1018 [0.097]	-0.1021 [0.097]	-0.1094 [0.097]
Religion (Pentecostals/SDA/other = reference)							
Catholic	-0.1344** [0.065]	-0.0434** [0.020]	-0.1249*** [0.027]	-0.1666** [0.071]	-0.1666** [0.071]	-0.1632** [0.071]	-0.1650** [0.071]
Protestant	0.0149 [0.067]	0.0015 [0.021]	-0.0133 [0.028]	0.017 [0.070]	0.017 [0.070]	0.0151 [0.070]	0.0186 [0.069]
Muslim	0.1801** [0.082]	0.0475* [0.025]	0.1709*** [0.034]	0.2403*** [0.089]	0.2403*** [0.088]	0.2344*** [0.088]	0.2301*** [0.088]
Area of residence							
Rural residence = 1 (zero otherwise)	0.3986*** [0.068]	0.1175*** [0.024]	-1.3482*** [0.024]	0.1016 [0.221]	0.1016 [0.220]	0.127 [0.221]	0.1195 [0.221]
Instrumental variables							
Time to get to water source			-0.0021***				

(minutes)			[0.000]				
Distance to NGO health unit (kilometers)			-0.0010*** [0.000]				
Control function variables							
Reduced form wealth index residuals					0.2301 [0.153]	0.2851* [0.158]	0.7586*** [0.202]
Interaction of wealth index residuals and wealth index						-0.0293 [0.021]	-0.0385* [0.022]
Interaction of primary education for the woman and wealth index residuals							-0.1132 [0.094]
Interaction of secondary education for the woman and wealth index residuals							-0.0178 [0.106]
Interaction of post-secondary education for the woman and wealth index residuals							-0.2790** [0.137]
Interaction of current age of the woman and wealth index residuals							-0.0130*** [0.003]
Constant	-6.1473*** [0.248]	-5.4297*** [0.106]	2.3190*** [0.099]	-5.7542*** [0.416]	-5.7542*** [0.415]	-5.7938*** [0.416]	-5.7899*** [0.416]
Observations	8,415	8,415	7,945	7,945	7,945	7,945	7,945
F/ Wald chi2(12)/ LR chi2(12)	F(12, 8402) =1602.16***	LR chi2(12) = 13121.92***	F(13,7931) = 796.66***	17940.09***	F(13, 7931)= 1390.17***	F(14, 7930) = 1291.17***	F(18, 7926) = 1008.39***
R-squared	0.696		0.566	0.692	0.695	0.695	0.696
Log likelihood		= -13566.26					
Vuong test of zip vs. standard Poisson:	z = 5.24 Pr>z = 0.0000						
Durbin (score) chi2(1)	= 2.269 (p = 0.1320)						
Wu-Hausman F(1,7931)	= 2.265 (p = 0.1323)						
Test for excluded instruments							
F(2,7931)	= 140.085						
Prob > F	= 0.0000						
Partial R2 for excluded instruments	= 0.0341						
Sargan (score) chi2(1)	= 0.256 (p = 0.6130)						
Basmann chi2(1)	= 0.255 (p = 0.6133)						

Note: ZIP logit model estimates are presented in appendix table A2. Standard errors are presented in parenthesis, ***, **, * significant at 1%, 5% and 10% respectively.

First Stage Wealth Index Full Model Results

The reduced form wealth index model results are presented in column (3) of table 4.2. The results indicate that the two instrumental variables - time to water source and distance to NGO health facility negatively and significantly affect wealth index with coefficients of 0.002 and 0.001 respectively. This implies that the more time a woman takes to get to the water source, and the longer the distance to a NGO health facility, the lower the wealth status of the woman other factors held constant. These results suggest that: first, limited access to infrastructure facilities like water is highly associated with poorer households relative to their richer counterparts (Brook and Smith, 2001); and second, long distances to health facilities are mostly experienced by poor people who compared to the rich, tend to live in isolated places with inadequate or no transportation means to health facilities (Kiwanuka et al., 2008).

Current age of the woman positively impacts wealth index with a highly significant coefficient. An increase in the woman's age by one year increases her wealth index by 0.02 other factors held constant. Current age of the woman squared has a significant negative impact on wealth index but the magnitude of the coefficient is quite small (0.0002). This relationship portrays an inverted U-shape. The age-wealth relationship reflects the life cycle with wealth increasing up to say retirement age and declining there after (Rigg and Sefton, 2004).

In terms of the woman's education level, all three dummy variables have a positive and highly significant impact on wealth index. In other words, women with primary, secondary and post-secondary education have wealth index that is 0.37, 1.00 and 1.60 higher respectively than their uneducated counterparts *ceteris paribus*. The differences in the magnitudes of coefficients suggest that wealth is an increasing function of women's education. This could be due to the fact that more educated women are more likely to get employed in the labour market, in turn they earn income and accumulate wealth relative to their uneducated counterparts (Sackey, 2005).

The marital status variable indicates that both the currently married and the divorced/separated/widowed women tend to have a lower wealth status than women who have never been married. For example, the wealth index of the currently married and divorced/separated/widowed women is 0.26 lower than that of the never married women, *ceteris paribus*. These results can be explained by the fact that the household size of married and divorced/separated/widowed women is more likely to be larger than that of the unmarried women. The larger household size may imply greater expenditure on items like food which in turn lowers income/wealth of married and divorced/separated/widowed women compared to the unmarried (Aidoo et al., 2013; Jayathirtha and Fox, 1996).

The results of the religion dummies show that relative to being Pentecostal/SDA/other religion, being Catholic is negatively correlated with wealth index, *ceteris paribus*. The wealth status of Catholic women is 0.12 lower than that of Pentecostal/SDA/other women, other factors held constant. Muslim women are likely to have 0.17 higher wealth index than Pentecostal/SDA/other women. The negative significant results for being a Catholic on wealth index are consistent with results by Grier (1997) who found that there exists a negative relationship between being a Catholic and one's income - in turn income highly affects one's wealth. Women residing in rural areas tend to have a lower wealth status than those in urban areas. The results indicate that rural women's wealth status is 1.35 units lower than that for urban women, *ceteris paribus*.

Testing for Validity of Instruments, Endogeneity and Heterogeneity for the Full Model

Wealth index is a potentially endogenous covariate of fertility. It is therefore important to instrument for wealth index and also to find valid instruments for it. Validity captures the relevance, strength and exogeneity of an instrument. According to Kabubo-Mariara et al. (2009a) and Mwabu (2009), relevance means that the instrumental variable should have a statistically significant effect on the endogenous variable, the strength of an instrument relates to the view that the size/magnitude of its coefficient should be large; and exogeneity implies that the instrument should not be correlated with the structural disturbance term. In our study the magnitude of the first-stage F-statistic and p-value (F-statistic = 140.085 and p-value = 0.0000) on excluded instruments: time to water source and distance to NGO health unit suggest that the two variables are relevant and valid instruments for wealth index. This is further reflected by the fact that the instruments have a significant impact on wealth index but an insignificant effect on fertility.

Wealth index is the only potentially endogenous variable considered in this study with two instruments used, thus there is possibility of overidentification in the structural model (Kabubo-Mariara et al., 2009a). We test whether the fertility model is well specified - that is to test whether the excluded instruments are part of the outcome model of interest and that the instruments are valid. To do so, the Sargan and Basmann tests are carried out. The results (magnitude of the coefficient = 0.26 and p-value = 0.61) do not reject the null hypothesis that the instrumental variables are uncorrelated with the error term of the fertility model, suggesting no over identification. Thus the structural/fertility model is correctly specified.

We also test whether the wealth index is really endogenous in the fertility model. Literature argues that poverty (measured by wealth index) is potentially endogenous to fertility (see Schultz and Mwabu 2003 and Bhasin et al. 2010). Testing for endogeneity of wealth index is achieved by conducting the Durbin-Wu-Hausman test for exogeneity. The results (magnitude of coefficient = 2.27 and the p-value = 0.13), suggest that wealth index may not necessarily be endogenous. However, after inclusion of interaction terms in columns 6 and 7 of table 4.2, the residuals became significant suggesting presence of endogeneity of wealth index in the fertility model (Ajakaiye and Mwabu, 2007). This seems to imply that failure to account for endogeneity of wealth index may underestimate its effect on fertility - thus putting less emphasis on improving wealth status as a measure of lowering fertility.

The control function approach (CFA) results testing for heterogeneity are presented in columns (6) and (7) of table 4.2. We accounted for heterogeneity in the fertility model by including the interaction of wealth index residuals with wealth index, woman's education and age. Heterogeneity may arise from unobserved factors which impact fertility but also are correlated with wealth index. The unobserved factors include individual women characteristics such as the level of fecundability - probability that a woman will conceive in a given period of time (Yan and Larsen, 2001), the background of parents and the desire for family-oriented or labour market-oriented activities. Other unobserved factors could include community characteristics, specifically group preference for large/small families and the level of support for family planning by community leaders (Angeles et al., 2003). It is worth noting that the IV results for the second stage fertility model and those in CFA model (with only residuals) are similar in terms of magnitudes and levels of significance but they differ marginally in terms of standard errors for some variables.

The control function variables (generated regressors) tend to introduce elements of the error term from the first stage model in to the disturbance term of the fertility model. Therefore, to account for the effects of ignored non-linear interactions of unobservables with factors influencing fertility, we introduce an interaction term of wealth index and its residuals into the fertility model (see Kabubo-Mariara et al., 2009a). Inclusion of the interaction of wealth index and its residuals, and other interaction terms increases the magnitude of the wealth index coefficient from 0.11 (OLS) to 0.31and 0.32 (CFA models). The magnitude of the coefficient of wealth index residual is increased from 0.23 to 0.29, and finally to 0.76 (see CFA models in table 4.2). This variation in magnitude of the coefficients indicates that without controlling for heterogeneity, the influence of wealth index would be underestimated in the fertility model. The interaction of wealth index and its residuals has a negative but insignificant effect on fertility in column (6). However, in column (7), the interaction of wealth index and its residuals has a negative and significant effect on fertility at 10 percent level. The significance of this interaction term suggests the presence of heterogeneity resulting from the interaction of wealth index and the unobserved factors that affect fertility.

The CFA results suggest that other sources of heterogeneity are the interaction of post-secondary education for the woman and wealth index residuals, and the interaction of current age of the woman and wealth index residuals. These results therefore suggest that the unobserved factors are not mean-independent of post-secondary education for the woman and her current age but are mean-independent of primary and secondary education of the woman (Kabubo-Mariara et al., 2009a). These results may be explained by the fact that factors like unobserved individual ability and motivation, and encouragement from parents and friends tend to affect one's educational level attainment, and in turn education affects fertility (Brand and Davis, 2011).

4.3 Regression Results and Discussion for the Rural and Urban Sub-Samples

Table 4.3 presents the OLS, ZIP, IV and the CFA model results for the rural and urban sub-samples. In general, the results of the rural sample are very close to those of the full sample which is expected because 84 percent of the full sample lives in rural areas. The urban area results are different from those of the full sample in terms of the magnitude, level of significance and in some cases signs of the coefficients.

The results show that the Wald Chi-square, F and LR Chi-square tests for goodness of fit reject the null hypothesis that all parameters are equal to zero. In other words, the estimated models fit the data better than the intercept-only model. The results of R-squared indicate that variables included in the rural and urban models explain 69 percent and 66 percent of the total variation in fertility respectively. These results are close to those of the full sample where the R-squared ranged between 69 percent and 70 percent. Consistent with the full model results, the ZIP model better estimates fertility than the standard Poisson model for rural areas (Vuong = z = 5.09 Pr>z = 0.0000) and urban areas (Vuong = z = 1.64 Pr>z =

0.0502). The Vuong test results for rural and urban areas are positive and significant thus favouring the estimation of a ZIP instead of a standard Poisson model in both cases.

For the OLS and the ZIP models in columns (1) and (2), the results for the rural sample show that wealth index which is treated as exogenous, negatively and significantly affects fertility. The coefficient for the OLS model (0.09) is larger than that of the ZIP model (0.03) although both are significant. The effect of wealth index on fertility for the urban sample is also negative and highly significant. The size of the coefficients for OLS (0.18) and ZIP (0.07) models is larger in urban than in rural areas i.e. the impact of wealth index on fertility is higher for urban than for rural women.

Except for primary education in urban areas, the effects of other explanatory variables on fertility for the two sub-samples are consistent with the full model results although differences in size and significance of the coefficients can be noted. The effect of primary education on fertility in urban areas differs from both the rural and full samples. Urban women with primary education tend to have lower fertility rates than their counterparts with no education. Although this effect is not statistically significant, it is worth noting as in other models (full and rural samples), primary education appeared to increase fertility relative to no education.

Testing for Validity of Instrumental Variables and Endogeneity for Rural and Urban Sub-Samples

Wealth index is potentially endogenous in the fertility models by area of residence. Thus, there is need to instrument for wealth index so that we account for its endogeneity. Consistent with the full sample, the Durbin-Wu-Hausman test results suggest that wealth index may not necessarily be endogenous in the fertility models by area of residence, but these results may be inconclusive. After the inclusion of interaction terms in columns 2 and 3 of table 4.4, the residuals of wealth index become significant suggesting that wealth index may be endogenous in the fertility model for rural areas. The results of the rural sample are consistent with the full model. In the urban sample, the insignificance of the residuals indicates the absence of endogeneity.

Table 4.3: Fertility Results for Area of Residence under different Assumptions

Variable	*Rural*				*Urban*			
	Fertility with exogenous wealth index		Instrumental variable model		Fertility with endogenous wealth index		Instrumental variable model	
	(1) Ordinary Least Square model (OLS)	(2) ZIP model	(3) First stage wealth index model	(4) Second stage fertility model with instrumented wealth index	(5) Ordinary Least Square model (OLS)	(6) ZIP model	(7) First stage wealth index model	(8) Second stage fertility model with instrumented wealth index
Wealth index	-0.0905*** [0.033]	-0.0317*** [0.010]		-0.3938* [0.213]	-0.1771*** [0.039]	-0.0705*** [0.018]		-0.2743** [0.112]
Current age of woman	0.4456*** [0.019]	0.2647*** [0.006]	0.0148** [0.007]	0.4544*** [0.020]	0.2147*** [0.035]	0.2701*** [0.019]	0.0509** [0.023]	0.2365*** [0.036]
Current age of woman squared	-0.0031*** [0.00029]	-0.0031*** [0.00009]	-0.0001 [0.00011]	-0.0032*** [0 .0003]	-0.0004 [0.00055]	-0.0031*** [0 .00028]	-0.0007* [0 .00037]	-0.0008 [0.00057]
Woman's education level (No education = reference)								
Primary education	0.1043* [0.057]	0.0274* [0.014]	0.3656*** [0.020]	0.2170** [0.097]	-0.1225 [0.177]	-0.0026 [0.060]	0.4836*** [0.117]	-0.0632 [0.193]
Secondary education	-0.4822*** [0.088]	-0.1574*** [0.030]	1.0119*** [0.030]	-0.1815 [0.236]	-0.6674*** [0.185]	-0.2132*** [0.069]	0.9876*** [0.120]	-0.5357** [0.227]
Post-secondary education	-1.6915*** [0.166]	-0.4477*** [0.065]	1.4833*** [0.058]	-1.2197*** [0.361]	-1.6001*** [0.213]	-0.5919*** [0.098]	1.5535*** [0.136]	-1.3903*** [0.292]
Marital status (Never married = reference)								
Currently married	0.8388*** [0.078]	1.7981*** [0.061]	-0.1669*** [0.029]	0.7904*** [0.091]	1.0241*** [0.116]	1.6136*** [0.106]	-0.4742*** [0.078]	0.9999*** [0.133]
Divorced/separated/widowed	-0.0041 [0.097]	1.6323*** [0.063]	-0.1410*** [0.036]	-0.0631 [0.107]	0.1905 [0.155]	1.3241*** [0.113]	-0.6272*** [0.104]	0.1537 [0.174]
Religion (Pentecostals/SDA/other = reference)								
Catholic	-0.1456* [0.075]	-0.0406* [0.021]	-0.1479*** [0.027]	-0.1923** [0.085]	-0.1084 [0.123]	-0.0639 [0.059]	0.0116 [0.084]	-0.1012 [0.128]
Protestant	0.0075 [0.077]	0.0023 [0.022]	-0.0128 [0.028]	0.0102 [0.080]	0.0298 [0.123]	-0.0128 [0.059]	-0.0069 [0.083]	0.0317 [0.127]
Muslim	0.1738* [0.097]	0.0415 [0.028]	0.2267*** [0.035]	0.2613** [0.112]	0.1665 [0.134]	0.0445 [0.064]	0.0625 [0.091]	0.2083 [0.140]
Instrumental variables								

Time to water source (minutes)			-0.0015*** [0.000]				-0.0085*** [0.001]	
Distance to NGO health facility (kilometers)			-0.0011*** [0.000]				-0.0014** [0.001]	
Constant	-6.4359*** [0.262]	-5.3609*** [0.110]	1.0160*** [0.095]	-6.2289*** [0.328]	-2.5098*** [0.508]	-5.2199*** [0.308]	2.2359*** [0.340]	-2.5785*** [0.557]
Observations	7,038	7,038	6,672	6,672	1,377	1,377	1,273	1,273
R-squared	0.693		0.272	0.689	0.661		0.344	0.658
F/Wald Chi2/LR Chi2	F(11, 7026) = 1444.56****	LR chi2(11) = 10804.40***	F(12, 6659) = 206.90***	Wald chi2(11) =14856.32***	F(11, 1365) = 242.15***	LR chi2(11) = 1887.07***	F(12, 1260) = 55.15***	Wald chi2(11) = 2436.39***
Log likelihood		= -11717.75				-1836.461		
Vuong test of zip vs. standard Poisson		z = 5.09 Pr>z = 0.0000				z = 1.64 Pr>z = 0.0502		

Durbin (score) chi2(1)	= 2.187 (p = 0.1392)		= 0.407 (p = 0.5236)
Wu-Hausman F(1,6659)	= 2.183 (p = 0.1396)	Wu-Hausman F(1,1260)	= 0.403 (p = 0.5258)
Test for excluded instruments			
F(2,6659)	= 91.2082	F(2,1260)	= 93.9347
Prob > F	= 0.0000		= 0.0000
Partial R2 for excluded instruments	= 0.0267		
Sargan (score) chi2(1)	= 0.370 (p = 0.5430)		= 0.047 (p = 0.8276)
Basmann chi2(1)	= 0.369 (p = 0.5434)		= 0.047 (p = 0.8285)

Note: ZIP logit model estimates are presented in appendix table A2. Standard errors are presented in parenthesis, ***, **, * significant at 1%, 5% and 10% respectively.

Results for Instrumental Variable Model in the Rural and Urban Sub Samples

First Stage Wealth Index Results

Consistent with the full sample, the results for the rural areas indicate that the two instrumental variables, time to water source and distance to NGO health facility negatively and significantly impact wealth index. The urban sample results also indicate that the two instruments are inversely and significantly correlated with wealth index. First, an increase in the time a woman takes to get to the water source by 1 minute lowers her wealth index by 0.002 in rural areas and 0.009 for urban areas. Second, an increase in the distance a woman travels to the NGO health facility by 1 kilometer will lower her wealth index by 0.001 in rural and urban areas. The intuition behind the results for time to water source and distance to NGO health facility is that the longer the time women spend collecting water, and the longer the distance to access private and affordable care in NGO health facility, the less likely they are to engage in productive activities which limits their income earning opportunities and wealth creation (Kasirye et al., 2004).

Current age of the woman has a positive and significant effect on wealth index for the rural and urban areas. For instance, an increase in age of a woman by 1 year is likely to increase her wealth index by 0.01 and 0.05 in rural and urban areas respectively. Current age of the woman squared negatively impacts wealth index for both sub samples but the effect is significant only for urban areas at 10 percent level. The age effects on wealth index indicate an inverted U-shaped relationship. This result portrays the life cycle effects of age - whereby wealth increases with one's age but later decreases say beyond retirement and or old age (Rigg and Sefton, 2004).

All three education level dummies positively and significantly affect wealth index for the two sub-samples. First, relative to those with no education, increasing primary education for women by 1 percent would increase wealth index by 0.37 in rural areas and 0.48 in urban areas. Second, increasing secondary education for women by 1 percent increases their wealth index by 1.01 in rural areas and 0.99 in urban areas, compared to those with no education. Third, a 1 percent increase in post-secondary education for women increases their wealth index by 1.48 in rural areas and 1.55 in urban areas, relative to those with no education. The differences in the magnitudes of the coefficients by level of education in rural and urban areas, suggest that wealth is an increasing function of women's education. In other words, the higher the level of education a woman has, the more likely that her wealth will increase, *ceteris paribus*. We hypothesize that educated women in rural and urban areas are more likely to participate in paid employment relative to their uneducated counterparts, which improves their earnings and wealth levels (Sackey, 2005).

The effect of marital status dummies on wealth index for the two sub-samples is negative and highly significant. Being currently married is likely to lower women's wealth index by 0.17 and 0.47 in rural and urban areas respectively, compared to those who have never married. The wealth index of divorced/separated/widowed women relative to those who have never married is 0.14 lower in rural areas and 0.63 lower in urban areas. These results are consistent with the full sample, suggesting that married, divorced and separated women tend to incur higher expenditures over the life cycle in turn lowering their wealth levels (Jayathirtha and Fox, 1996).

Religion also impacts wealth index in Uganda. Being a Catholic is likely to lower a woman's wealth index by 0.15 relative to being a Pentecostal/SDA/other woman in rural areas. The effect is significant at 1 percent level. Compared to a Pentecostal/SDA/other woman, being a Muslim woman in rural areas significantly increases her wealth index by 0.23 other factors held constant.

Second Stage Fertility Model with Instrumented Wealth Index

The results of the second stage fertility model for the two sub-samples are presented in columns (4) and (8) of table 4.3. They indicate that an increase in wealth index is likely to reduce fertility by 0.39 and 0.27 children in rural and urban areas respectively, *ceteris paribus*. These results suggest that wealthier women are likely to have fewer children than their poorer counterparts. The two sub-sample results are consistent with the full sample results. However, differences arise in the level of significance and magnitude of coefficients. These results could be explained by the fact that relative to their poorer counterparts, wealthier women are more likely to invest in the wellbeing of their children which comes at a cost such as educating them, thus they prefer having fewer children whom they can cater for.

Results for Control Function Approach in the Rural and Urban Sub-Samples

The control function approach results for the rural and urban sub-samples are presented in table 4.4. The table presents first the results with fertility and wealth index residuals; second fertility, wealth index residuals and the interaction of wealth index residuals with wealth index, and third fertility and other interaction terms. Columns 1, 2 and 3 present results for rural areas while columns 4, 5 and 6 present results for urban areas. The results for the rural sample are consistent with the full sample. The urban sample results differ with those of the full sample.

Testing for Heterogeneity in the Fertility-Wealth Index Relationship

Like in the full sample, this section tests for heterogeneity in the wealth index-fertility relationship. We account for heterogeneity in fertility by interacting wealth index residuals with wealth index, education dummies and current age of the woman. The results indicate that interacting wealth index residuals with wealth index, post-secondary education and current age have a negative and statistically significant effect on fertility, suggesting the existence of heterogeneity in rural areas. In urban areas, the sources of heterogeneity are from interacting wealth index residuals with wealth index, and wealth index residuals with woman's current age both of which are statistically significant (table 4.4).

Table 4.4: Fertility Results for Area of Residence Control Function Approach Models

Variable	*Rural*			*Urban*		
	(1) Fertility with wealth index residuals	(2) Fertility, wealth index residuals and their interactions with wealth index	(3) Fertility and other interaction terms	(4) Fertility with wealth index residuals	(5) Fertility, wealth index residuals and their interactions with wealth index	(6) Fertility and other interaction terms
Wealth index	-0.3938* [0.212]	-0.3527* [0.213]	-0.3570* [0.213]	-0.2743** [0.113]	-0.2997*** [0.113]	-0.2973*** [0.113]
Current age of woman	0.4544*** [0.020]	0.4535*** [0.020]	0.4547*** [0.020]	0.2365*** [0.036]	0.2372*** [0.036]	0.2343*** [0.036]
Current age of woman squared	-0.0032*** [0.0003]	-0.0032*** [0.0003]	-0.0032*** [0.0003]	-0.0008 [0 .0006]	-0.0008 [0 .0006]	-0.0008 [0.0006]
Woman's education level (No education = reference)						
Primary education	0.2170** [0.097]	0.2092** [0.097]	0.2128** [0.097]	-0.0632 [0.194]	-0.0285 [0.194]	-0.0406 [0.194]
Secondary education	-0.1815 [0.235]	-0.1944 [0.235]	-0.1817 [0.235]	-0.5357** [0.228]	-0.4701** [0.231]	-0.4783** [0.231]
Post-secondary education	-1.2197*** [0.359]	-1.2334*** [0.359]	-1.1836*** [0.360]	-1.3903*** [0.293]	-1.3051*** [0.297]	-1.3039*** [0.297]
Marital status (Never married = reference)						
Currently married	0.7904*** [0.090]	0.7908*** [0.090]	0.7945*** [0.090]	0.9999*** [0.133]	1.0058*** [0.133]	1.0197*** [0.134]
Divorced/separated/widowed	-0.0631 [0.106]	-0.0616 [0.106]	-0.0635 [0.106]	0.1537 [0.175]	0.1447 [0.175]	0.1449 [0.175]
Religion (Pentecostals/SDA/other = reference)						
Catholic	-0.1923** [0.084]	-0.1927** [0.084]	-0.1939** [0.084]	-0.1012 [0.129]	-0.1198 [0.129]	-0.1223 [0.129]
Protestant	0.0102 [0.080]	0.0021 [0.080]	0.0049 [0.080]	0.0317 [0.128]	0.0197 [0.128]	0.0174 [0.128]
Muslim	0.2613** [0.111]	0.2494** [0.111]	0.2424** [0.111]	0.2083 [0.140]	0.2015 [0.140]	0.1847 [0.140]
Control function variables						
Reduced form wealth index residuals	0.3168	0.4000*	0.8626***	0.0766	-0.0955	0.2842

	[0.214]	[0.220]	[0.266]	[0.121]	[0.155]	[0.270]
Interaction of wealth index residuals and wealth index		-0.0486* [0.028]	-0.0556* [0.030]		0.0576* [0.033]	0.044 [0.034]
Interaction of primary education for the woman and wealth index residuals			-0.0974 [0.113]			-0.0758 [0.155]
Interaction of secondary education for the woman and wealth index residuals			-0.0157 [0.131]			0.0942 [0.163]
Interaction of post-secondary education for the woman and wealth index residuals			-0.3539** [0.180]			-0.1113 [0.195]
Interaction of current age of the woman and wealth index residuals			-0.0131*** [0.004]			-0.0120** [0.005]
Constant	-6.2289*** [0.326]	-6.2422*** [0.326]	-6.2594*** [0.326]	-2.5785*** [0.559]	-2.5963*** [0.559]	-2.5410*** [0.559]
Observations	6,672	6,672	6,672	1,273	1,273	1,273
R-squared	0.693	0.693	0.694	0.659	0.66	0.663
F-Test	F(12, 6659) = 1251.21***	F(13, 6658) = 1155.52***	F(17, 6654) = 886.67***	F(12, 1260) = 203.18***	F(13, 1259) = 188.09***	F(17, 1255) = 145.25***

Note: Standard errors are presented in parenthesis, ***, **, * significant at 1%, 5% and 10% respectively.

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The rural/urban results controlling for heterogeneity, indicate an increase in the magnitude of the wealth index coefficient after inclusion of interaction terms. For instance, in rural areas, the magnitude of wealth index increases from 0.09 (OLS model) and 0.03 (ZIP model) in table 4.3, to 0.35 and 0.36 (CFA models in columns 2 and 3). In urban areas, the magnitude of wealth index increases from 0.18, and from 0.07 in the OLS and the ZIP models - table 4.3 respectively, to 0.30 for the CFA models in columns 5 and 6 of table 4.4. The size of the wealth index residuals in rural areas increases from 0.32 to 0.40 and then to 0.86 (CFA models). The residuals in the urban models are insignificant. The results for the two sub-samples imply that failure to control for heterogeneity would slightly underestimate the impact of wealth index on fertility in rural and urban areas.

4.4 Regression Results and Discussion for Fertility Models with Regional Dummies

This chapter also analyzed the effect of wealth index on fertility while including regional dummies. Table A1 presents the results for the fertility model while controlling for the regional dummies. Columns 1 and 2 (OLS and ZIP respectively) present results where endogeneity of wealth index in the fertility model is not controlled for. Columns (3) and (4) present the two-stage least square results. The control function approach results are presented in columns (5), (6) and (7). Except for the results of the effects of regional dummies on fertility, those for other independent variables are consistent with the full sample results presented in table 4.2.

The results for R-squared values indicate that between 69 percent and 70 percent of the total variation in fertility is explained by the explanatory variables. This is consistent with the full model. The Wald Chi-square, F and LR Chi-square tests for goodness of fit suggest that the model parameters are jointly different from zero; hence the estimated models fit the data better than the intercept-only model. The Vuong test also favours choice of the ZIP over the Poisson model as in the full, rural and urban sample results.

The results indicate that relative to a woman living in the Western region, a woman from Central Uganda would have 0.12 and 0.04 less children for the OLS and ZIP models respectively. Living in the Eastern relative to the Western region will lower fertility by 0.11 and 0.04 children for the OLS and ZIP models respectively. The results for the Eastern and Northern regions could be explained by the effects of insecurity caused by the war which occurred for more than 15 years in Northern Uganda. The Eastern region was affected by the distress and conflict caused by people migrating there from the Northern region to escape insecurity. In turn insecurity and instability in the Eastern and Northern regions disrupted economic activities, normal family life and child bearing, thus lowering fertility rates despite the fact that these are the poorest regions in the country (Republic of Uganda, 2004).

Results for Instrumental Variable Model with Regional Dummies

First Stage Wealth Index Results

The instrumental variables used here are time to water source and distance to most common agricultural input market which are different from those used in the full and sub-sample models. This is partly due the fact that distance to NGO health facility (used in the full and the two sub-sample models) was significant in both the structural and reduced form models controlling for regional dummies, hence not fulfilling the qualities of a valid instrument. The two instruments in column 3 of table A1, negatively and significantly affect wealth index. An increase in time to water source by 1 minute lowers the wealth index by 0.003, while an increase in the distance to most common agricultural market by 1 kilometer lowers the wealth index by 0.002. This implies that first, the more time a woman takes to get to the water source, the lower will be her wealth status. Second, the longer the distance a woman travels to get to the most common agricultural input market, the lower will be her wealth status other factors held constant. In other words, limited access to infrastructural services like water and markets is highly associated with poorer than wealthier women.

The results in table A1 column (3) show that living in Central relative to the Western region increases the wealth status of women by 0.06, other factors held constant. These results could be explained by the fact that the Central region is the most developed of all the four regions of the country. It has the best infrastructure, services and markets for output. All these work in favour of wealth accumulation in the Central region. On the contrary, living in the Eastern and Northern regions has a negative, but insignificant effect on wealth index.

Second Stage Fertility Results for Instrumented Wealth Index with Regional Dummies

The results indicate that living in the Central and Eastern regions is associated with lower fertility rates than being located in the Western region, other factors held constant. For instance relative to living in the Western region, women living in the Central and Eastern regions are likely to have 0.11 and 0.10 fewer children respectively. The coefficient for Northern region is negative but insignificant.

Testing for Validity of Instrumental Variables, Endogeneity and Heterogeneity with Regional Dummies

Table A1 also presents the results testing for the validity of instrumental variables, endogeneity and heterogeneity while controlling for regional dummies. The joint test of significance for the two instruments causes the null hypothesis that the two instruments are equal to zero to be rejected, thus suggesting that the two instruments are relevant and valid. To check for overidentification of the models, the Sargan and Basmann tests are conducted. These results (magnitude of the coefficient = 0.01 and the p-value = 0.91) indicate that there is no overidentification problem. Hence the fertility model is correctly specified and the two instrumental variables are valid.

We further test for endogeneity of wealth index in the fertility model with regional dummies. The post estimation endogeneity test results were inconclusive. Although the CFA model results in column (5) show that residuals are insignificant, they become significant in column (6) after the inclusion of the interaction term (wealth index with its residuals) in the fertility model. The significance of the residuals in column (6) suggests that wealth index may be endogenous to fertility.

Control Function Approach Fertility Results with Regional Dummies

The CFA results are presented in columns (5), (6) and (7) of appendix table A1. The results indicate that living in the Central region is likely to lower women's fertility relative to living in the Western region, other factors held constant. For example, compared to living in the Western region, living in the Central region will lower fertility by 0.11, 0.12 and 0.11 children in columns (5), (6) and (7) respectively. Relative to living in the Western region, living in the Eastern region lowers fertility by 0.10 children for all the CFA models.

The results testing for heterogeneity arising from unobserved factors in the fertility models with regional dummies are presented in columns (6) and (7) of table A1. The effect of interacting wealth index and residuals on fertility is negative and insignificant. The inclusion of other interaction terms in column (7) indicates that interacting wealth index residuals with wealth index, post-secondary education and woman's current age are sources of heterogeneity. With the new control variables introduced in the fertility model, the magnitude of the wealth index coefficient increases from 0.19 (OLS) to 0.32 (CFA) - suggesting that, the influence of wealth on fertility would be underestimated, if heterogeneity is not accounted for.

4.5 Conclusion and Policy Implications

Summary and Conclusion

This chapter sought to investigate the effect of poverty on fertility. Our study uses wealth index as a proxy for poverty and number of children ever born for fertility. We use various estimation methods, specifically the OLS, ZIP, Instrumental Variable and the control function approach.

The results indicate that wealth index is negatively correlated with fertility of the woman. Furthermore, women's post-primary (secondary and post-secondary) education has negative and significant effect on fertility, suggesting the importance of investing in human capital to reduce fertility. Age of a woman positively affects fertility while the impact of age squared on fertility is negative. Thus, the age variable indicates a non-linear impact on fertility for all models. Marital status also plays a key role in influencing the number of children a woman will bear: being married positively and significantly affects fertility relative to not being married. Religion also influences fertility with Muslim women having higher fertility rates relative to their Pentecostal/SDA/other counterparts. Another result is that educated women are generally wealthier than their uneducated counterparts.

This chapter makes several contributions to literature. First, to the best of my knowledge this chapter is the first to control for both endogeneity and heterogeneity in the wealth index-fertility relationship for the case of Uganda. The instrumental variable results suggest that wealth index may not be endogenous to fertility. For all the models, the findings indicate the presence of heterogeneity in the fertility-wealth index relationship. The indicators of heterogeneity include the interaction of wealth index with wealth index residuals, interaction of post-secondary education with wealth index residual as well as the interaction of current age of the woman with wealth index residual. In other words, the effect of wealth index changes depending on the woman's level of education and her age. Therefore failure to address heterogeneity would underestimate the effect of wealth index on fertility. In turn, wealth creation as a measure for lowering fertility would be given less weight in favour of other policy interventions. Second, this study is the first to use the ZIP model to investigate the wealth index-fertility relationship in Uganda. The ZIP model treats fertility as a count variable and it also helps to account for the many childless women encountered in the fertility data. Compared with the ZIP, the OLS model may generate biased results (Long, 1997; Poston and McKibben, 2003). In this chapter, under the OLS model where wealth index is treated as exogenous, the effect of wealth index on fertility may be overestimated, thereby generating biased conclusions and policies. Third, the chapter also recommends important policies for lowering poverty and in turn reducing fertility in Uganda.

Policy Implications

The findings of this study suggest a number of policy implications: First, improvement in household wealth index will enhance its welfare and reduce women's fertility rates**.** This policy recommendation is based on our findings that wealth index negatively affects fertility.

Second, investment in female education especially post-primary (secondary and post-secondary) education should be promoted in order to reduce fertility in the country. This policy is based on the study findings that women with post-primary education are likely to have lower fertility rates than their counterparts with no education. The policy can be promoted by extending Universal Secondary Education (USE) to other parts of the country, as the current USE policy which offer free secondary education is in few selected schools and areas.

The chapter demonstrates the importance of accounting for endogeneity, and also heterogeneity due to unobservable determinants of fertility that could be correlated with poverty. Ignoring heterogeneity would for instance, underestimate the effect of wealth index on fertility, and in turn wealth improvement will be given less emphasis compared to other policy alternatives.

CHAPTER FIVE: CHILD NUTRITIONAL STATUS AND POVERTY

5.0 Introduction

This chapter presents the descriptive statistics and regression results investigating the effect of poverty on child nutritional status in Uganda. The nutritional status of children aged between 0-59 months is measured by height-for-age Z-scores (HAZ) and the probability of a child being stunted (equal to 1 if height-for-age <-2, and zero otherwise). Wealth index is used to proxy poverty. We first discuss the descriptive statistics followed by the regression results of the full sample, and sub-samples for area of residence (urban/rural).

5.1 Descriptive Statistics

The descriptive statistics for the variables used in the analysis are presented in table 5.1. The results indicate that children aged between 0-59 months have on average -1.54 Z-scores of height-for-age. This is quite comparable with -1.5 Z-scores reported by the Uganda Demographic and Health Survey (UDHS) of 2006. Consistent with the UDHS 2006 report, the results in table 5.1 further show that 38 percent of children are stunted in Uganda (Uganda Bureau of Statistics and Macro International Inc., 2007).

Table 5.1 shows that the mean wealth index of households in which children live is 1.2. The wealth index ranges from 0.01 to 5.41 with a median of 0.9871. Fifty percent of the children are male. Only 2 percent of the children in the sample are of multiple births - this is lower than that for Kenya and Senegal where 3 percent of the children are of multiple births (Kabubo-Mariara et al., 2012; 2009b; Linnemayr and Alderman, 2006). The results further show that, on average, most of the children are of the 4^{th} birth order with mean age of 28 months.

The mean age of mothers in the sample is 28.98 years and their average height is 159 centimeters. The results indicate that 77 percent of the households where the child under five years belong are male-headed and that the household on average comprises of 6.7 members. The mean age of a household head is 36.96 years. The education level statistics for mothers indicate that 24 percent have no education, 63 percent have primary education, 11 percent possess secondary education and only 2 percent have post-secondary education.

The marital status categories show that 3 percent of the mothers have never been married, 89 percent are currently married and 8 percent are divorced/separated/widowed. The data also shows that 39 percent of the mothers used professional care at birth (nurse/midwife). In addition, 89 percent of the children in the sample reside in rural areas compared to only 11 percent in urban areas. In terms of the regions of the country, the results indicate that 30 percent of the children live in the Central region, 31 percent in the Eastern region, 33 percent in the Northern region and only 6 percent in the Western region.

Table 5.1: Descriptive Statistics for Child Nutritional Status Model Variables

Variable	Observations	Mean	Standard Deviation
Height-for-age (HAZ)	2356	-1.54	1.56
Probability of being stunted (<-2 = 1, zero otherwise)	2356	0.38	0.49
Wealth index	2500	1.20	0.86
Sex of child (Male = 1, zero otherwise)	2500	0.50	0.50
Child of multiple birth	2500	0.02	0.15
Birth order	2500	4.36	2.60
Age of child (months)	2500	27.92	17.20
Age of child squared (months)	2500	1075.27	1029.37
Mother's age (years)	2500	28.98	6.65
Mother's age squared (years)	2500	884.21	408.47
Mother's height (centimeters)	2473	159.01	6.46
Sex of household head (Male =1, zero otherwise)	2500	0.77	0.42
Household size	2500	6.70	2.70
Age of household head	2500	36.96	11.76
Education level of mother			
No education	2500	0.24	0.43
Primary	2500	0.63	0.48
Secondary	2500	0.11	0.31
Post-secondary	2500	0.02	0.15
Marital status			
Never married	2500	0.03	0.16
Currently married	2500	0.89	0.31
Divorced/separated/widowed	2500	0.08	0.27
Professional care at birth (nurse/midwife)	2500	0.39	0.49
Area of residence (rural = 1, zero otherwise)	2500	0.89	0.31
Regions of the country			
Central	2498	0.30	0.46
Eastern	2498	0.31	0.46
Northern	2498	0.33	0.47
Western	2498	0.06	0.24
Proxies of market access			
Distance to feeder roads (kilometers)	2495	3.32	8.15
Distance to telephone facility (kilometers)	2400	1.44	2.99
Time to water source (minutes)	2405	60.02	57.26

Source: Author's computation based on a combined dataset of UDHS 2006 and UNHS 2005/06

Table 5.1 also shows the proxies of market access which are used as instrumental variables for wealth index in the child nutritional status model - these include distance to feeder roads (kilometers), distance to telephone (kilometers) and time to water source in minutes (one way). On average, women are located 3.32 kilometers away from feeder roads and 1.44

kilometers from telephone facilities. It takes an average of 60.02 minutes for women to get to the water source.

The descriptive statistics by region (not shown) further indicates that relative to the Western region, the average distance to feeder roads and to telephone facilities in the Central region are 3.63 kilometers and 1.59 kilometers respectively, while the time to water source is 57.11 minutes. On average, the distances to feeder roads and to the telephone facilities in the Eastern region are 1.30 kilometers and 1.17 kilometers respectively, while the time to water source is 60.74 minutes compared to the Western region. Relative to the Western region, the Northern region has mean distance to feeder roads and to telephone facilities of 5.44 and 1.5 kilometers respectively, and time to water source of 62.56 minutes. The mean distance to feeder roads and to telephone facilities in the Western region are 0.83 and 1.50 kilometers respectively while time to water source is 56.27 minutes.

Table A9 in the appendix presents the descriptive statistics for rural/urban sub-samples. As expected, the mean values for variables in the rural sample are quite comparable with the full sample results in table 5.1. In rural areas, for instance, height-for-age (HAZ) has an average of -1.60 Z-scores almost close to -1.54 Z-scores for the full sample. The mean probability of a child being stunted is 0.40 in rural areas relative to 0.38 in the full sample. On average, wealth index is 1.03 comparable to 1.20 for the full sample. The urban sample results however differ from those for the full sample. The mean HAZ is -0.99 in urban areas better than -1.54 in the full sample, while the probability of a child being stunted (0.26) is lower in urban areas than for the full sample (0.38); suggesting that on average children in urban areas are better off in terms of child nutrition than the average Ugandan child. In the rural/urban sub-samples, the differences in the mean values for majority of the variables are statistically significant; except for male children, multiple births children, child’s age, maternal height, divorced/separated/widowed mothers and distance to telephone facility.

5.2 Regression Results and Discussion for the Full Sample

This section presents and discusses the results for the effect of poverty on child nutritional status. The results are presented in tables 5.2 and appendix table A3. The following height-for-age (HAZ) models are estimated: an Ordinary Least Square (OLS) model which treats wealth index as exogenous and an instrumental variable (IV) model accounting for potential endogeneity of wealth index. The control function approach (CFA) model to account for possible heterogeneity in child nutritional status is also estimated. Since the probability of a child being stunted is a binary variable - first, a probit model treating wealth index as exogenous and second, an instrumental variable probit model controlling for potential endogeneity of wealth index are estimated. To control for heterogeneity in the probability of a child being stunted, a probit model using the CFA is also estimated. We mainly discuss marginal effects for the probability of a child being stunted (chronic malnutrition) results - because marginal effects in non-linear models give the exact magnitude of a change in the dependent variable due to a change in the covariates compared to the coefficients (Dong and Lewbel, 2010; Cameron and Trivedi, 2005).

The results for child nutritional status are presented in table 5.2. Column (1) presents the OLS model results, column (2) the marginal effects after probit, column (3) the second stage instrumental variable model, and column (4) the marginal effects after IVProbit. Columns (5) and (7) present the control function approach models for HAZ. The marginal effects after probit models for the control function approach (probability of a child being stunted) are presented in columns (6) and (8).

The results testing for the goodness of fit of the model (Wald Chi-square, F and LR Chi-square) are highly significant, thus suggesting that all model parameters are jointly different from zero. Therefore all the models in table 5.2 fit the data better than the intercept-only model. The R-squared results for HAZ models are quite low ranging from 5 to 17 percent. The pseudo R-squared is also quite low. It indicates that the independent variables explain only 9 percent of the total variation in chronic malnutrition. The low R-squared and pseudo R-squared are common for studies using cross sectional data.

Table 5.2: Effect of the Wealth Index on Child Nutritional Status under different Assumptions - Full Sample

Variables	Child Nutritional Status Models (HAZ and Probability of a Child being Stunted)							
	Models with exogenous wealth index		Models with instrumented wealth index		Control function approach models			
	(1) OLS HAZ model	(2) Marginal effects after probit	(3) 2nd stage HAZ model	(4) Marginal effects after IVProbit	(5) HAZ, wealth index residuals	(6) Marginal effects after probit	(7) HAZ, wealth index residuals and interactions with wealth index	(8) Marginal effects after probit
Wealth index	0.2208*** [0.049]	-0.0580*** [0.018]	1.0826 [0.726]	-0.2667 [0.209]	1.0612 [0.664]	-0.2621 [0.232]	1.0713 [0.665]	-0.2655 [0.232]
Sex of child (Male = 1, zero otherwise)	-0.1641*** [0.059]	0.0603*** [0.021]	-0.1205* [0.067]	0.0454* [0.023]	-0.1200* [0.063]	0.0481** [0.022]	-0.1201* [0.063]	0.0481** [0.022]
Child of multiple birth	-0.8709*** [0.196]	0.2842*** [0.066]	-0.6980** [0.280]	0.2440** [0.113]	-0.7072*** [0.259]	0.2647*** [0.090]	-0.7080*** [0.259]	0.2650*** [0.090]
Birth order	-0.0075 [0.022]	0.0028 [0.008]	-0.0162 [0.025]	0.0048 [0.008]	-0.0139 [0.023]	0.0044 [0.008]	-0.0143 [0.023]	0.0045 [0.008]
Age of child (months)	-0.0843*** [0.007]	0.0245*** [0.003]	-0.0836*** [0.007]	0.0233*** [0.004]	-0.0832*** [0.007]	0.0245*** [0.003]	-0.0833*** [0.007]	0.0245*** [0.003]
Age of child squared (months)	0.0011*** [0.0001]	-0.0003*** [0.0004]	0.0010*** [0.0001]	-0.0003*** [0.0001]	0.0010*** [0.0001]	-0.0003*** [0.00004]	0.0010*** [0.0001]	-0.0003*** [0.00004]
Height of mother (centimeters)	0.0490*** [0.005]	-0.0158*** [0.002]	0.0585*** [0.010]	-0.0170*** [0.002]	0.0588*** [0.010]	-0.0179*** [0.004]	0.0590*** [0.010]	-0.0179*** [0.004]
Mother’s age (years)	0.0472 [0.037]	-0.0087 [0.013]	0.035 [0.045]	-0.0058 [0.015]	0.0333 [0.043]	-0.0061 [0.015]	0.0336 [0.043]	-0.0061 [0.015]
Mother’s age squared (years)	-0.0006 [0.001]	0.0001 [0.0002]	-0.0004 [0.001]	0.00003 [0.0002]	-0.0003 [0.001]	0.00003 [0.0002]	-0.0003 [0.001]	0.00003 [0.0002]
Age of household head	0.00236 [0.003]	-0.0010 [0.001]	0.0022 [0.003]	-0.001 [0.001]	0.0023 [0.003]	-0.0012 [0.001]	0.0023 [0.003]	-0.0012 [0.001]
Household size	-0.0015 [0.013]	0.0039 [0.005]	-0.0245 [0.023]	0.0102 [0.006]	-0.0254 [0.022]	0.0107 [0.008]	-0.0254 [0.022]	0.0107 [0.008]
Sex of household head (Male =1, zero otherwise)	0.1637** [0.080]	-0.0477* [0.029]	0.1691* [0.087]	-0.0546* [0.030]	0.1667** [0.082]	-0.0573* [0.029]	0.1654** [0.083]	-0.0569* [0.030]
Education level of mother *(No education = reference)*								
Primary	0.0689 [0.076]	-0.0429 [0.026]	-0.1876 [0.236]	0.0174 [0.076]	-0.1877 [0.222]	0.014 [0.077]	-0.1893 [0.222]	0.0146 [0.077]
Secondary	0.1374 [0.124]	-0.1021** [0.040]	-0.5646 [0.616]	0.0726 [0.202]	-0.5512 [0.567]	0.0612 [0.205]	-0.556 [0.568]	0.063 [0.205]
Post-secondary	0.4457** [0.226]	-0.1910*** [0.067]	-0.8305 [1.179]	0.0785 [0.403]	-0.7587 [1.051]	0.0411 [0.384]	-0.7667 [1.051]	0.0432 [0.385]
Marital status *(Never married = reference)*								

Currently married	0.2248 [0.200]	-0.0782 [0.074]	0.2172 [0.216]	-0.0700 [0.073]	0.2078 [0.204]	-0.0716 [0.075]	0.2067 [0.204]	-0.071 [0.075]
Divorced/separated/widowed	0.3751* [0.212]	-0.0792 [0.070]	0.4408* [0.237]	-0.0906 [0.069]	0.4222* [0.220]	-0.0899 [0.071]	0.4206* [0.220]	-0.0891 [0.071]
Professional care at birth (nurse/midwife)	0.1819*** [0.066]	-0.0528** [0.023]	-0.0028 [0.181]	-0.0066 [0.060]	-0.0055 [0.172]	-0.0096 [0.060]	-0.0059 [0.172]	-0.0094 [0.060]
Area of residence (rural = 1, zero otherwise)	-0.1734 [0.120]	0.0194 [0.043]	0.9275 [0.923]	-0.2613 [0.277]	0.8935 [0.840]	-0.2502 [0.301]	0.9015 [0.840]	-0.2531 [0.300]
Control function variables								
Reduced form wealth index residuals					-0.8493 [0.666]	0.208 [0.232]	-0.8332 [0.668]	0.2031 [0.233]
Interaction of wealth index residuals and wealth index							-0.0122 [0.042]	0.004 [0.015]
Constant	-9.5357*** [0.920]		-12.3741*** [2.588]		-12.3348*** [2.400]		-12.3732*** [2.404]	
Observations	2,346	2,346	2,249	2,249	2,249	2,249	2,249	2,249
R-squared /Pseudo R-squared	0.166	0.0922	0.054		0.165	0.0932	0.165	0.0932
F/Wald Chi/LR chi2	F(19, 2326) = 24.30***	LR chi2(19) = 287.92***	Wald chi2(19) = 377.07***	Wald chi2(19) = 297.68***	F(20, 2228) = 22.05***	LR chi2(20) = 278.64***	F(21, 2227) = 21.00***	LR chi2(21) = 278.71***
Log likelihood		-1416.6108		-3389.3698		-1355.8055		-1355.7714
Durbin (score) chi2(1)			1.62059 (p = 0.2030)					
Wu-Hausman F(1,2228)			1.60661 (p = 0.2051)					
Test for excluded instruments								
F(2,2228)			6.05075	6.05075				
Prob > F			0.0024	0.0024				
Partial R2 for excluded instruments			0.0054	0.0054				
Sargan (score) chi2(1)			0.23756 (p = 0.6260)	0.576172 (p = 0.4478)				
Basmann chi2(1)			0.235367 (p = 0.6276)	0.570938 (p = 0.4499)				
Wald test of exogeneity				chi2(1) = 0.87 Prob > chi2 = 0.3511				

Note: Standard errors in parenthesis, ***, **, * Significant at 1%, 5% and 10% respectively.

Columns (6) & (8) Marginal effects after probit (for models of probability of a child being stunted with wealth index residuals, and probability of being stunted with wealth index residuals and interaction with wealth index respectively).

The OLS results treating wealth index as exogenous indicate that wealth index positively and significantly affects nutritional status of children aged between 0-59 months. The results in column (2) indicate an inverse correlation between wealth index and the probability of a child being stunted. For example, an increase in wealth index by 1 increases the height of children by 0.22 Z-scores relative to their counterparts from poor households, other factors held constant. The marginal effects with exogenous wealth index show that the probability of a child being stunted falls by 0.06 points with a one unit increase in wealth index, *ceteris paribus*. These results support Sahn and Stifel (2003) who found that asset (wealth) index is an important and valid determinant of child nutritional status. Although wealth index positively affects the height of the children in the second stage IV HAZ model, and control function approach models, this effect is insignificant. While the marginal effects after IVProbit and those after the probit control function approach models indicate an inverse correlation of wealth index with chronic malnutrition, the results are insignificant.

The results also indicate that boys tend to have lower nutritional status than girls other factors held constant. Compared to girls, boys' height-for-age is on average 0.16 and 0.12 Z-sores lower in OLS and in all other HAZ models respectively. The marginal effects in column (2) show that boys are 0.06 points more likely to be stunted than girls, other factors held constant. The marginal effects after IVProbit and probit CFA models indicate that boys are 0.05 points more likely to be chronically malnourished than girls. The results can be explained first, by physiological factors such that girls tend to grow faster than boys. Second, due to sociological factors in the African context, girls often spend more time with their mothers than boys. In turn, girls have more food and thus better nutrition than boys (Abalo, 2009). Our results support findings by Ssewanyana (2003); Teshome et al. (2009) and Masiye et al. (2010) which also found that boys are likely to be more malnourished than girls other factors held constant.

Furthermore results in table 5.2 indicate that children of multiple births are likely to be more malnourished than singletons. For instance, the OLS and second stage IV HAZ results show that the height of a child of multiple births is 0.87 and 0.70 Z-scores lower than that of a singleton respectively. The results of multiple birth children for the control function approach HAZ models are consistent with those for the second stage IV HAZ model in terms of signs but with slight differences in the magnitudes and levels of significance of the coefficients. The marginal effects after probit and IVProbit (column 2 and 4 respectively) show that children of multiple births are 0.28 and 0.24 points respectively more likely to be stunted than singletons. Using the control function approach, we found that a child of a multiple birth's probability of being stunted is 0.26 points higher (in column 6), and 0.27 points higher (in column 8, and column 2 of table A3) than that for singletons, *ceteris paribus.* These results support studies by Linnemayr and Alderman (2006); Kabubo-Mariara et al. (2009b) and Adewara and Visser (2011) which also conclude that children of multiple births are more likely to be malnourished than singletons. These results can be explained by less breast feeding and low birth weight which are often associated with multiple birth children (Kabubo-Mariara et al., 2009b).

The age of a child in months is inversely and significantly correlated with his/her nutrition other factors held constant. Results for all models in table 5.2 show that the height of a child falls by 0.08 Z-scores as a child's age increases by one more month, other factors held constant. The results for child's age squared show a positive and significant influence on his/her nutritional status. The marginal effects indicate that the probability of a child being stunted increases by 0.02 points with a 1 month increase in the child's age. A child's age exhibits a U-shaped relationship with his/her nutritional status. These results support previous child nutrition studies (Ssewanyana, 2003; Garcia and Alderman, 1989; Chirwa and Ngalwa, 2006). As infants grow older they tend to be malnourished because of weaning which reduces breast milk available to them (Adewara and Visser, 2011; Babatunde et al., 2011), but malnutrition declines as they mature and a variety of nutritious foods are introduced (Kabubo-Mariara et al., 2009b).

The results for mother's height indicate that a child born of a tall mother is likely to have better nutritional status than his/her counterparts born of a shorter mother, holding other factors constant. The OLS model results suggest that an increase in mother's height by 1 centimeter increases the child's height by 0.05 Z-scores, *ceteris paribus*. The other HAZ model results (columns 3, 5 and 7 of table 5.2, and 1 of table A3) indicate that an increase in mother's height by 1 centimeter increases child's height by 0.06 Z-scores other factors held constant. The likelihood of children being stunted is 0.02 points lower with a one centimeter increase in mother's height for all models in table 5.2, *ceteris paribus*. Our findings are consistent with studies by Strauss (1990) and Horton (1988) which found a positive and significant impact of mother's stature on the nutritional status of children. The results for the probability of a child being stunted further support a study by Adair and Guilkey (1997) which indicates that mother's height lowers the likelihood of stunting in children. These results can be explained by the fact that maternal height incorporates the genetic factors and family background characteristics which affect child nutrition as well but are not captured by other maternal characteristics such as education (Sahn and Alderman, 1997; Kabubo-Mariara et al., 2009b).

Children from male-headed households are likely to be better nourished than those from female-headed households holding other factors constant. This effect is statistically significant for all models. For example relative to children from female-headed households, those from male-headed households are 0.16 Z-scores taller (OLS model) and 0.17 Z-scores taller for other HAZ models in table 5.2. Similarly results further indicate an inverse correlation between male household headship and the likelihood of a child being stunted. The marginal effects where wealth index is treated as exogenous and those with instrumented wealth index indicate that the probability of a child being stunted is 0.05 points lower for children from a male-headed household than those from a female-headed one, *ceteris paribus*. The results for the CFA models show that the probability of a child being stunted is 0.06 points lower in a male-headed household than in a female-headed one. These results could be explained by the fact that relative to female-headed households, male-headed households tend to have better access to economic resources and opportunities like jobs that in turn positively affect the nutrition of children (Babatunde and Martinetti, 2010; Haidar and Kogi-Makau, 2009). Male-headed households are also likely to have more adults - head and spouse whose resources are used to care for children compared to female-headed households which may have fewer adults, and therefore limited resources.

However, our findings for the effect of gender of household head on child nutrition, do not concur with some studies such as Rogers (1991) and Bomela (2007). These studies found that children from female-headed households had better nutritional status than those from male-headed ones. This difference in results could be explained by the fact that relative to Uganda, the focus of this thesis, Dominican Republic and South Africa are middle income countries where Rogers (1991) and Bomela (2007) respectively carried out their studies. Compared to Uganda, the high level of development in the two countries allows a higher participation rate of women in the labour market which in turn increases their power in decision making over consumption of food and other nutrients for children from female-headed households. In addition, literature has shown that female-headed households in Uganda are poorer than male-headed households (Ssewanyana, 2009) - this might negatively impact the quality and quantity of food available for boosting the nutritional status of children from female-headed households.

Mother's education has a positive effect on child nutritional status, but only the effect of post-secondary education is significant in the OLS model. The OLS results show that children born of mothers with post-secondary education are 0.45 Z-scores taller than children whose mothers have no formal education. The marginal effects for mother's education in column 2 of table 5.2 show a significant inverse correlation with the child's probability of being stunted. For instance, chronic malnutrition is 0.10 and 0.19 points lower for children born to mothers with secondary and post-secondary education respectively, relative to children whose mothers have no formal education. Our findings can be explained by the fact that maternal education may facilitate acquisition of general health/nutritional knowledge in form of care practices such as hygiene, and ability to detect, and to seek treatment for illnesses (Glewwe, 1999). In turn, access to such nutritional knowledge by mothers, can improve child nutritional status (Thomas et al., 1991; Frosta et al., 2005). These findings support studies by Strauss (1990) and Kabubo-Mariara et al. (2009b) which conclude that maternal education especially post-primary education is an important determinant of child nutritional status.

Further, relative to mothers who have never married, the divorced/separated/widowed mothers tend to have better nourished children. Children of divorced/separated/widowed mothers are 0.38 Z-scores taller in the OLS model, 0.44 Z-scores taller in the second stage instrumental variable model, and 0.42 Z-scores taller in the CFA models than children for mothers who have never married, *ceteris paribus*. Mothers who use professional care at birth (i.e. nurse/midwife) are likely to have better nourished children than those who do not holding other factors constant. For instance, children whose mothers use professional care at birth are 0.18 Z-scores taller in the OLS model than children whose mothers do not use such care, other factors held constant. The marginal effect in column (2) indicates that the likelihood of being stunted is 0.05 points lower for children whose mothers use professional care at birth than children of mothers who do not use such care. These results could be explained by the possibility that such mothers obtain pre-natal care and useful information about child nurturing from the nurses/midwives, which positively impact the nutrition of the children (Garcia and Alderman, 1989). It is also possible that those mothers have a better general access to health care providers which could have also helped with the child nutrition.

Testing for Validity of Instruments, Endogeneity and Heterogeneity for the Full Sample

Wealth index is potentially endogenous in the child nutritional status model. For this reason, it is important to instrument for wealth index in order to account for its endogeneity. For reliability of results, it is crucial to test for the validity of its identifying instruments (relevance, strength and exogeneity of instruments). The instrumental variables used in the full model are distance to feeder roads and distance to telephone, and the test results for these excluded instruments indicate the magnitude of the first-stage F-statistic as 6.05 and p-value as 0.00. In addition, the instruments are significant in the wealth index equation but not in any of the child nutritional status models. These test results imply that all instruments are relevant and valid for wealth index. The first-stage F-statistic is less than 10 percent suggesting that although the instruments are weak, the results can still be used for inference (Mwabu, 2009; Mugo, 2012). Except for the test results for excluded instruments, other first stage wealth index results are not presented in this chapter.

Due to the fact that wealth index is the only potentially endogenous variable in the child nutritional status model, yet we have two indentifying instruments, it is crucial to test for overidentification. In other words, we have to check whether the excluded instruments are correlated with the error term of the child nutritional status model. To this effect, the Sargan and Basmann tests are conducted - both tests fail to reject the null hypothesis that instruments are uncorrelated with the error term of the child nutritional status models; thus indicating absence of overidentification. Therefore the two instruments were correctly excluded from the child nutritional status model, and the model is correctly specified.

We also check whether wealth index is really endogenous in the child nutritional status model. This was done by carrying out the Durbin-Wu-Hausman test for exogeneity in the HAZ model, and the Wald test of exogeneity in the probability of a child being stunted model. The test for endogeneity of wealth index was necessary because literature argues that poverty, (in this thesis measured by wealth index) is potentially endogenous to child nutritional status (Haddad et al., 2003; Lawson, 2004). The results for the instrumental variable models (second stage IV and IVProbit) indicate that wealth index may be exogenous in the child nutritional status model. This result is however not unusual, as Haddad et al. (2003) reported that in some countries, per capita consumption (a proxy for poverty) was not necessarily endogenous to child nutrition. The test results are further supported by the fact that the residuals of wealth index in the CFA models are insignificant.

The control function approach results testing for heterogeneity in the full sample are presented in columns (7) and (8) of table 5.2, and table A3 (columns 1 and 2). To account for heterogeneity, we included interaction terms of wealth index with its residuals, and also interactions of each of mother's education, and age variables with wealth index residuals as control variables. The results indicate that none of these control variables is significant. This therefore suggests absence of heterogeneity that would arise from unobserved factors that affect child nutritional status but may be correlated with wealth index.

5.3 Regression Results and Discussion for the Rural and Urban Sub-Samples

The results for the rural and urban sub-samples are presented in tables 5.3 and 5.4. The OLS, second stage instrumental variable and marginal effects after probit and IVProbit results are presented in table 5.3. The control function approach results are in table 5.4. The HAZ results are presented in columns 1, 3, 5 and 7 of table 5.3, and also in columns 1, 3, 5 and 6 of table 5.4. Columns 2, 4 and 6 of table 5.3 along with columns 2 and 4 of table 5.4 present marginal effects of the probability of a child being stunted. In terms of signs and statistical levels of significance of the coefficients and marginal effects, the rural sample results are consistent with the full sample results. The magnitudes of the coefficients and marginal effects in the rural sample differ slightly from the full sample. The IVProbit and probit control function approach model results for urban areas are presented in appendix table A5. The instrumental variable (time to water source) for urban areas, is invalid in the probability of a child being stunted model and therefore the results are not discussed.

The test results for the model's goodness of fit (Wald Chi-square, LR Chi-square and F) in tables 5.3 and 5.4 for rural/urban sub-samples are highly significant and indicate that all the model parameters are jointly different from zero. This implies therefore that all models fit the data better than an intercept-only model. The R-squared results show that all the covariates explain between 12 percent and 18 percent of the total variation in child nutritional status. The pseudo R-squared is 9 percent and 12 percent in rural and urban areas respectively. The R-squared and pseudo R-squared depict similar low levels as in the full model.

The OLS results in rural and urban sub-samples indicate that wealth index positively affects child nutritional status; the results are statistically significant at 1 percent and 10 percent respectively. For instance, an increase in wealth index by 1 unit, increases children's height by 0.21 Z-scores (in rural areas) and by 0.24 Z-scores (in urban areas), other factors held constant. The marginal effects indicate that wealth index negatively impacts the child's probability of being stunted, but this is only significant for rural areas when wealth index is treated as exogenous. In rural areas, children's likelihood of being stunted is 0.07 points lower with a 1 unit increase in wealth index, *ceteris paribus*. These results support studies by Valdivia (2004) and Kabubo-Mariara et al. (2009b) which found that household assets have a large and significant effect on child nutritional status in rural areas. The marginal effect for wealth index in rural areas is larger than that of the full model. This suggests that the wealth index is an important predictor of child nutritional status in rural areas.

In rural areas, results for child characteristics (male child, multiple birth child, age in months), and household characteristics (mother's height, mother's age, mother's education, age of the household head and male headship of a household) in table 5.3, are consistent with the full sample results in terms of signs and levels of statistical significance. However, there are slight variations in the magnitude of the coefficients and marginal effects. The marginal effects in column (2) of table 5.3 indicate that; the likelihood of being stunted in rural areas for children born of mothers with secondary and post-secondary education is respectively 0.08 and 0.16 points lower than that for children born of uneducated mothers, *ceteris paribus*. Our findings are consistent with a study by Babatunde et al. (2011) which suggests that maternal education lowers childhood malnutrition. Maternal education may allow mothers to access various care practices and knowledge such as feeding on nutritious foods that help to lower chronic malnutrition in children.

The marginal effects after IVProbit in rural areas show that household size positively impacts the probability of a child being stunted at 10 percent level of significance, other factors held constant. For example, chronic malnutrition is 0.01 points higher for children in large households than their counterparts in small households. The results could imply competition for food amongst siblings (Kabubo-Mariara et al., 2009b). Consistent with the full sample, using professional care at child birth by mothers in rural areas positively and significantly affects children's nutrition. When wealth index is treated as exogenous, first the results show that children born of mothers who use professional care at birth are 0.18 Z-scores taller than children born of mothers who do not use such care, other factors held constant. Second, the marginal effects indicate that the probability of being stunted for children whose mothers use professional care at birth is 0.05 points lower than their counterparts whose mothers do not use this care.

In urban areas, only the male child dummy, age of child, age of child squared, mother's height and education levels (primary, secondary and post-secondary), have significant impacts on child nutritional status. These results differ from the full and rural samples in terms of level of significance, magnitudes of the coefficients and marginal effects. It is important to note that the effect of maternal education (primary, secondary and post-secondary) on children's height is positive and significant in urban areas. The reverse is observed for the impact of maternal education on the probability of a child being stunted. This suggests that education effects on child nutritional status are greater in terms of magnitudes and significance of coefficients in urban than rural areas. These results could be due to the fact that educated women in urban areas are more informed and exposed to child care practices like hygiene and feeding which improve nutrition than their educated rural counterparts.

Columns (3) and (7) of table 5.3 present the second stage child nutrition results with instrumented wealth index. The marginal effects after IVProbit in rural areas are presented in column (4). The results indicate that wealth index has an insignificant effect on the child nutritional status in rural and urban areas. In urban areas, education (primary and post-secondary) positively and significantly impacts child nutritional status (column 7). The effects of child's age and age squared on his/her height are highly significant and portray a U-shaped relationship with child nutritional status in urban areas.

Table 5.3: Effect of Wealth Index on Child Nutritional Results under OLS, Probit and IVProbit Assumptions – Rural/Urban Sub Samples

Variables	Child Nutritional Status Models (HAZ and Probability of a Child being Stunted)						
	Rural				*Urban*		
	Models with exogenous wealth index		Models with instrumented wealth		Models with exogenous wealth index		Model with instrumented wealth
	(1) OLS HAZ model	(2) Marginal effects after Probit	(3) 2nd stage HAZ model	(4) Marginal effects after IVProbit	(5) OLS HAZ model	(6) Marginal effects after Probit	(7) 2nd stage HAZ model
Wealth index	0.2076*** [0.055]	-0.0659*** [0.021]	0.7571 [0.707]	-0.3253 [0.205]	0.2357* [0.122]	-0.0059 [0.033]	-0.0789 [0.447]
Sex of child (Male = 1, zero otherwise)	-0.1315** [0.061]	0.0563** [0.022]	-0.0924 [0.066]	0.0383 [0.024]	-0.3795* [0.215]	0.0695 [0.057]	-0.349 [0.220]
Child of multiple birth	-0.8618*** [0.200]	0.2643*** [0.069]	-0.8131*** [0.255]	0.2297** [0.107]	-0.9177 [0.929]	0.4343 [0.293]	-1.2057 [0.982]
Birth order	-0.006 [0.023]	0.002 [0.008]	-0.0195 [0.029]	0.008 [0.009]	0.0245 [0.093]	0.0118 [0.026]	-0.0594 [0.116]
Age of child (months)	-0.0860*** [0.007]	0.0256*** [0.003]	-0.0846*** [0.008]	0.0239*** [0.004]	-0.0788*** [0.023]	0.0138** [0.007]	-0.0866*** [0.024]
Age of child squared (months)	0.0011*** [0.0001]	-0.0003*** [0.0004]	0.0011*** [0.0001]	-0.0003*** [0.0001]	0.0010** [0.0004]	-0.0002* [0.0001]	0.0011*** [0.0004]
Height of mother (centimeters)	0.0499*** [0.005]	-0.0163*** [0.002]	0.0547*** [0.010]	-0.0175*** [0.002]	0.0423** [0.020]	-0.0103* [0.006]	0.0273 [0.024]
Mother’s age (years)	0.0317 [0.039]	-0.0038 [0.014]	0.0357 [0.041]	-0.0034 [0.014]	0.1246 [0.148]	-0.0478 [0.038]	0.2046 [0.171]
Mother’s age squared (years)	-0.0004 [0.001]	1.80e-06 [0.0002]	-0.0004 [0.001]	-0.00002 [0.0002]	-0.0016 [0.002]	0.0007 [0.001]	-0.0029 [0.003]
Age of household head	0.0021 [0.003]	-0.0009 [0.001]	0.0023 [0.003]	-0.0009 [0.001]	0.0059 [0.013]	-0.0022 [0.003]	0.0103 [0.014]
Household size	-0.006 [0.014]	0.0035 [0.005]	-0.0212 [0.021]	0.0110* [0.006]	0.0315 [0.049]	0.0033 [0.013]	0.0737 [0.057]
Sex of household head (Male = 1, zero otherwise)	0.1680** [0.083]	-0.0544* [0.030]	0.1841** [0.087]	-0.0635** [0.032]	0.0968 [0.297]	0.0362 [0.079]	-0.0268 [0.327]
Education level of mother *(No education = reference)*							
Primary	0.0310 [0.077]	-0.0285 [0.028]	-0.1167 [0.215]	0.0402 [0.069]	0.8390** [0.405]	-0.2060** [0.095]	0.9886* [0.516]
Secondary	0.1338 [0.136]	-0.0795* [0.046]	-0.2866 [0.584]	0.1329 [0.193]	0.7969* [0.455]	-0.2636*** [0.096]	1.0270 [0.672]
Post-secondary	0.3748 [0.263]	-0.1566* [0.088]	-0.3486 [1.146]	0.1914 [0.387]	1.2421** [0.609]	-0.2520*** [0.046]	1.6544* [0.978]
Marital status (Never married = reference)							
Currently married	0.205	-0.0324	0.1938	-0.0253	0.293	-0.2473	0.5963

	[0.226]	[0.086]	[0.236]	[0.085]	[0.502]	[0.156]	[0.513]
Divorced/separated/widowed	0.3153 [0.237]	-0.0458 [0.085]	0.3562 [0.256]	-0.0633 [0.085]	0.6707 [0.569]	-0.1343 [0.098]	0.8984 [0.589]
Professional care at birth (nurse/midwife)	0.1827*** [0.067]	-0.0500** [0.024]	0.0772 [0.172]	0.0054 [0.059]	0.1448 [0.285]	-0.0456 [0.078]	0.4231 [0.317]
Constant	-9.4829*** [0.937]		-10.5997*** [1.771]		-10.8841*** [3.586]		-9.5157** [3.815]
Observations	2,098	2,098	2,004	2,004	248	248	229
R-squared/Pseudo R-squared	0.158	0.0885	0.117		0.171	0.1205	0.153
F/Wald Chi/LR chi2	F(18, 2079) = 21.61***	LR chi2(18) = 249.29***	Wald chi2(18) = 345.99***	Wald chi2(18) = 274.25***	F(18, 229) = 2.63***	LR chi2(18) = 34.38**	Wald chi2(18) = 44.04***
Log likelihood		-1284.3613		-2862.8408		-125.47064	
Durbin (score) chi2(1)			0.646281(p=0.4214)				0.469035(p=0.4934)
Wu-Hausman			F(1,1984) = 0.640038 (p = 0.4238)				F(1,209) = 0.42895(p= 0.5132)
Test for excluded instruments							
F-value			F(2,1984)=6.73581	F(2,1984) = 6.73581			F(1,210) = 17.9692
Prob > F			0.0012	0.0012			= 0.0000
Partial R2 for excluded instruments			0.0067	0.0067			= 0.0788
Sargan (score) chi2(1)			1.17583(p=0.2782)	0.121084 (p = 0.7279)			
Basmann chi2(1)			1.16478(p=0.2805)	0.119883 (p = 0.7292)			
Wald test of exogeneity				chi2(1) = 1.31 Prob > chi2 = 0.2527			

Note: Standard errors in parenthesis. ***, **, * Significant at 1%, 5% and 10% respectively

Testing for Validity of Instrumental Variables and Endogeneity for the Rural/Urban Sub-Samples

In this section, we test for the validity of the identifying instruments, and also account for the endogeneity of wealth index in the child nutrition models for the rural and urban sub-samples. The rural sample uses the same instruments as the full sample (distance to feeder road and distance to telephone facility), while the urban model employs only time to water source as the instrument. We used different instruments for the rural/urban sub-samples because distance to feeder roads and telephone facilities are jointly and statistically significant in the rural but not in the urban wealth index models. In addition, feeder roads are mostly common in rural than in urban areas. For urban areas, time to water source was found to satisfy the qualities of a valid instrument for the height-for-age (HAZ) model. In the urban sub-sample, the instrumental variable (time to water source), used in the height-for-age model, is invalid in the probability of a child being stunted model. Nevertheless, probability of a child being stunted urban sample results are presented in appendix table A5. Further, it may take a shorter time for women in urban areas to access the water source compared to their rural counterparts.

The test results on excluded instruments show F-statistics of 6.74 and 17.97 for rural and urban models respectively. The p-values are 0.00 in rural and urban areas. These results suggest that the instruments used in each case are relevant and valid for wealth index but weak for rural areas. The Durbin-Wu-Hausman test for exogeneity results shows that wealth index may not be endogenous to child nutritional status. The Wald test of exogeneity indicates absence of endogeneity of wealth index to the probability of a child being stunted in rural areas. Thus the rural/urban results with exogenous wealth index are reliable as they are free of possible endogeneity bias. In addition, the CFA results in table 5.4 show that residuals of wealth index are insignificant in all rural/urban child nutritional status models, thus supporting exogeneity of wealth index.

Other diagnostic tests checking for overidentification (Sargan and Basmann tests) were conducted for the rural model. These test results support acceptance of the null hypothesis that the instruments are uncorrelated with the disturbance term of the child nutritional status model, thus suggesting absence of overidentification. Therefore the two instruments are not correlated with the error term of the child nutrition model in rural areas; and the model is properly specified.

Results for Control Function Approach Model in the Rural and Urban Sub-Samples

The control function approach (CFA) model results for the rural and urban sub-samples are presented in table 5.4. Columns 1, 2, 3 and 4 present the rural sample results; while the urban sample results are in columns 5 and 6. The area of residence child nutritional status models with wealth index residuals are presented in columns 1, 2 and 5; while those for wealth index residuals and their interactions with wealth index are in columns 3, 4 and 6. The results for child nutritional status models with other interaction terms are presented in columns 3, 4 and 5 of table A3. In general, the CFA results for rural areas are consistent with those for the full sample. The urban results differ from the full model in terms of magnitude of the coefficients and statistical level of significance. Except for primary and post-secondary education, child age and age squared, the rest of the coefficients are insignificant in the urban sample. Primary education positively and significantly affects child nutritional status in urban areas. The urban sample results indicate that children born of mothers with primary education are 1.05 Z-scores taller than those whose mothers are uneducated, *ceteris paribus.* The urban model results in table A3 further indicate that children of mothers with primary and post-secondary education are 1.09 and 1.88 Z-scores taller respectively than children of uneducated mothers, other factors held constant. This emphasizes further the fact that maternal education is associated with improved child nutrition.

Table 5.4: Child Nutritional Status Control Function Approach Model Results by Area of Residence

Variables	Child Nutritional Status Models (HAZ and Probability of a Child being Stunted)					
	Rural				*Urban*	
	(1) HAZ with wealth index residuals	(2) Marginal effects after probit	(3) HAZ, wealth index residuals and their interactions with wealth index	(4) Marginal effects after probit	(5) HAZ with wealth index residuals	(6) HAZ, wealth index residuals and their interactions with wealth
Wealth index	0.7648 [0.687]	-0.3419 [0.248]	0.8138 [0.689]	-0.3602 [0.248]	-0.1088 [0.506]	-0.1138 [0.509]
Sex of child (Male = 1, zero otherwise)	-0.0898 [0.065]	0.0401* [0.023]	-0.0892 [0.065]	0.0398* [0.023]	-0.3412 [0.227]	-0.3397 [0.228]
Child of multiple birth	-0.8155*** [0.247]	0.2514*** [0.087]	-0.8156*** [0.247]	0.2519*** [0.087]	-1.243 [1.037]	-1.2327 [1.044]
Birth order	-0.019 [0.027]	0.008 [0.010]	-0.0198 [0.027]	0.0083 [0.010]	-0.0629 [0.123]	-0.0634 [0.124]
Age of child (months)	-0.0843*** [0.007]	0.0255*** [0.003]	-0.0845*** [0.007]	0.0256*** [0.003]	-0.0857*** [0.025]	-0.0857*** [0.025]
Age of child squared (months)	0.0011*** [0.0001]	-0.0003*** [0.0001]	0.0011*** [0.0001]	-0.0003*** [0.0001]	0.0011*** [0.0004]	0.0011*** [0.0004]
Height of mother (centimeters)	0.0551*** [0.010]	-0.0189*** [0.003]	0.0557*** [0.010]	-0.0191*** [0.003]	0.0262 [0.026]	0.0258 [0.026]
Mother's age (years)	0.0353 [0.041]	-0.0036 [0.015]	0.0354 [0.041]	-0.0034 [0.015]	0.2141 [0.184]	0.2144 [0.185]
Mother's age squared (years)	-0.0004 [0.001]	-0.00002 [0.0002]	-0.0004 [0.001]	-0.00002 [0.0002]	-0.003 [0.003]	-0.003 [0.003]
Age of household head	0.0023 [0.003]	-0.0009 [0.001]	0.0023 [0.003]	-0.0009 [0.001]	0.0097 [0.015]	0.0097 [0.015]
Household size	-0.0222 [0.021]	0.0121 [0.008]	-0.0232 [0.021]	0.0125* [0.008]	0.0774 [0.061]	0.0774 [0.062]
Sex of household head (Male = 1, zero otherwise)	0.1823** [0.086]	-0.0675** [0.031]	0.1778** [0.086]	-0.0657** [0.031]	-0.0298 [0.337]	-0.0289 [0.338]
Education level of mother (No education = reference)						
Primary	-0.1207 [0.211]	0.0419 [0.075]	-0.1303 [0.212]	0.0454 [0.075]	1.0489* [0.590]	1.0514* [0.592]
Secondary	-0.2962 [0.572]	0.1388 [0.214]	-0.3186 [0.572]	0.1474 [0.214]	1.0755 [0.749]	1.0821 [0.753]
Post-secondary	-0.3542	0.191	-0.3874	0.1976	1.6935	1.7032

	[1.106]	[0.418]	[1.106]	[0.417]	[1.058]	[1.064]
Marital status (Never married = reference)						
Currently married	0.1915 [0.232]	-0.026 [0.088]	0.1855 [0.232]	-0.0222 [0.088]	0.609 [0.532]	0.6104 [0.534]
Divorced/separated/widowed	0.3526 [0.250]	-0.065 [0.088]	0.3471 [0.250]	-0.0609 [0.088]	0.9091 [0.610]	0.919 [0.619]
Professional care at birth (nurse/midwife)	0.0736 [0.169]	0.005 [0.061]	0.0699 [0.169]	0.0062 [0.061]	0.4575 [0.352]	0.4588 [0.353]
Control function variables						
Reduced form wealth index residuals	-0.5653 [0.689]	0.2796 [0.248]	-0.5232 [0.691]	0.2615 [0.249]	0.345 [0.527]	0.3173 [0.590]
Interaction of wealth index residuals and wealth index			-0.0458 [0.050]	0.0188 [0.018]		0.0125 [0.119]
Constant	-10.6500*** [1.760]		-10.7571*** [1.764]		-9.4977** [3.953]	-9.4355** [4.006]
Observations	2,004	2,004	2,004	2,004	229	229
R-squared /Pseudo R-squared	0.158	0.0898	0.158	0.0902	0.175	0.175
F/Wald Chi/LR chi2	F(19, 1984) = 19.53***	LR chi2(19) = 241.79***	F(20, 1983) = 18.60***	LR chi2(20) = 242.82***	F(19, 209) = 2.33***	F(20, 208) = 2.20***
Log likelihood		-1224.6808		-1224.1633		

Note: Standard errors in parenthesis.

***, **, * Significant at 1%, 5% and 10% respectively

Columns (2) & (4) show Marginal effects after probit (models for Probability of being stunted with wealth index residuals, and Probability of being stunted, wealth index residuals and their interactions with wealth index respectively).

Testing for Heterogeneity in the Child Nutritional Status-Wealth Index Relationship

We also tested for heterogeneity in the wealth-child nutritional status relationship in the rural/urban models by including several control variables: wealth index residuals interacted with wealth index, primary education, secondary education, post-secondary education, and mother's age. These results are presented in columns 3, 4 and 6 of table 5.4. Other interaction terms are presented in columns 3, 4 and 5 of table A3. The rural model results testing for heterogeneity in table A3 indicate that the interaction of primary education with wealth index residuals negatively affects child nutritional status and the effect is significant, suggesting the existence of heterogeneity in rural areas. These results may be explained by the view that, unobserved mother's ability is likely to impact her education, and in turn her education affects child nutritional status (Mwabu, 2007; Card, 2001). In other words, the impact of primary education on child nutritional status is different when primary education is interacted with unobservable factors (at individual and household levels). Thus, failure to account for heterogeneity would overestimate impact of wealth index on child nutritional status. In turn, more emphasis will be put on wealth creation as a means of lowering child malnutrition than other alternative measures. Consistent with the full model are the urban area results which indicate absence of heterogeneity in the child nutrition model.

5.4 Regression Results and Discussion for Child Nutritional Status with Regional Dummies

The thesis also tested for the effect of wealth index on child nutritional status while including regional dummies (table A4). The results for the marginal effects after IVProbit indicate that chronic malnutrition falls by 0.42 points when wealth index increases by one unit, *ceteris paribus*. Only the results for the effect of living in the Northern region on child nutritional status are significant - the marginal effect after probit indicates that relative to children that live in the Western region, children living in the Northern region are 0.09 points less likely to be stunted, *ceteris paribus*. These results support the findings in the UDHS 2006 report by Uganda Bureau of Statistics and Macro International Inc. (2007) which indicate that prevalence of stunting is highest in Southwest region (50 percent) for children aged between 0-59 months in the country. It is important to note that in our analysis, we use the UNHS regional classification which has only four regions: Central, Eastern, Northern and Western (reference category). In this UNHS classification, the Southwest region (of the UDHS) is part of the Western region. However, the UDHS classification has nine regions[5]. The inclusion of regional dummies in the analysis shows that the effects of other explanatory variables on child nutritional status do not change the findings of earlier full sample results. In addition, consistent with the full model, the results with regional dummies suggest absence of endogeneity of wealth index, and also heterogeneity that may arise from unobserved factors that affect child nutritional status.

5.5 Conclusion and Policy Implications

Summary and Conclusion

In this chapter we sought to investigate the effect of poverty on child nutritional status using UDHS 2006 and UNHS 2005/2006 datasets. Poverty was proxied by wealth index. Child nutritional status was measured by height-for-age Z-scores (HAZ) and the probability of being stunted. A child is considered to be stunted or to suffer chronic malnutrition if his/her height-for-age Z-scores fall below -2 standard deviations from the median of the reference population (Uganda Bureau of Statistics and Macro International Inc., 2007; Uganda Bureau of Statistics and ICF International Inc., 2012). Various estimation methods are employed to capture the impact of poverty on child nutritional status: OLS, instrumental variable and control function approach models for height-for-age. For the probability of a child being stunted, we estimated the probit, IVProbit models and control function approach models.

The results indicate that wealth index is positively correlated with height-for-age but has a negative effect on the probability of a child being stunted, suggesting that though wealth index cannot be measured in cardinal terms, it’s a good proxy for children’s wellbeing (Kabubo-Mariara et al., 2009b; Sahn and Stifel, 2003). The child characteristics also have an important impact on his/her nutritional status. Specifically, boys are more likely to suffer malnutrition than girls, suggesting the influence of physiological and sociological factors on child nutritional status (Abalo, 2009). Children of a multiple birth have poorer nutritional status than singletons. A child’s age is strongly correlated with his/her height and the likelihood of being stunted and exhibits a U-shaped relationship with child nutritional status.

Household characteristics also affect the nutritional status of children. Particularly, mother’s education improves child nutritional status, but its effect becomes stronger beyond primary education. This result suggests the importance of investing in post-primary maternal

[5] UDHS regions include Central 1, Central 2, Kampala, East Central, Eastern, North, West Nile, Western and Southwest. Also north sub regions were included to capture internally displaced persons (IDPs) and Karamoja areas.

education to improve the nutrition of children (Kabubo-Mariara et al., 2009b; Strauss, 1990). Mother's height positively affects child nutritional status, suggesting the effect of genetic factors on child nutrition (Strauss, 1990; Horton, 1988; Kabubo-Mariara et al., 2009b). Children from male-headed households are likely to have better nutrition relative to their counterparts from female-headed households. This finding may suggest the presence of gender differences in access to and control over household resources which are crucial for improving child nutritional status. The results also indicate that household size is positively correlated with chronic malnutrition suggesting competition for food amongst siblings (Kabubo-Mariara et al., 2009b). The results further indicate that using professional care at birth significantly improves the nutritional status of children. This may suggest that mothers who use professional care at birth are exposed to nutritional knowledge from nurses/midwives which they apply to improve the nutrition of their children (Garcia and Alderman, 1989).

The results also indicate that there is consistency between rural and full sample findings. The main difference between rural and urban sub-sample results is the significance of the effect of maternal education on child nutritional status. The regional dummies' results indicate that relative to living in the Western region, residing in the Northern region significantly lowers the likelihood of a child being stunted. This may suggest existence of regional disparities in chronic malnutrition in Uganda.

Our results show that wealth index may not be endogenous to child nutritional status suggesting that the estimates are not biased by endogeneity of wealth index. The results however, suggest evidence of heterogeneity in rural areas arising from the interaction of mother's primary education with the wealth index residuals. The presence of heterogeneity seems to suggest that unobserved ability of the mother may affect her education, which then impacts child nutritional status.

This chapter makes several contributions to the literature. First, this thesis uses a unique combination of the nationally representative datasets - UDHS 2006 and UNHS 2005/2006 to investigate the effect of poverty on child nutritional status. The study uses community variables unique to the UNHS to help instrument for the potentially endogenous wealth index variable in the UDHS dataset. The thesis thus contributes to earlier studies by using innovative datasets and methods. The second contribution is that our study controls for estimation issues of endogeneity of poverty, and also heterogeneity that would arise from unobserved factors that affect child nutrition but may also be correlated with poverty. Literature shows that poverty is potentially endogenous to child nutritional status and therefore accounting for endogeneity of poverty avoids biased estimates and misleading policy conclusions (Haddad et al., 2003; Ssewanyana, 2003). The evidence of heterogeneity in this study suggests that failure to account for it would overestimate the effect of wealth index on child nutritional status. This may place more emphasis on improving wealth status as a measure of lowering child malnutrition at the expense of other intermediate policies. Third, this study recommends important policies for improving child nutritional status and reduction of poverty in Uganda.

Policy Implications

The findings in this chapter suggest a number of policy implications. Improvement in the household wealth index will make better its wellbeing as well as child nutritional status. This is based on the study findings that wealth index positively and significantly affects child nutritional status.

Investment in female education especially post-primary education should be promoted in the country. This is because the study has found mother's education to be an important factor in improving child nutritional status. Rural/urban differences in female education must be addressed in the country in order to lower child malnutrition. This is based on the study findings of greater effects of maternal education on child nutrition in urban than in rural areas.

The use of professional care at birth should be promoted as the study found it to significantly improve child nutritional status. This can be attained through improvement in service delivery at the maternal/reproductive health care centers throughout the country (covering rural/urban areas as well as regions). For instance, more skilled health workers should be trained and sent to work in rural areas as this will encourage women from different parts of the country to use the services of professionals at delivery. In addition, mothers should be taught about the need to use professional care at birth so as to encourage them to seek such care.

CHAPTER SIX: CHILD NUTRITIONAL STATUS, POVERTY AND GENDER OF HOUSEHOLD HEAD

6.0 Introduction

This chapter investigates whether the effect of poverty on child nutritional status varies by gender of the household head in Uganda. We first discuss the descriptive statistics followed by the regression results. These results are then used to draw conclusions and policy implications.

6.1 Descriptive Statistics

The descriptive statistics for the variables used in the analysis are presented in table 6.1. The test results of significance for the difference between means of variables, in male and female-headed households are also presented in table 6.1. Seventy seven percent of the households are male-headed while only twenty three percent are female-headed (results not shown). On average, the height-for-age of children under five years from male-headed households (MHHs) and female-headed households (FHHs) are -1.52 and -1.58 Z-scores respectively. The MHHs Z-scores are comparable with the national average of -1.5 Z-scores reported by the Uganda Demographic and Health Survey of 2006 (Uganda Bureau of Statistics and Macro International Inc., 2007). However, the Z-scores for children from FHHs are 0.08 Z-scores lower than the national scores. In addition, 38 percent of the children from MHHs suffer chronic malnutrition compared to 40 percent from FHHs[6]. The difference between the means of HAZ-scores and the probability of a child being stunted by gender of household head is not statistically significant (the results are not presented). The wealth index in MHHs ranges from 0.01 to 5.30 with a mean of 1.20. In FHHs, the wealth index ranges from 0.15 to 5.41 with a mean of 1.21. The difference in the means of wealth index between MHHs and FHHs is not statistically significant.

Table 6.1 indicates that the proportions of male children from MHHs and FHHs are 51 percent and 48 percent respectively. Only 2 percent of the children from MHHs and 3 percent from FHHs are of multiple births. Children from MHHs and FHHs are on average of the 4th birth order, with a mean age of about 28 months. The average age of mothers from MHHs is 28.79 years compared to 29.63 years for mothers from FHHs (the difference between the two means is statistically significant: $p = 0.008$).

[6] The proportion of stunted children in MHHs is comparable with the findings of the UDHS 2006 report which indicates that 38 percent of children under five years of age are stunted (Uganda Bureau of Statistics, 2007).

Table 6.1: Descriptive Statistics by Gender of the Household Head

Variables	*Male Headed Household (MHH)*		*Female Headed Household (FHH)*	
	Observations	Mean¥	Observations	Mean¥
Height-for-age (HAZ)	1825	-1.52 [1.55]	531	-1.58 [1.59]
Probability of being stunted (<-2 = 1, zero otherwise)	1825	0.38 [0.49]	531	0.40 [0.49]
Wealth index	1934	1.20 [0.85]	566	1.21 [0.91]
Sex of child (Male = 1, zero otherwise)	1934	0.51 [0.50]	566	0.48 [0.50]
Child of multiple birth	1934	0.02 [0.14]	566	0.03 [0.17]
Birth order	1934	4.35 [2.56]	566	4.42 [2.73]
Age of child (months)	1934	27.96 [17.07]	566	27.77 [17.63]
Age of child squared (months)	1934	1073.43 [1024.67]	566	1081.56 [1046.16]
Mother's height (centimeters)	1915	158.92 [6.40]	558	159.33 [6.68]
Mother's age (years)	1934	28.79*** [6.39]	566	29.63*** [7.44]
Mother's age squared (years)	1934	869.86*** [390.49]	566	933.24*** [461.73]
Household size	1934	6.81*** [2.65]	566	6.33*** [2.84]
Age of household head	1934	36.75* [11.14]	566	37.69* [13.64]
Education level of mother				
No education	1934	0.24 [0.43]	566	0.23 [0.42]
Primary	1934	0.62 [0.48]	566	0.63 [0.48]
Secondary	1934	0.11 [0.31]	566	0.11 [0.32]
Post-secondary	1934	0.02 [0.16]	566	0.02 [0.14]
Marital status				
Never married	1934	0.01*** [0.10]	566	0.09*** [0.28]
Currently married	1934	0.96*** [0.19]	566	0.65*** [0.48]
Divorced/separated/widowed	1934	0.03*** [0.166]	566	0.26*** [0.44]
Professional care at birth (Nurse/Midwife)	1934	0.38** [0.49]	566	0.43** [0.50]
Area of residence (rural = 1 and zero otherwise)	1934	0.90*** [0.29]	566	0.86*** [0.35]
Regions of the country				
Central	1933	0.30 [0.46]	565	0.31 [0.46]

Eastern	1933	0.33*** [0.47]	565	0.26*** [0.44]
Northern	1933	0.32 [0.47]	565	0.35 [0.48]
Western	1933	0.06 [0.23]	565	0.07 [0.26]
Proxies of market access				
Distance to telephone facility (kilometers)	1852	1.46 [2.99]	548	1.35 [3.03]
Time to water source (minutes)	1883	58.98* [55.39]	522	63.76* [63.45]

Source: Author's computation based on combined dataset of UDHS 2006 and UNHS 2005/06.
***, **, * show that the difference in the means of variables by gender of household head is significant at 1%, 5% and 10% respectively.
¥ Standard deviations in square parenthesis.

Mothers are on average 159 centimeters tall in both types of households. Male-headed households are on average slightly larger than female-headed households containing 6.81 versus 6.33 members (p = 0.00). The mean age of the household head in MHHs and FHHs is 36.75 years and 37.69 years respectively (p = 0.09). Results further suggest that the difference in means of each level of education by gender of household head is statistically insignificant (results not shown).

In MHHs, 96 percent of the mothers are currently married compared to 65 percent in FHHs (p = 0.00). As expected, mothers in FHHs are more likely to be divorced/separated/widowed (26 percent) than in MHHs (3 percent) with the p-value = 0.00. Table 6.1 further shows that only 38 percent of the mothers from MHHs used professional care at birth compared to 43 percent from FHHs (p = 0.03). In terms of area of residence, 90 percent of the MHHs are found in rural areas compared to only 86 percent of the FHHs (p = 0.00). The results for the regional dummies show that the proportion of MHHs (30 percent) and FHHs (31 percent) in the Central region is quite comparable. In the Eastern region 33 percent of the households in which children live are male-headed relative to 26 percent that are female-headed; this depicts 7 percent more MHHs than FHHs. The Northern and Western regions have lower proportions of MHHs than FHHs. It is however only in the Eastern region that the difference of proportions between the two means is statistically significant (p = 0.00).

The last two rows of table 6.1 present the proxies of market access: distance to telephone facility in kilometers and time to water source in minutes (one way). The proxies are used as instrumental variables for the potentially endogenous wealth index in the child nutritional status models. On average, MHHs are situated 1.46 kilometers away from the telephone facility relative to 1.35 kilometers for FHHs. The results also indicate that it takes an average of 58.98 minutes for individuals in MHHs to get to the water source compared to an average of 63.76 minutes for those in FHHs. The difference in the means for time to water source is significant ($p = 0.09$).

6.2 Regression Results and Discussion

This section presents and discusses the regression results of whether the effect of poverty on child nutritional status varies in MHHs and FHHs. The hypothesis is that reducing poverty in FHHs has a stronger effect on child nutritional status than in MHHs. The results for child nutritional status, poverty and gender of household head under different assumptions are presented in table 6.2, while the control function approach (CFA) results are presented in table 6.3.The following child nutritional status models by gender of the household head are estimated: the Ordinary Least Square (OLS) model which treats wealth index as exogenous and the instrumental variable model accounting for potential endogeneity of wealth index. The control function approach models to account for possible heterogeneity in child nutritional status are also estimated.

Table 6.2 (columns 1 and 3) present the OLS models for MHHs and FHHs respectively. The second stage instrumental variable models for MHHs and FHHs are presented in columns (2) and (4) respectively. The CFA results in table 6.3 are presented as follows: the models with wealth index residuals are presented in columns (1) and (4); columns (2) and (5) present models with wealth index residuals, and the interaction of wealth index residuals with wealth index, while columns (3) and (6) present models with other interaction terms.

The results testing for goodness of fit of the model (Wald Chi-square and F) are highly significant, implying that all model parameters are jointly different from zero. Thus all models in tables 6.2 and 6.3 fit the data better than an intercept-only model. The R-squared results are rather low, i.e. ranging from 15 to 16 percent for MHHs models; and 8 percent to 24 percent for FHHs models. However, these low R-squared results are common in studies using cross sectional data.

6.2.1 Results for the Ordinary Least Squares and Instrumental Variable Models

The results in table 6.2 treating wealth index as exogenous (OLS) in columns (1) and (3) indicate that wealth index is positively and significantly correlated with child nutritional status in both MHHs and FHHs, *ceteris paribus.* An increase in wealth index by 1 unit increases children’s height by 0.22 Z-scores in both household types. The results further indicate that boys are more likely to suffer malnutrition than girls in both household types, other factors held constant. For example, the OLS results indicate that relative to girls, boys' height is on average 0.14 Z-scores and 0.22 Z-scores lower in MHHs and FHHs respectively. The larger coefficient in FHHs implies that relative to girls, boys from FHHs have lower nutritional status than those from MHH. This finding supports a study by Kabubo-Mariara et al. (2009b) which argues that boys in FHHs are at a higher risk of suffering malnutrition compared to girls. The findings on the effect of sex of children on their nutritional status, can be explained by physiological factors (girls mature faster than boys), and sociological factors - girls spend more time with their mothers, thus girls are more often fed than boys (Abalo, 2009). In general our results are also consistent with studies by Masiye et al. (2010) and Teshome et al. (2009) that indicate that boys experience higher levels of malnutrition than girls.

In addition, children of multiple births are likely to be more malnourished than singletons. Compared to singletons, the height of children of multiple births is 0.82 Z-scores lower in MHHs and 1.04 Z-scores lower in FHHs, *ceteris paribus.* The differences in the magnitude of the coefficients suggest that relative to singletons, the nutritional status of multiple births children from FHHs is lower than for their counterparts from MHHs. In general, the poor nutritional status of multiple birth children is related to the fact that low birth weight is common among children of multiple births relative to singletons (Kabubo-Mariara et al., 2009b). Nevertheless, we speculate that compared to mothers from MHHs, those from FHHs are more likely to suffer malnutrition due to inadequate funds to afford a balanced diet. Therefore, for such malnourished mothers, breast feeding children of multiple births may be inadequate, thus increasing the risk of poor nutrition among these children.

Table 6.2: Effect of Wealth Index on Child Nutritional Status by Gender of Household Head under different Assumptions

Variables	*Male Headed Household (MHHs)*		*Female Headed Household (FHHs)*	
	(1) HAZ with exogenous wealth index	(2) Instrumental variable model	(3) HAZ with exogenous wealth index	(4) Instrumental variable model
	OLS model	2nd stage HAZ model	OLS model	2nd stage HAZ model
Wealth index	0.2245*** [0.058]	0.0656 [0.413]	0.2210** [0.097]	-0.6535 [0.768]
Sex of child (Male = 1, zero otherwise)	-0.1399** [0.067]	-0.1111 [0.072]	-0.2244* [0.128]	-0.195 [0.152]
Child of multiple birth	-0.8182*** [0.231]	-0.8572*** [0.269]	-1.0378*** [0.388]	-1.3647*** [0.502]
Birth order	-0.0071 [0.026]	-0.0108 [0.028]	-0.0011 [0.047]	-0.0308 [0.056]
Age of child (months)	-0.0790*** [0.008]	-0.0761*** [0.008]	-0.1020*** [0.015]	-0.1058*** [0.017]
Age of child squared (months)	0.0010*** [0.0001]	0.0010*** [0.0001]	0.0013*** [0.0002]	0.0014*** [0.0003]
Height of mother (centimeters)	0.0509*** [0.005]	0.0475*** [0.007]	0.0443*** [0.010]	0.0257 [0.018]
Mother's age (years)	0.0128 [0.045]	0.0435 [0.050]	0.1299* [0.069]	0.1014 [0.078]
Mother's age squared (years)	-0.0001 [0.001]	-0.0005 [0.001]	-0.0018* [0.001]	-0.0014 [0.001]
Age of household head	0.0048 [0.004]	0.0041 [0.004]	-0.0004 [0.006]	-0.0064 [0.009]
Household size	-0.0036 [0.015]	-0.0058 [0.019]	0.005 [0.026]	0.0322 [0.041]
Mother's primary education	0.1377 [0.086]	0.1913 [0.157]	-0.1848 [0.163]	-0.0398 [0.282]
Mother's secondary education	0.1325 [0.140]	0.2845 [0.381]	0.0937 [0.281]	0.6864 [0.670]
Mother's post-secondary education	0.5263** [0.257]	0.8201 [0.736]	0.1133 [0.494]	1.3668 [1.052]
Currently married mothers	0.4634 [0.355]	0.3569 [0.412]	0.1015 [0.260]	0.2371 [0.299]
Divorced/separated/widowed mothers	0.6368 [0.394]	0.5846 [0.456]	0.2783 [0.273]	0.4124 [0.309]

Professional care at birth (nurse/midwife)	0.1531** [0.075]	0.2259* [0.125]	0.2866** [0.139]	0.5033** [0.225]
Area of residence (rural = 1, zero otherwise)	-0.1623 [0.142]	-0.3502 [0.541]	-0.1912 [0.229]	-1.2688 [0.923]
Constant	-9.5366*** [1.106]	-9.1235*** [1.576]	-9.5810*** [1.870]	-4.2893 [4.322]
Observations	1,820	1,694	526	466
R-squared	0.157	0.149	0.211	0.083
F/Wald Chi/LR chi2	F(18, 1801) = 18.66***	Wald chi2(18) = 289.27***	F(18, 507) = 7.51***	Wald chi2(18) = 106.57***
Durbin (score) chi2(1)		0.139 (p = 0.7095)		= 1.766 (p = 0.1839)
Wu-Hausman		F(1, 1674) = 0.137 (p = 0.7112)		F(1, 446) = 1.697 (p = 0.1934)
Test for excluded instruments				
F-test		F(2,1674) =18.404		F(2,446) = 4.805
Prob > F		0.0000		0.0086
Partial R2 for excluded instruments		0.0215		0.0211
Sargan (score) chi2(1)		= 0.125 (p = 0.7238)		= 0.033 (p = 0.8562)
Basmann chi2(1)		= 0.123 (p = 0.7253)		= 0.031 (p = 0.8592)

Note: Standard errors in parenthesis. ***, **, * Significant at 1%, 5% and 10% respectively

Table 6.2 shows that the effects of children's age and age squared on their nutritional status portray a U-shaped relationship. An increase in children's age by 1 month reduces children's height by 0.08 Z-scores and 0.10 Z-scores in MHHs and FHHs respectively, other factors held constant. The coefficient of child's age on his/her nutrition is larger in FHHs than MHHs, illustrating the higher level of malnutrition in FHHs as children grow older. It is possible that mothers in FHHs also work; leaving the nurturing of their young children to care takers e.g. other siblings, house maids, neighbours, and relatives, who may not appropriately feed the children (Nair et al., 2014).

The height of the mother positively affects the nutritional status of children, other factors held constant. An increase in mother's height by 1 centimeter increases children's height by 0.05 Z-scores and 0.04 Z-scores in MHHs and FHHs respectively. These results portray minor differences in the size of the coefficient of mother's height in both household types. This positive correlation of mother's height with child nutritional status is consistent with a study by Abalo (2009) which concludes that mother's height positively and significantly impacts height-for-age Z-scores. It is important to note that mother's height in child nutritional status models accounts for both genetic and family background characteristics not captured by maternal education (Kabubo-Mariara et al., 2009b).

The results further show that mother's age positively influences child nutritional status. The reverse is observed for mother's age squared. However, the coefficients are only significant for FHHs in the OLS model at 10 percent level (column 3 of table 6.2). For instance, an increase in mother's age by 1 year increases children's height by 0.13 Z-scores, *ceteris paribus*. The results for mother's age suggest that children born of younger women are more likely to be malnourished than children born of older mothers (Kabubo-Mariara et al., 2009b; Strauss, 1990).

In addition, table 6.2 shows that mother's post-secondary education is positively and significantly correlated with child nutritional status in MHHs (OLS model). Children born of mothers with post-secondary education are 0.53 Z-scores taller than children of uneducated mothers; and this effect is stronger in MHHs than FHHs. We speculate that mothers from MHHs access more family support than those from FHHs, enabling the former to give better care to their children, in turn improving their nutritional status (Moestue and Huttly, 2008).

The use of professional care at birth by mothers positively and significantly affects child nutritional status. In MHHs, the OLS results show that children whose mothers use professional care at birth are 0.15 Z-scores taller than children whose mothers do not. In FHHs, the coefficient for use of professional care at birth is larger in terms of magnitude (0.29 Z-scores) than in MHHs. The difference in coefficients by type of household suggests that using professional care at birth is more beneficial in improving the nutritional status of children from FHHs than their counterparts from MHHs. The use of professional care at birth may be a proxy for maternal access to modern health care which may indirectly improve the nutritional status of children by enhancing general health (Garcia and Alderman, 1989). We speculate that mothers as main care givers to children may be able to make decisions and implement them faster in FHHs than in MHHs where they have to consult with or gain authorization from their spouses.

The second stage IV results in table 6.2 indicate that wealth index insignificantly impacts child nutritional status. Except for the effect of sex of the child on his/her nutritional status, the IV results for other child characteristics (child of multiple birth, and age and age squared of the child) do not differ considerably from the OLS results. Other than the magnitudes of the coefficients, the signs and levels of significance remain the same. The results for mother's height in MHHs are consistent with those for OLS; but for FHHs this coefficient becomes insignificant. The IV results for use of professional care at birth are consistent in terms of signs. Nonetheless, it must be noted that the coefficients for use of professional care at birth in both types of households become larger; but still the magnitude in FHHs is higher than in MHHs.

Testing for Endogeneity and Validity of Instruments

Wealth index is potentially endogenous in the child nutritional status models by gender of household head. We therefore, instrument for wealth index to account for its endogeneity. The validity of identifying instruments for wealth index is also tested. Two instrumental variables are used in this chapter: distance to telephone facility and time to water source. The results in column (2) of table 6.2 show that the F-statistic is 18.40 and is significant at all conventional levels of testing in the MHHs child nutritional status model. Column (4) of table 6.2 further indicates that the F-statistic in FHHs is 4.81 with a p-value = 0.0086. These results suggest that the instrumental variables are valid and relevant for wealth index in both models by gender of household head, but weak in the case of FHHs.

Wealth index is the only potentially endogenous variable considered in the child nutritional status models by gender of household head; but we have two instrumental variables. We therefore test for overidentification - to verify whether the two instruments are not correlated with the error terms of the child nutrition models in MHHs and FHHs. We conducted the Sargan and Basmann tests of overidentification. Both test results accept the null hypothesis that instruments are uncorrelated with the error terms of the child nutritional status models in MHHs and FHHs; thus suggesting absence of overidentification. These results also imply that the child nutritional status models by gender of household head are correctly specified (StataCorp, 2009; Mugo, 2012).

The Durbin-Wu-Hausman (DWH) test of exogeneity was conducted to check whether wealth index is really endogenous in the child nutrition models by gender of household head. The results indicate that wealth index may not be endogenous. However, with the addition of interaction terms in the FHHs child nutrition model (column (6) of table 6.3), the wealth index residuals became significant, suggesting possible endogeneity of wealth index. This implies that the CFA is a better estimation method because it accounts for both endogeneity of wealth index, and heterogeneity that may arise from unobservables correlated with child nutritional status and wealth index (Ajakaiye and Mwabu, 2007). Failure to control for endogeneity may overestimate the impact of wealth index on child nutritional status leading to over emphasis of the importance of wealth creation as a policy for improving child nutritional status against alternative policy options.

In addition, using the OLS and instrumental variable models by gender of household head, the thesis also tests whether the effect of poverty on child nutritional status varies with inclusion of regional dummies in the analysis. The results are presented in table A6 and they indicate that no regional dummy is significant in the child nutritional status models for MHHs and FHHs. The effects of other variables on child nutrition in table A6 are comparable to results in table 6.2 above. Nonetheless, the results with regional dummies do not reveal presence of endogeneity of wealth index in the child nutritional status models by gender of household head.

6.2.2 Results for Control Function Approach Models

The control function approach results are presented in table 6.3. Except for the slight differences in the magnitudes of the coefficients, the CFA results by gender of household head are consistent with the respective IV second stage model results in terms of signs and levels of significance. Most importantly, the coefficient of wealth index is statistically insignificant in all CFA models.

The CFA results testing for heterogeneity in child nutritional status models are presented in table 6.3 columns 2 and 3 (MHHs), and columns 5 and 6 (FHHs). We tested for heterogeneity by including in the child nutritional status models interaction terms as new control variables. We used interaction of wealth index residuals with each of the following variables: wealth index, mother's primary education, mother's secondary education, mother's post-secondary education and mother's age. The results show that none of the interaction terms is significant in the child nutritional status models by gender of household head; thus implying absence of heterogeneity that would arise from unobservables correlated with child nutrition and wealth index.

The CFA results testing for the effect of poverty on child nutritional status in MHHs and FHHs with regional dummies are presented in table A7 of the appendix. These results are consistent with the IV findings in table A6. The effects of other variables on child nutrition by gender of household head are comparable to the CFA results in table 6.3. Results also suggest absence of heterogeneity that could arise from unobservable determinants of child nutritional status in MHHs and FHHs; but may also affect wealth index.

Table 6.3: Control Function Approach Results for Child Nutritional Status by Gender of Household Head

Variables	*Male Headed Household (MHHs)*			*Female Headed Household (FHHs)*		
	(1) Wealth index residuals	(2) Wealth index residuals and interactions with wealth index	(3) Other interactions	(4) Wealth index residuals	(5) Wealth index residuals and interactions with wealth index	(6) Other interactions
Wealth index	0.0628 [0.436]	0.0706 [0.437]	0.0475 [0.437]	-0.7223 [0.772]	-0.6414 [0.780]	-0.645 [0.788]
Sex of child (Male = 1, zero otherwise)	-0.1107 [0.072]	-0.1107 [0.072]	-0.1149 [0.072]	-0.2049 [0.141]	-0.2069 [0.141]	-0.1828 [0.142]
Child of multiple birth	-0.8580*** [0.273]	-0.8598*** [0.273]	-0.8538*** [0.274]	-1.3759*** [0.475]	-1.3722*** [0.476]	-1.3795*** [0.475]
Birth order	-0.0112 [0.028]	-0.0116 [0.028]	-0.0119 [0.028]	-0.03 [0.052]	-0.0315 [0.052]	-0.0353 [0.052]
Age of child (months)	-0.0762*** [0.008]	-0.0762*** [0.008]	-0.0764*** [0.008]	-0.1042*** [0.016]	-0.1043*** [0.016]	-0.1071*** [0.016]
Age of child squared (months)	0.0010*** [0.0001]	0.0010*** [0.0001]	0.0010*** [0.0001]	0.0013*** [0.0003]	0.0013*** [0.0003]	0.0014*** [0.0003]
Height of mother (centimeters)	0.0474*** [0.007]	0.0475*** [0.007]	0.0476*** [0.007]	0.0235 [0.018]	0.0253 [0.018]	0.0246 [0.019]
Mother's age (years)	0.0439 [0.051]	0.0449 [0.051]	0.0466 [0.051]	0.1030 [0.074]	0.1019 [0.074]	0.1020 [0.074]
Mother's age squared (years)	-0.0005 [0.001]	-0.0005 [0.001]	-0.0006 [0.001]	-0.0015 [0.001]	-0.0014 [0.001]	-0.0014 [0.001]
Age of household head	0.0041 [0.004]	0.0041 [0.004]	0.004 [0.004]	-0.006 [0.008]	-0.0057 [0.008]	-0.0058 [0.008]
Household size	-0.0055 [0.020]	-0.0054 [0.020]	-0.0035 [0.020]	0.0367 [0.041]	0.0345 [0.041]	0.0397 [0.042]
Mother's primary education	0.1923 [0.164]	0.1917 [0.164]	0.1939 [0.164]	0.0135 [0.296]	-0.0059 [0.297]	-0.0093 [0.298]
Mother's secondary education	0.2879 [0.402]	0.2855 [0.402]	0.2918 [0.403]	0.7498 [0.671]	0.7092 [0.674]	0.706 [0.682]
Mother's post-secondary education	0.8148 [0.746]	0.8133 [0.746]	0.8288 [0.748]	1.4792 [1.058]	1.389 [1.066]	1.3749 [1.072]
Currently married mothers	0.3576 [0.414]	0.3591 [0.414]	0.3461 [0.415]	0.2633 [0.280]	0.2585 [0.280]	0.2317 [0.285]
Divorced/separated/widowed mothers	0.5776 [0.462]	0.578 [0.463]	0.5562 [0.463]	0.4624 [0.289]	0.4534 [0.289]	0.4246 [0.294]

Professional care at birth (nurse/midwife)	0.2272* [0.131]	0.2274* [0.131]	0.2310* [0.131]	0.5409** [0.232]	0.5338** [0.232]	0.5259** [0.236]
Area of residence (rural = 1, zero otherwise)	-0.3514 [0.564]	-0.3472 [0.564]	-0.3728 [0.564]	-1.3469 [0.923]	-1.2623 [0.931]	-1.2608 [0.939]
Control function variables						
Reduced form wealth index residuals	0.1578 [0.440]	0.18 [0.448]	0.3966 [0.574]	1.0197 [0.780]	1.0724 [0.784]	1.7420* [0.957]
Interaction of wealth index residuals and wealth index		-0.015 [0.056]	0.0269 [0.063]		-0.0553 [0.076]	-0.0497 [0.082]
Interaction of mother's primary education and wealth index residuals			-0.0644 [0.190]			-0.4326 [0.346]
Interaction of mother's secondary education and wealth index residuals			-0.1961 [0.237]			-0.2674 [0.384]
Interaction of mother's post-secondary education and wealth index residuals			-0.3877 [0.301]			1.0114 [0.696]
Interaction of mother's age and wealth index residuals			-0.0059 [0.011]			-0.0145 [0.015]
Constant	-9.1071*** [1.639]	-9.1462*** [1.646]	-9.1591*** [1.650]	-3.9468 [4.285]	-4.3297 [4.319]	-4.1863 [4.370]
Observations	1,694	1,694	1,694	466	466	466
R-squared	0.152	0.152	0.153	0.223	0.224	0.237
F/Wald Chi	F(19, 1674) = 15.78***	F(20, 1673) = 14.99***	F(24, 1669) = 12.58***	F(19, 446) = 6.75***	F(20, 445) = 6.43***	F(24, 441) = 5.70***

Note: Standard errors in parenthesis. ***, **, * Significant at 1%, 5% and 10% respectively

6.3 Conclusion and Policy Implications

Summary and Conclusion

This chapter sought to investigate whether the effect of poverty on child nutritional status varies in MHHs and FHHs using UDHS 2006 and UNHS 2005/2006 datasets. Poverty is measured by wealth index and child nutritional status by height-for-age Z-scores (HAZ) for children aged between 0-59 months. Several estimation techniques - the ordinary least squares, instrumental variable and the control function approach methods are used to achieve the objective of this chapter.

The results show that wealth index positively and significantly affects child nutritional status in both MHHs and FHHs. The results suggest that wealth index is equally vital in determining child nutritional status in both MHHs and FHHs (see Kennedy and Haddad, 1994). However, except for the OLS, other estimation techniques suggest that wealth index has no effect on child nutritional status in MHHs and FHHs when other characteristics of the household and children are controlled for. Children's characteristics also greatly influence their nutritional status. Boys are more likely to be malnourished than girls, but the impact is stronger in FHHs than in MHHs. Relative to singletons, children of multiple births suffer more malnutrition, with multiple birth children from FHHs experiencing poorer nutritional status than those from MHHs. The age of a child exhibits a U-shaped relationship with his/her nutritional status in all models. However, as children grow older, the intensity of malnutrition is greater in FHHs than in MHHs. More often due to work, mothers of children in FHHs than in MHHs may leave their young children with care takers - who are not be able to substitute maternal responsibilities like breast feeding which is very important for child nutritional status (Nair et al., 2014).

Household characteristics also impact child nutritional status. Mother's post-secondary education positively and significantly affects child nutritional status in MHHs but not in FHHs. These results may suggest that mothers in MHHs tend to get family support, which enables them to give better care to their children compared to mothers in FHHs (Moestue and Huttly, 2008). The height of the mother is positively correlated with child nutritional status suggesting the influence of genetic factors on child nutrition. The results for mother's height are significant in all models for MHHs compared to only the OLS results for FHHs. These results suggest that mother's height is equally important in influencing child nutritional status in both MHHs and FHHs. The age of the mother exhibits an inverted U-shaped relationship with child nutritional status in FHHs only using the OLS. In other words, children born to younger mothers have poorer nutritional status than those born to older mothers. These results suggest the need to discourage teenage pregnancies (Kabubo-Mariara et al., 2009b). The use of professional care at birth is associated with lower child malnutrition - the impact is larger in FHHs than MHHs. This may suggest that decision making on whether to use professional care at birth is easily made in FHHs than MHHs. The IV results suggest that wealth index may not be endogenous, and also that heterogeneity is absent.

The main difference in results by gender of household head is that child characteristics, namely: age, gender and children of multiple births have a greater effect on child nutrition in FHHs than MHHs. In addition, using professional care at birth largely affects child nutritional status in FHHs compared to MHHs.

This chapter makes three contributions to the literature. First, to the best of my knowledge this study is the first to test whether the effect of poverty on child nutritional status varies by gender of household head in Uganda. Second, the chapter controls for endogeneity of poverty, and heterogeneity that would arise from unobservables that affect child nutritional status but also impact poverty by gender of household head. Third, the study also recommends important policies for improving child nutritional status by gender of household head and reduction of poverty in Uganda.

Policy Implications

The findings of the study point at a number of policy recommendations. The welfare status in both MHHs and FHHs should be improved so as to lower child malnutrition in Uganda. This is based on the OLS results that wealth index is a significant factor that affects child nutritional status in MHHs and FHHs.

Investment in female post-primary education is essential for improving child nutritional status in Uganda. This policy is supported by the study findings that post-secondary education is positively correlated with child nutritional status in MHHs.

The public offer of health care services should be promoted for vulnerable women, those living in FHHs or in rural areas to lower malnutrition. This policy is based on the study findings that using professional care at birth by mothers improves nutritional status of children, with its effect being bigger in FHHs than MHHs. We believe that professional care at birth is a proxy of access to health care.

CHAPTER SEVEN: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

7.0 Introduction

This chapter presents a summary, conclusions and policy implications of the thesis. The chapter also presents limitations of the study and suggests areas for further research.

7.1 Summary and Conclusion

Motivation and Methods

This thesis investigates the effect of poverty on health status in Uganda, and draws policy implications from the findings. The thesis addressed three objectives: first, we investigate the effect of poverty on fertility; second, the effect of poverty on child nutritional status; and third, whether the effect of poverty on child nutritional status varies by gender of household head. Fertility is measured using the number of children ever born to a woman. Child nutritional status is measured by height-for-age Z-scores and the probability of a child being stunted. Poverty is proxied by wealth index.

The study was motivated by the fact that the indicators of health status in Uganda have remained poor over the last decade and those indicators are worse among the poor households. Health related challenges are manifested in form of poor health status - chronic malnutrition, high fertility rates, and high maternal and infant mortality. In addition, the health sector continues to be constrained by inadequate quantity and distribution of medical personnel, shortage of medicines and inadequate skills of health workers. Majority of poor households live in rural areas and cannot afford the relatively high cost of health care. Understanding how poverty and health status are related is crucial for policy interventions intended to improve people's wellbeing in Uganda. Further, there is a dearth of knowledge on the health status-poverty nexus in Uganda, and no study has adequately explored issues such as reverse causality between poverty and health status, and heterogeneity that may arise from unobservable factors that affect health status but may be correlated with poverty.

Two datasets - the Uganda Demographic and Health Survey (UDHS) of 2006 and the Uganda National Household Survey (UNHS) of 2005/2006 (community module) were used. Various estimation methods were employed to achieve the objectives of this study. While investigating the effect of poverty on fertility in chapter four, the following models were estimated - an Ordinary Least Square (OLS), Zero-Inflated Poisson (ZIP), an Instrumental Variable (IV) and the Control Function Approach (CFA) models. In chapter five, we tested for the effect of poverty on child nutritional status using the following models - OLS, IV and

CFA models for height-for-age. For the probability of a child being stunted, we estimated the probit, IVProbit and CFA models. In chapter six, we investigated whether the effect of poverty on child nutritional status varies by gender of household head. The chapter estimated several models - an OLS, an IV and the CFA models.

Results and Discussion

Fertility and Poverty

Results in chapter four indicate that wealth index is negatively correlated with fertility of the woman for all models. These results suggest that wealthier women prefer quality rather than quantity of children and would therefore invest more resources in fewer children rather than having additional children who may increase family expenditures (Becker, 1960; Gauthier et al., 2004). Furthermore, women's post-primary (secondary and post-secondary) education has negative and significant effect on their fertility implying that investment in human capital is needed to reduce fertility (Shapiro, 2011; Bhasin et al., 2010; Schultz and Mwabu, 2003). Age of a woman has a positive but non-linear relationship with fertility for all models. Marital status also plays a key role in influencing the number of children a woman will bear: as expected, married women are more likely to have more children than women who have never married. Religion also influences fertility with Muslim women having higher fertility rates relative to their Pentecostal/SDA/other counterparts. Another intermediate result is that educated women are generally wealthier than their uneducated counterparts.

Furthermore, the IV results suggest that wealth index may not be endogenous in the poverty-fertility relationship. The CFA fertility model results suggest the presence of heterogeneity as indicated by the significant effect of the interaction of wealth index with wealth index residuals, interaction of post-secondary education with wealth index residual as well as the interaction of current age of the woman with wealth index residuals. In other words, the effect of wealth index may vary depending on its level, maternal post-secondary education and age. Further, the presence of heterogeneity in the wealth-fertility relationship (Bhasin et al., 2010) suggests that failure to account heterogeneity would underestimate the effect of wealth index on fertility. In turn, poverty reduction as a measure for lowering fertility would be given less weight in favour of other policy interventions.

Child Nutritional Status and Poverty

Results for the effect of poverty on child nutritional status in chapter five indicate that wealth index is positively correlated with height-for-age and exhibits a negative relationship with the probability of a child being stunted. These results imply that while wealth index is not measurable in cardinal units compared to income and consumption expenditure, it is a suitable indicator for welfare of children (Kabubo-Mariara et al. 2009b; Sahn and Stifel, 2003; Harttgen et al. 2012; Ssewanyana and Kasirye, 2012; Abalo, 2009). Characteristics of children also have an important impact on their nutritional status. Specifically, boys are more likely to suffer malnutrition than girls suggesting that physiological and sociological factors impact child nutritional status (Abalo, 2009). Children of multiple births have poorer nutritional status than singletons. A child's age is strongly correlated with his/her height and the likelihood of being stunted implying that the weaning process increases the probability of older children being malnourished (Kabubo-Mariara et al. 2009b; Ssewanyana, 2003; Chirwa and Ngalawa, 2006).

Findings in chapter five also show that household characteristics affect the nutritional status of children. Particularly, mother's education improves child nutritional status, and its effect becomes stronger with increased education. These results suggest the importance of investing in human capital to improve child nutrition (Strauss, 1990; Kabubo-Mariara et al., 2009b), and also point to the fact that maternal education may capture child care practices like hygiene which could improve child nutritional status (Thomas et al., 1991; Frosta et al., 2005). Mother's height positively affects child nutritional status, suggesting that genetic factors affect child nutritional status (Strauss, 1990; Horton, 1988; Kabubo-Mariara et al. 2009b). Furthermore, household size is positively correlated with chronic malnutrition in rural areas, pointing to likelihood of competition for food amongst siblings (Kabubo-Mariara et al. 2009b). Using professional care at birth (a proxy for access to health care) significantly improves the nutritional status of children - suggesting that mothers acquire prenatal and postnatal care as well as other important information for child nurturing from nurses/midwives (Garcia and Alderman 1989).

The analysis by area of residence (rural/urban), indicate consistency between rural and full sample results which is expected as 89 percent of all children in the sample reside in rural areas. The main difference between rural and urban sub-samples is the fact that in rural areas, primary education has an insignificant effect on child nutritional status, while in urban areas children of mothers with primary education are less likely to suffer malnutrition. The regional dummies' results indicate that relative to living in the Western region, residing in the Northern region significantly lowers the likelihood of a child being stunted.

The results in chapter five further suggest that wealth index may not be endogenous to child nutritional status, implying that estimates were not biased by endogeneity of wealth index. These results are consistent with Haddad et al. (2003), who found that per capita consumption a proxy for poverty was not endogenous to child nutrition in some countries. However, there is evidence of heterogeneity in child nutritional status models for rural areas arising from the interaction of mother's primary education with the wealth index residuals. Failure to account for heterogeneity would overestimate the effect of wealth index on child nutritional status - thus placing more emphasis on improving wealth status as a measure of lowering child malnutrition at the expense of other intermediate policies. These results may also suggest that maternal education is affected by her unobserved innate ability (Mwabu, 2007; Card, 2001), and in turn maternal education affects child nutritional status.

Child Nutritional Status, Poverty and Gender of Household Head

Results in chapter six indicate that while wealth index positively affects child nutritional status in both male and female-headed households, this effect is measured with precision only in the OLS model. These results point to the fact that wealth index is a good measure of children's nutrition irrespective of the gender of the head (see Kennedy and Haddad, 1994)[7]. Further, results indicate that boys are more likely to be malnourished than girls, but the impact is stronger in FHHs than MHHs. Relative to singletons, children of multiple births suffer more malnutrition, with multiple birth children from FHHs experiencing poorer nutritional status than those from MHHs. The age of a child, exhibits a U-shaped relationship with his/her nutritional status in all models. However, as children grow older, the intensity of malnutrition is greater in FHHs than in MHHs. Often, mothers of children in FHHs are more likely than those in MHHs to work outside their homes, leaving their children with possibly unsuitable caretakers, thus increasing chances of malnutrition in children due reduced frequency of breastfeeding (Nair et al., 2014).

Mother's post-secondary education positively and significantly affects child nutritional status in MHHs but not in FHHs. We speculate that mothers in MHHs are more likely to be supported by their family members - hence enhancing better child nourishing (Moestue and Huttly, 2008). The height of the mother is positively correlated with child nutritional status, but seems to be more important in MHHs than FHHs suggesting that genetic factors affect child nutritional status irrespective of gender of the household head (Kennedy and Haddad,

[7] Although Kennedy and Haddad (1994) used per capita total expenditure (a proxy for poverty), their results suggest that it is an important determinant of child nutrition in FHHs versus MHHs.

1994). The age of the mother exhibits an inverted U-shaped relationship with child nutritional status in FHHs (for the OLS model); thus it is imperative to reduce births among teenagers (Kabubo-Mariara, 2009b). The use of professional care at birth is associated with lower child malnutrition in MHHs and FHHs, and the effect on child nutritional status is larger in FHHs than MHHs. These results may suggest that decision making on usage of professional care at birth is easily made by mothers in FHHs relative to those in MHHs.

The IV results in chapter six also suggest that wealth index may not be endogenous to child nutritional status in FHHs and MHHs. The results further show absence of heterogeneity in the poverty-nutritional status relationship in all models by gender of household head.

Contribution of the Thesis

This thesis makes a number of contributions to the literature. First, it uses a unique combination of the nationally representative datasets - UDHS 2006 and UNHS 2005/2006 to investigate the effect of poverty on health status (fertility and child nutritional status). The study uses community variables unique to the UNHS to instrument for the potentially endogenous wealth variable in the UDHS dataset. The thesis thus contributes to earlier studies by using more innovative datasets and methods. Second, the study addresses estimation issues of endogeneity of poverty, and also heterogeneity that would arise from unobserved factors that affect health status but may be correlated with poverty. Accounting for endogeneity of poverty, and heterogeneity in the health status studies avoids biased estimates and misleading policy conclusions. Third, the thesis contributes by using new techniques/methods of estimation such as the Zero-Inflated-Poisson (ZIP) model, to incorporate aspects ignored by other studies. One such aspect is fertility being a count variable, and this thesis is the first study to use the ZIP model to analyze fertility as a count variable in the context of a developing country, in this case Uganda. The ZIP model helps to estimate the number of children ever born, while accounting for the many childless women that often characterize fertility data. Failure to account for the nature of the fertility variable may generate biased results. Fourth, the study extends the analysis of the effect of poverty on health status to a context with new characteristics of high fertility exhibited in Uganda. Fifth, chapter five of the thesis explains child nutrition using height-for-age Z-scores and the probability of a child being stunted in Uganda. Several studies have used height-for-age, weight-for-age and weight-for-height Z-scores; but this current study in addition to height-for-age, analyzes the probability of a child being stunted. Studying the probability of a child being stunted is vital, as it increases the awareness on the need to improve child health especially given that stunted children are often vulnerable to infections and other diseases, and are faced with nutrient deficiencies. Therefore, interventions targeting stunted children, improve their health plus that of the entire population (Onis and Blössner, 1997). In other words, stunting has implications for policy as it affects other aspects of child health like infant mortality and cognitive growth. Sixth, chapter six of this thesis is the first to test whether the effect of wealth index on child nutritional status varies by gender of household head in Uganda. Seventh, the thesis recommends important policies for lowering poverty and improving health status in Uganda.

7.2 Policy Implications

The findings of this thesis suggest a number of policy implications: First, results for chapter four suggest that improvement in welfare is crucial for fertility reduction. For instance, increasing asset income by households should be encouraged which in turn will improve their wealth status. Asset income can be increased by improving the physical environment such as household material resources for the members (Kabubo-Mariara et al., 2012). In turn, reducing fertility via welfare improvement may generate growth benefits for the country. For instance, the findings that increasing wealth index by 1, results in 0.31 fewer children may imply that 100 women of reproductive age will have 31 fewer children, while 1,000,000 of such women will have 310, 000 fewer children. Such reduction in fertility may translate into savings for investments as the government may now have to build fewer classrooms, provide fewer vaccination kits, etc for the children.

In addition, increased investment in female education especially post-primary (secondary and post-secondary) education is needed in order to reduce fertility in the country. Investment in female post-primary education can be promoted by making secondary education universal. The current government strategy of Universal Secondary Education (USE), aiming at free secondary education for the many primary school graduates in Uganda, is limited to a few schools and selected areas.

The findings of chapter five further suggest the need to improve welfare (wealth status) in order to lower child malnutrition in the country. Results further imply need for investment in female education especially post-primary education. This is because the study has found mother’s education to be an important factor in improving child nutritional status. Like mentioned earlier, one way of investing in female post-primary education, is making secondary education more universal. In addition, the results by area of residence suggest that rural/urban differences in female education should be addressed in order to lower child malnutrition. This is based on the study findings of greater effects of maternal education on child nutrition in urban compared to rural areas.

Findings in chapter five further imply that the government should also promote the use of professional care at birth because the study found it to significantly improve child nutritional status. For instance, more qualified skilled health workers should be sent to rural areas by the government. In addition, women should be educated on the importance of using professional care at birth. In turn, women from different parts of the country will be encouraged to use services of professionals at delivery, and thereby gaining knowledge that can help improve nutritional status of their children.

Results in chapter six suggest that the welfare status in both MHHs and FHHs should be improved so as to lower child malnutrition in Uganda. This is based on the study finding that wealth index is a significant factor that affects child nutritional status irrespective of the gender of household head. Furthermore, investment in female post-primary education is crucial in reducing child malnutrition in Uganda. However, this policy should focus on reducing differentials in the effects of female education on child nutrition, for women in both types of households. In turn, the benefits of education in form of improving children's nutrition will be spread to FHHs as well. This policy is supported by the findings that post-secondary education is positively correlated with child nutritional status in MHHs.

In addition, results suggest that the usage of health care services in form of professional care at birth should be promoted irrespective of gender of household head as this is likely to have positive impacts on child nutritional status. Nonetheless, the policy should endeavor to reduce variations in the use of professional care at birth among women. This policy is based on the findings that usage of professional care at birth has a larger effect on child nutritional status in female than male-headed households.

Further, the government should discourage teenage pregnancies in the country, as results indicate that mother's age is an important determinant of child nutritional status in FHHs. This can be done by sensitizing the teenagers on the risks associated with early pregnancies such as dropping out of school, complications at birth, increased child and maternal mortality and even falling into poverty (see Greene and Merrick, 2005).

7.3 Limitations of the Study and Areas for Further Research

This thesis has attempted to take into account simultaneity between health status and poverty. Finding suitable instrumental variables that affect wealth index and not health status is however, quite difficult. This thesis has made a good attempt at addressing the identification issue, but does not claim to have fully addressed the endogeneity problem. Future research should employ experimental treatment designs/approaches in economics while investigating the effect of poverty on health status in order to control for endogeneity of poverty. There may also be value in assessing whether alternative methods such as multilevel/hierarchical models could be applied to answer similar questions as those addressed in this thesis.

Due to data limitations, this thesis could not analyze the effect of diseases such as HIV/AIDS (Uganda being among countries with highest prevalence rate in Africa), and tuberculosis which are likely to affect fertility and child nutrition outcomes; and also pre-dispose households to poverty. To derive comprehensive policies for improving health status and lowering poverty in Uganda, future studies should test the effect of HIV/AIDS and tuberculosis on health status.

The thesis uses the UDHS 2006 and UNHS 2005/06 as it was the most recent available data at the time of data analysis for this thesis. The UDHS 2011 dataset was made available to the public when the thesis was at a very advanced stage and so could not be used. Future studies could consider extending the analysis in this thesis using the UDHS 2011 with a view of contributing to relevant policy using the most recent datasets.

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Appendices

Table A1: Fertility Results with Regional Dummies under different Assumptions

Variable	Fertility with Exogenous Wealth Index		Instrumental Variable Model		Control Function Approach Models		
	(1) Ordinary Least Square model	(2) ZIP model	(3) First stage wealth index model	(4) Second stage fertility model with instrumented wealth index	(5) Fertility with wealth index residuals	(6) Fertility, wealth index residuals and interactions with wealth index	(7) Fertility and other interactions
Wealth index	-0.1907*** [0.022]	-0.0633*** [0.008]		-0.3484*** [0.095]	-0.3484*** [0.095]	-0.3100*** [0.098]	-0.3245*** [0.099]
Current age of woman	0.4062*** [0.017]	0.2660*** [0.006]	0.0430*** [0.008]	0.4193*** [0.018]	0.4193*** [0.018]	0.4189*** [0.018]	0.4191*** [0.018]
Current age of woman squared	-0.0026*** [0.00026]	-0.0031*** [0.00009]	-0.0005*** [0.00013]	-0.0028*** [0.00028]	-0.0028*** [0.00027]	-0.0028*** [0.00027]	-0.0028*** [0.00027]
Woman's education level (No education = reference)							
Primary education	0.0713 [0.053]	0.0330** [0.014]	0.4262*** [0.025]	0.1433** [0.068]	0.1433** [0.068]	0.1336* [0.069]	0.1400** [0.069]
Secondary education	-0.4995*** [0.076]	-0.1642*** [0.026]	1.3765*** [0.033]	-0.2846* [0.156]	-0.2846* [0.156]	-0.3182** [0.157]	-0.2888* [0.158]
Post-secondary education	-1.7137*** [0.121]	-0.4999*** [0.051]	2.1832*** [0.054]	-1.3463*** [0.247]	-1.3463*** [0.247]	-1.4051*** [0.250]	-1.3332*** [0.251]
Marital status (Never married = reference)							
Currently married	0.8503*** [0.067]	1.7518*** [0.053]	-0.3325*** [0.033]	0.8075*** [0.078]	0.8075*** [0.078]	0.8070*** [0.078]	0.7996*** [0.078]
Divorced/separated/widowed	-0.0678 [0.084]	1.5611*** [0.055]	-0.2238*** [0.041]	-0.1113 [0.091]	-0.1113 [0.091]	-0.1112 [0.091]	-0.1234 [0.091]
Religion (Pentecostals/SDA/Other = reference)							
Catholic	-0.1293** [0.066]	-0.0428** [0.020]	-0.1912*** [0.032]	-0.1644** [0.071]	-0.1644** [0.071]	-0.1589** [0.071]	-0.1626** [0.071]
Protestant	0.0311 [0.067]	0.0056 [0.021]	-0.0870*** [0.033]	0.0216 [0.070]	0.0216 [0.070]	0.0204 [0.070]	0.0261 [0.070]
Muslim	0.1670** [0.082]	0.0426* [0.025]	0.2706*** [0.040]	0.2302*** [0.089]	0.2302*** [0.089]	0.2194** [0.089]	0.2144** [0.089]
Regions of the country (Western = reference)							
Central	-0.1185** [0.060]	-0.0405** [0.018]	0.0639** [0.029]	-0.1133* [0.063]	-0.1133* [0.063]	-0.1163* [0.063]	-0.1101* [0.062]
Eastern	-0.1082* [0.059]	-0.0408** [0.018]	-0.0334 [0.029]	-0.1023* [0.062]	-0.1023* [0.061]	-0.1037* [0.061]	-0.0998 [0.061]
Northern	-0.0517	-0.0188	-0.0182	-0.0637	-0.0637	-0.0661	-0.06

	[0.067]	[0.020]	[0.032]	[0.069]	[0.069]	[0.069]	[0.069]
Instrumental variables							
Time to water source (minutes)			-0.0034*** [0.000]				
Distance to most common agricultural input market (kilometers)			-0.0019*** [0.001]				
Control function variables							
Reduced form wealth index residuals					0.1572 [0.098]	0.2009** [0.102]	0.8475*** [0.150]
Interaction of wealth index residuals and wealth index						-0.0278 [0.018]	-0.0378** [0.018]
Interaction of primary education for the woman and wealth index residuals							-0.1374 [0.085]
Interaction of secondary education for the woman and wealth index residuals							-0.0621 [0.092]
Interaction of post-secondary education for the woman and wealth index residuals							-0.2488** [0.115]
Interaction of current age of the woman and wealth index residuals							-0.0184*** [0.003]
Constant	-5.5797*** [0.237]	-5.2781*** [0.103]	0.9583*** [0.115]	-5.5607*** [0.254]	-5.5607*** [0.253]	-5.5843*** [0.254]	-5.5680*** [0.253]
Observations	8,410	8,410	7,940	7,940	7,940	7,940	7,940
R-squared/Pseudo R2	0.695		0.397	0.692	0.694	0.694	0.696
F/Wald Chi/LR chi2(14)	F(14, 8395) = 1364.72***	LR chi2(14) = 13095.69***	F(15, 7924) = 347.26***	Wald chi2(14) =17827.86***	F(15, 7924) = 1196.78***	F(16, 7923) = 1122.32***	F(20, 7919) = 906.32***
Log likelihood		= -13570.58					
Vuong test of zip vs. standard Poisson:		z = 5.27 Pr>z = 0.0000					
Durbin (score) chi2(1)	= 2.586 (p = 0.1078)						
Wu-Hausman F(1,7924)	= 2.581 (p = 0.1082)						
Test for excluded instruments							
F(2,7924)	= 253.715						
Prob > F	= 0.0000						
Partial R2 for excluded instruments	= 0.0602						
Sargan (score) chi2(1)	= 0.012 (p = 0.9127)						
Basmann chi2(1)	= 0.012 (p = 0.9128)						

Note: ZIP logit model estimates are presented in table A2. Standard errors are presented in parenthesis, *** significant at 1%, ** significant at 5% and * significant at 10% respectively.

Table A2: The Logit Estimates for the Zero-Inflated-Poisson Model - All Samples

Variable	Full model	Rural model	Urban model	Model with regional dummies
Women's education level				
Primary education	-0.2774 [0.289]	-0.0839 [0.302]	-2.0075* [1.055]	-0.2901 [0.288]
Secondary education	-0.7369 [0.691]	-0.4336 [0.732]	-2.7826 [1.734]	-0.7193 [0.663]
Post-secondary education	-1.362 [3.734]	-0.129 [1.715]	-1.0015 [2.650]	-0.7651 [2.025]
Religion				
Catholic	0.0559 [0.468]	0.021 [0.471]	11.3368 [572.068]	0.078 [0.474]
Protestant	-0.1935 [0.499]	-0.2584 [0.505]	11.4585 [572.068]	-0.1702 [0.504]
Muslim	0.1654 [0.570]	-0.2084 [0.629]	12.8195 [572.067]	0.2076 [0.575]
Rural residence = 1 (zero otherwise)	-0.0582 [0.468]			
Regions of the Country				
Central				-0.1321 [0.376]
Eastern				-0.4925 [0.393]
Northern				-0.4056 [0.446]
Constant	-4.0775*** [0.649]	-4.1805*** [0.477]	-14.8776 [572.067]	-3.8729*** [0.537]
Observations	8,415	7,038	1,377	8,410

Note: Standard errors are presented in parenthesis, *** significant at 1%, ** significant at 5% and * significant at 10% respectively.

Table A3: Child Nutritional Status Results for Control Function Approach Models with Other Interaction Variables

Variables	Child Nutritional Status Models (HAZ and the Probability of a Child being Stunted)						
	Full Sample Results		Rural Sub Sample Results		Urban Sub Sample Results	Regional Dummies' Results	
	(1) HAZ and other interactions	(2) Marginal effects after probit	(3) HAZ and other interactions	(4) Marginal effects after probit	(5) HAZ and other interactions	(6) HAZ and other interactions	(7) Marginal effects after probit
Wealth index	1.0592 [0.666]	-0.2579 [0.232]	0.8185 [0.690]	-0.3522 [0.248]	-0.2749 [0.528]	0.5266 [1.142]	-0.5263 [0.406]
Sex of child (Male = 1, zero otherwise)	-0.1208* [0.063]	0.0484** [0.022]	-0.0892 [0.065]	0.0401* [0.023]	-0.3121 [0.231]	-0.1380** [0.064]	0.0458** [0.022]
Child of multiple birth	-0.6990*** [0.259]	0.2667*** [0.090]	-0.7995*** [0.248]	0.2515*** [0.087]	-1.3705 [1.054]	-0.8258** [0.369]	0.1881 [0.136]
Birth order	-0.014 [0.023]	0.0046 [0.008]	-0.0199 [0.028]	0.0081 [0.010]	-0.0913 [0.127]	-0.0107 [0.023]	0.0039 [0.008]
Age of child (months)	-0.0834*** [0.007]	0.0246*** [0.003]	-0.0843*** [0.007]	0.0256*** [0.003]	-0.0813*** [0.025]	-0.0828*** [0.007]	0.0245*** [0.003]
Age of child squared (months)	0.0010*** [0.0001]	-0.0003*** [0.00004]	0.0011*** [0.0001]	-0.0003*** [0.0001]	0.0010** [0.0004]	0.0010*** [0.0001]	-0.0003*** [0.00004]
Height of mother (centimeters)	0.0591*** [0.010]	-0.0178*** [0.004]	0.0561*** [0.010]	-0.0191*** [0.003]	0.0205 [0.027]	0.0509*** [0.016]	-0.0211*** [0.006]
Mother's age (years)	0.0353 [0.043]	-0.0066 [0.015]	0.0372 [0.041]	-0.0035 [0.015]	0.2585 [0.189]	0.0451 [0.051]	0.0032 [0.018]
Mother's age squared (years)	-0.0004 [0.001]	0.00004 [0.0002]	-0.0004 [0.001]	-0.00002 [0.0002]	-0.0037 [0.003]	-0.0005 [0.001]	-0.0001 [0.0003]
Age of household head	0.0022 [0.003]	-0.0012 [0.001]	0.0021 [0.003]	-0.001 [0.001]	0.0131 [0.015]	0.0032 [0.003]	-0.0016 [0.001]
Household size	-0.0255 [0.022]	0.0107 [0.008]	-0.0246 [0.021]	0.0126* [0.008]	0.0844 [0.062]	-0.0094 [0.028]	0.0154 [0.010]
Sex of household head (Male =1, zero otherwise)	0.1709** [0.083]	-0.0557* [0.030]	0.1824** [0.086]	-0.0654** [0.032]	-0.0605 [0.344]	0.1736** [0.087]	-0.0664** [0.031]
Education level of mother *(No education = reference)*							
Primary	-0.1858 [0.222]	0.0122 [0.077]	-0.131 [0.212]	0.0433 [0.075]	1.0921* [0.599]	-0.0256 [0.370]	0.0945 [0.127]
Secondary	-0.5458 [0.568]	0.0606 [0.205]	-0.3252 [0.573]	0.1438 [0.214]	1.1648 [0.764]	-0.1841 [1.317]	0.4266 [0.404]
Post-secondary	-0.7507 [1.052]	0.0419 [0.385]	-0.4044 [1.107]	0.1956 [0.416]	1.8788* [1.086]	-0.0147 [2.135]	0.5345 [0.396]
Marital status *(Never married = reference)*							
Currently married	0.2044 [0.205]	-0.079 [0.076]	0.1728 [0.233]	-0.0263 [0.089]	0.703 [0.542]	0.239 [0.206]	-0.0967 [0.076]

Divorced/separated/widowed	0.4186* [0.221]	-0.0951 [0.071]	0.337 [0.251]	-0.0634 [0.089]	1.0436* [0.630]	0.3946* [0.219]	-0.0993 [0.070]
Professional care at birth (nurse/midwife)	-0.0053 [0.172]	-0.0109 [0.060]	0.0672 [0.169]	0.0051 [0.061]	0.601 [0.370]	0.0866 [0.463]	0.1265 [0.166]
Area of residence = (1, zero otherwise)	0.8849 [0.841]	-0.2424 [0.303]					
Regions of the country *(Western = reference)*							
Central						-0.1416 [0.140]	-0.0383 [0.048]
Eastern						-0.0601 [0.133]	-0.0588 [0.045]
Northern						-0.0476 [0.150]	-0.058 [0.051]
Control function variables							
Reduced form wealth index residuals	-0.5776 [0.728]	0.2639 [0.254]	-0.1964 [0.752]	0.2572 [0.272]	-0.1685 [0.898]	-0.504 [1.169]	0.5953 [0.416]
Interaction of wealth index residuals and wealth index	-0.0026 [0.045]	-0.0032 [0.017]	-0.0309 [0.055]	0.0124 [0.020]	-0.0187 [0.129]	0.0133 [0.038]	0.0005 [0.014]
Interaction of mother's primary education and wealth index residuals	-0.1549 [0.161]	-0.0082 [0.056]	-0.2882* [0.175]	0.0327 [0.063]	0.7216 [0.506]	0.091 [0.147]	-0.074 [0.051]
Interaction of mother's secondary education and wealth index residuals	-0.1504 [0.191]	0.0453 [0.068]	-0.2637 [0.221]	0.056 [0.081]	0.5607 [0.519]	0.0295 [0.166]	-0.0346 [0.058]
Interaction of mother's post-secondary education and wealth index residuals	-0.1913 [0.258]	0.0468 [0.100]	-0.2702 [0.289]	0.0616 [0.111]	0.67 [0.699]	0.0067 [0.221]	-0.032 [0.086]
Interaction of mother's age and wealth index residuals	-0.0045 [0.008]	-0.0021 [0.003]	-0.0042 [0.009]	-0.0009 [0.003]	0.0054 [0.024]	0.0049 [0.007]	-0.0027 [0.003]
Constant	-12.3963*** [2.407]		-10.8294*** [1.769]		-9.1598** [4.085]	-10.1173*** [2.673]	
Observations	2,249	2,249	2,004	2,004	229	2,247	2,247
R-squared/ Pseudo R-squared	0.166	0.0938	0.159	0.0905	0.183	0.165	0.0955
F/LR chi2/Wald chi	F(25, 2223) = 17.66***	LR chi2(25) = 280.49***	F(24, 1979) = 15.60***	LR chi2(24) = 243.47***	F(24, 204) = 1.91**	F(27, 2219) = 16.20***	LR chi2(27) = 285.33***
Log likelihood		-1354.8801		-1223.841			-1351.0136

Note: Standard errors in parenthesis, *** significant at 1%, ** significant at 5%, and * significant at 10% respectively.

Table A4: Effect of Wealth Index on Child Nutritional Status under different Assumptions - Regional Dummies' Results

Variables	Child Nutritional Status Models (HAZ and the Probability of a Child being Stunted)							
	Models with exogenous wealth index		Models with instrumented wealth index		Control function approach models			
	(1) OLS model	(2) Marginal effects after probit	(3) IV 2nd stage HAZ model	(4) Marginal effects after IVProbit	(5) HAZ with wealth index residuals	(6) Marginal effects after probit	(7) HAZ, wealth index residuals and interactions with wealth index	(8)Marginal effects after probit
Wealth index	0.2565*** [0.042]	-0.0609*** [0.016]	0.5415 [1.201]	-0.4166** [0.203]	0.5282 [1.140]	-0.5273 [0.404]	0.5331 [1.141]	-0.5267 [0.404]
Sex of child (Male = 1, zero otherwise)	-0.1660*** [0.059]	0.0608*** [0.021]	-0.1380** [0.065]	0.0343 [0.029]	-0.1386** [0.063]	0.0463** [0.022]	-0.1383** [0.064]	0.0464** [0.022]
Child of multiple birth	-0.8553*** [0.197]	0.2812*** [0.067]	-0.8198** [0.385]	0.1301 [0.182]	-0.8243** [0.368]	0.1831 [0.136]	-0.8193** [0.368]	0.1837 [0.136]
Birth order	-0.009 [0.022]	0.0029 [0.008]	-0.0114 [0.023]	0.0033 [0.007]	-0.0111 [0.023]	0.0039 [0.008]	-0.0106 [0.023]	0.0039 [0.008]
Age of child (months)	-0.0845*** [0.007]	0.0246*** [0.003]	-0.0827*** [0.007]	0.0184** [0.009]	-0.0828*** [0.007]	0.0243*** [0.003]	-0.0828*** [0.007]	0.0244*** [0.003]
Age of child squared (months)	0.0011*** [0.0001]	-0.0003*** [0.00004]	0.0010*** [0.0001]	-0.0002* [0.0001]	0.0010*** [0.0001]	-0.0003*** [0.00004]	0.0010*** [0.0001]	-0.0003*** [0.00004]
Height of mother (centimeters)	0.0488*** [0.005]	-0.0157*** [0.002]	0.0511*** [0.016]	-0.0161*** [0.003]	0.0510*** [0.016]	-0.0212*** [0.006]	0.0511*** [0.016]	-0.0212*** [0.006]
Mother's age (years)	0.0431 [0.038]	-0.0075 [0.013]	0.0472 [0.048]	0.0004 [0.015]	0.0458 [0.051]	0.0029 [0.018]	0.045 [0.051]	0.0029 [0.018]
Mother's age squared (years)	-0.0005 [0.001]	0.0001 [0.0002]	-0.0006 [0.001]	-0.0001 [0.0002]	-0.0005 [0.001]	-0.0001 [0.0003]	-0.0005 [0.001]	-0.0001 [0.0003]
Age of household head	0.0022 [0.003]	-0.0009 [0.001]	0.0031 [0.003]	-0.0011 [0.001]	0.0031 [0.003]	-0.0015 [0.001]	0.0031 [0.003]	-0.0015 [0.001]
Household size	-0.0016 [0.013]	0.004 [0.005]	-0.0097 [0.029]	0.0120** [0.005]	-0.0096 [0.028]	0.0157 [0.010]	-0.0099 [0.028]	0.0157 [0.010]
Sex of household head (Male =1, zero otherwise)	0.1595** [0.080]	-0.0471 [0.029]	0.1796** [0.089]	-0.0548* [0.030]	0.1778** [0.086]	-0.0697** [0.031]	0.1791** [0.087]	-0.0695** [0.031]
Education level of mother *(No education = reference)*								
Primary	0.054 [0.076]	-0.0439* [0.026]	-0.027 [0.384]	0.0765 [0.089]	-0.0239 [0.370]	0.0953 [0.127]	-0.0271 [0.370]	0.095 [0.127]
Secondary	0.1271 [0.125]	-0.1036*** [0.040]	-0.1861 [1.371]	0.3358 [0.255]	-0.174 [1.315]	0.4253 [0.403]	-0.1858 [1.316]	0.4243 [0.404]
Post-secondary	0.4019* [0.225]	-0.1886*** [0.067]	-0.0386 [2.283]	0.4518 [0.305]	-0.0045 [2.132]	0.533 [0.397]	-0.0232 [2.133]	0.5319 [0.400]

***Marital status** (Never married = reference)*								
Currently married	0.2367 [0.200]	-0.0864 [0.074]	0.2242 [0.206]	-0.0652 [0.072]	0.2253 [0.205]	-0.0889 [0.076]	0.2264 [0.205]	-0.0887 [0.076]
Divorced/separated/widowed	0.3901* [0.212]	-0.0866 [0.069]	0.3898* [0.223]	-0.0798 [0.068]	0.3840* [0.218]	-0.0941 [0.070]	0.3852* [0.218]	-0.0939 [0.070]
Professional care at birth (nurse/midwife)	0.1851*** [0.066]	-0.0543** [0.023]	0.0864 [0.475]	0.1005 [0.110]	0.089 [0.462]	0.1286 [0.165]	0.0831 [0.462]	0.128 [0.165]
Regions of the country (Western = reference)								
Central	-0.1303 [0.130]	-0.0576 [0.044]	-0.1447 [0.151]	-0.0222 [0.054]	-0.1381 [0.139]	-0.0403 [0.048]	-0.1373 [0.139]	-0.0402 [0.048]
Eastern	-0.0728 [0.130]	-0.0599 [0.044]	-0.0661 [0.138]	-0.0361 [0.050]	-0.0598 [0.133]	-0.0579 [0.045]	-0.0588 [0.133]	-0.0578 [0.045]
Northern	-0.023 [0.129]	-0.0890** [0.044]	-0.051 [0.164]	-0.0372 [0.063]	-0.0452 [0.150]	-0.0585 [0.051]	-0.0455 [0.150]	-0.0586 [0.051]
Control function variables								
Reduced form wealth index residuals					-0.2766 [1.141]	0.4698 [0.404]	-0.3059 [1.146]	0.467 [0.406]
Interaction of wealth index residuals and wealth index							0.0105 [0.037]	0.001 [0.013]
Constant	-9.5555*** [0.918]		-10.1750*** [2.810]		-10.1418*** [2.668]		-10.1488*** [2.669]	
Observations	2,344	2,344	2,247	2,247	2,247	2,247	2,247	2,247
R-squared /Pseudo R-squared	0.165	0.0933	0.147		0.164	0.0944	0.164	0.0944
F/Wald Chi/LR chi2	F(21, 2322) = 21.88***	LR chi2(21) = 290.79***	Wald chi2(21) = 399.25***	Wald chi2(21) = 594.29***	F(22, 2224) = 19.87***	LR chi2(22) = 281.89***	F(23, 2223) = 19.00***	LR chi2(23) = 281.90***
Log likelihood		-1413.7311		-3737.8941		-1352.7327		-1352.7299
Durbin (score) chi2(1)			0.059369 (p = 0.8075)					
Wu-Hausman F(1,2224)			0.058763 (p = 0.8085)					
Test for excluded instruments								
F(1,2225)			2.90736	2.90736				
Prob > F			0.0883	0.0883				
Partial R2 for excluded instruments			0.0013	0.0013				
Wald test of exogeneity				chi2(1) = 1.36 Prob > chi2 = 0.2427				

Note: Standard errors in parenthesis, *** significant at 1%, ** significant at 5%, and * significant at 10% respectively.

Table A5: Effect of Wealth Index on Child Nutritional Status under different Assumptions – Urban Sub Sample Results

Variables	Probability of a Child being Stunted			
	IVProbit model	Control function approach models		
	(1) Marginal effects after IVProbit	(2) Marginal effects after probit and wealth index residuals	(3) Marginal effects after probit, wealth index residuals and interactions with wealth index	(4) Marginal effects after probit and other interactions
Wealth index	0.2353** [0.112]	0.2906* [0.160]	0.3031* [0.158]	0.4324** [0.170]
Sex of child (Male = 1, zero otherwise)	0.0409 [0.059]	0.0391 [0.059]	0.0352 [0.059]	0.0148 [0.060]
Child of multiple birth	0.5924*** [0.180]	0.7149*** [0.154]	0.6880*** [0.192]	0.7648*** [0.102]
Birth order	0.0583* [0.030]	0.0686* [0.036]	0.0695* [0.036]	0.0898** [0.037]
Age of child (months)	0.0137* [0.007]	0.0146** [0.007]	0.0147** [0.007]	0.0127* [0.007]
Age of child squared (months)	-0.0002* [0.0001]	-0.0002* [0.0001]	-0.0002* [0.0001]	-0.0002 [0.0001]
Height of mother (centimeters)	0.0003 [0.007]	0.0013 [0.007]	0.0032 [0.007]	0.006 [0.008]
Mother's age (years)	-0.0962** [0.042]	-0.1165** [0.051]	-0.1150** [0.050]	-0.1499*** [0.053]
Mother's age squared (years)	0.0014** [0.001]	0.0017** [0.001]	0.0017** [0.001]	0.0022*** [0.001]
Age of household head	-0.003 [0.004]	-0.0029 [0.004]	-0.0029 [0.004]	-0.0049 [0.004]
Household size	-0.021 [0.015]	-0.0268 [0.018]	-0.0272 [0.018]	-0.0359* [0.019]
Sex of household head (Male =1, zero otherwise)	0.0766 [0.089]	0.0868 [0.086]	0.0837 [0.086]	0.0959 [0.085]
Education level of mother *(No education = reference)*				
Primary	-0.3360*** [0.102]	-0.4117*** [0.132]	-0.4174*** [0.131]	-0.4959*** [0.135]
Secondary	-0.4331*** [0.111]	-0.4935*** [0.140]	-0.5111*** [0.137]	-0.5968*** [0.138]
Post-secondary	-0.3302***	-0.2962***	-0.2969***	-0.3112***

	[0.064]	[0.042]	[0.043]	[0.046]
Marital status *(Never married = reference)*				
Currently married	-0.3407** [0.159]	-0.4235** [0.172]	-0.4455*** [0.172]	-0.5349*** [0.170]
Divorced/separated/widowed	-0.1684* [0.096]	-0.1760** [0.073]	-0.2011*** [0.061]	-0.2260*** [0.048]
Professional care at birth (nurse/midwife)	-0.1492* [0.085]	-0.2099* [0.109]	-0.2192** [0.110]	-0.3216*** [0.124]
Control function variables				
Reduced form wealth index residuals		-0.3031* [0.165]	-0.1697 [0.184]	-0.1159 [0.252]
Interaction of wealth index residuals and wealth index			-0.0555 [0.036]	-0.0543 [0.041]
Interaction of mother's primary education and wealth index residuals				-0.3461** [0.143]
Interaction of mother's secondary education and wealth index residuals				-0.2021 [0.149]
Interaction of mother's post-secondary education and wealth index residuals				-0.2775 [0.260]
Interaction of mother's age and wealth index residuals				0.0023 [0.006]
Observations	229	229	229	229
Pseudo R-squared		0.1536	0.1631	0.1927
F/Wald Chi/LR chi2	Wald chi2(18) = 54.76***	LR chi2(19) = 39.81***	LR chi2(20) = 42.28***	LRchi2(24)=49.95***
Log likelihood	-385.91674	-109.6867	-108.45141	104.61942
Test for excluded instruments				
F(1,210)	17.9692			
Prob > F	Prob > F = 0.0000			
Partial R2 for excluded instruments	0.0788			
Wald test of exogeneity	3.74 Prob > chi2 = 0.0530			

Note: Standard errors in parenthesis, *** significant at 1%, ** significant at 5%, and * significant at 10% respectively.

Table A6: Effect of wealth index on Child Nutritional Status by Gender of Household Head under different assumptions – Regional Sample Results

Variables	*Male Headed Household (MHHs)*		*Female Headed Household (FHHs)*	
	(1) HAZ with exogenous wealth index	(2) Instrumental variable model	(3) HAZ with exogenous wealth index	(4) Instrumental variable model
	OLS model	2nd stage HAZ model	OLS model	2nd stage HAZ model
Wealth index	0.2579*** [0.050]	0.2202 [0.247]	0.2689*** [0.084]	-0.4536 [0.642]
Sex of child (Male = 1, zero otherwise)	-0.1407** [0.067]	-0.1348** [0.068]	-0.2293* [0.128]	-0.2269 [0.144]
Child of multiple birth	-0.8050*** [0.231]	-0.7981*** [0.241]	-1.0466*** [0.391]	-1.1195** [0.451]
Birth order	-0.0093 [0.026]	-0.0122 [0.026]	-0.0041 [0.047]	-0.0418 [0.056]
Age of child (months)	-0.0795*** [0.008]	-0.0801*** [0.008]	-0.1025*** [0.015]	-0.1048*** [0.017]
Age of child squared (months)	0.0010*** [0.0001]	0.0010*** [0.0001]	0.0014*** [0.0002]	0.0014*** [0.0003]
Height of mother (centimeters)	0.0502*** [0.005]	0.0497*** [0.006]	0.0464*** [0.010]	0.0345** [0.015]
Mother’s age (years)	0.0075 [0.045]	0.0214 [0.048]	0.1297* [0.069]	0.0765 [0.078]
Mother’s age squared (years)	-0.000014 [0.001]	-0.0002 [0.001]	-0.0018 [0.001]	-0.0009 [0.001]
Age of household head	0.0045 [0.004]	0.0027 [0.004]	-0.0002 [0.006]	-0.0067 [0.009]
Household size	-0.0022 [0.015]	-0.0057 [0.017]	0.0026 [0.026]	0.0164 [0.034]
Mother’s primary education	0.1212 [0.086]	0.1195 [0.115]	-0.2075 [0.165]	-0.0337 [0.290]
Mother’s secondary education	0.116 [0.140]	0.1625 [0.305]	0.0879 [0.284]	0.9595 [0.854]
Mother’s post-secondary education	0.4843* [0.257]	0.5434 [0.578]	0.0486 [0.494]	0.8576 [0.952]
Currently married mothers	0.4863	0.4355	0.0795	0.1513

	[0.355]	[0.386]	[0.262]	[0.294]
Divorced/separated/widowed mothers	0.6498* [0.394]	0.6745 [0.435]	0.2612 [0.277]	0.3879 [0.305]
Professional care at birth (nurse/midwife)	0.1549** [0.075]	0.1991* [0.120]	0.2926** [0.140]	0.5104** [0.248]
Central	-0.155 [0.152]	-0.1088 [0.153]	-0.0719 [0.262]	0.0874 [0.363]
Eastern	-0.0721 [0.150]	-0.0622 [0.151]	-0.0478 [0.264]	0.0743 [0.339]
Northern	-0.0066 [0.150]	0.014 [0.151]	-0.1289 [0.259]	0.0262 [0.389]
Constant	-9.4622*** [1.106]	-9.4818*** [1.204]	-10.0263*** [1.846]	-6.6439** [3.156]
Observations	1,819	1,770	525	483
R-squared	0.157	0.156	0.21	0.085
F/Wald Chi/LR chi2	F(20, 1798) = 16.80***	Wald chi2(20) = 303.16***	F(20, 504) = 6.70***	Wald chi2(20) = 100.50***
Durbin (score) chi2(1)		= 0.020751 (p = 0.8855)		= 1.79694 (p = 0.1801)
Wu-Hausman		F(1,1748) = 0.020493 (p = 0.8862)		F(1,461) = 1.7215 (p = 0.1902)
Test for excluded instruments				
F-test		F(1,1749) = 76.7146		F(1,462) = 10.6466
Prob > F		0.0000		0.0012
Partial R2 for excluded instruments		0.0420		0.0225

Note: Standard errors in parenthesis, *** significant at 1%, ** significant at 5%, and * significant at 10% respectively.

Table A7: Effect of wealth index on Child Nutritional Status by Gender of Household Head with Regional Dummies under the Control Function Approach

Variables	*Male Headed Household (MHHs)*			*Female Headed Household (FHHs)*		
	(1) Wealth index residuals	(2) Wealth index residuals and interactions with wealth index	(3) Other interactions	(4) Wealth index residuals	(5) Wealth index residuals and interactions with wealth index	(6) Other interactions
Wealth index	0.2185 [0.260]	0.2108 [0.265]	0.1979 [0.266]	-0.4364 [0.596]	-0.3555 [0.604]	-0.2907 [0.619]
Sex of child (Male = 1, zero otherwise)	-0.1348** [0.069]	-0.1350** [0.069]	-0.1341* [0.069]	-0.2292* [0.136]	-0.2306* [0.136]	-0.2232 [0.137]
Child of multiple birth	-0.7985*** [0.243]	-0.7986*** [0.243]	-0.8054*** [0.244]	-1.1271*** [0.429]	-1.1258*** [0.430]	-1.1273*** [0.431]
Birth order	-0.0122 [0.026]	-0.0119 [0.026]	-0.0133 [0.026]	-0.0374 [0.052]	-0.0401 [0.052]	-0.039 [0.053]
Age of child (months)	-0.0801*** [0.008]	-0.0801*** [0.008]	-0.0804*** [0.008]	-0.1034*** [0.016]	-0.1033*** [0.016]	-0.1038*** [0.016]
Age of child squared (months)	0.0010*** [0.0001]	0.0010*** [0.0001]	0.0010*** [0.0001]	0.0014*** [0.0003]	0.0014*** [0.0003]	0.0014*** [0.0003]
Height of mother (centimeters)	0.0497*** [0.006]	0.0496*** [0.006]	0.0492*** [0.006]	0.0348** [0.014]	0.0368** [0.015]	0.0369** [0.015]
Mother's age (years)	0.0217 [0.048]	0.0213 [0.048]	0.0218 [0.049]	0.0814 [0.073]	0.0824 [0.073]	0.0894 [0.074]
Mother's age squared (years)	-0.0002 [0.001]	-0.0002 [0.001]	-0.0002 [0.001]	-0.001 [0.001]	-0.001 [0.001]	-0.0011 [0.001]
Age of household head	0.0027 [0.004]	0.0027 [0.004]	0.0029 [0.004]	-0.0062 [0.008]	-0.0059 [0.008]	-0.0059 [0.008]
Household size	-0.0057 [0.017]	-0.0056 [0.017]	-0.0037 [0.017]	0.0166 [0.032]	0.0153 [0.032]	0.0172 [0.033]
Mother's primary education	0.1200 [0.118]	0.1215 [0.118]	0.1225 [0.119]	-0.0211 [0.283]	-0.0404 [0.284]	-0.0652 [0.288]
Mother's secondary education	0.1647 [0.321]	0.1691 [0.322]	0.1714 [0.324]	0.9491 [0.802]	0.8818 [0.806]	0.7614 [0.826]
Mother's post-secondary education	0.5445 [0.589]	0.5523 [0.591]	0.5685 [0.594]	0.8594 [0.904]	0.7514 [0.913]	0.6375 [0.929]

Currently married mothers	0.4355 [0.389]	0.4341 [0.389]	0.4382 [0.389]	0.1576 [0.278]	0.1467 [0.278]	0.1166 [0.284]
Divorced/separated/widowed mothers	0.6732 [0.440]	0.6716 [0.440]	0.6637 [0.440]	0.4204 [0.292]	0.4021 [0.293]	0.3657 [0.298]
Professional care at birth (nurse/midwife)	0.2000 [0.125]	0.2007 [0.126]	0.2029 [0.126]	0.5269** [0.245]	0.5171** [0.246]	0.4921* [0.253]
Central	-0.1096 [0.154]	-0.1091 [0.154]	-0.122 [0.154]	0.0856 [0.343]	0.0741 [0.344]	0.0694 [0.347]
Eastern	-0.0634 [0.152]	-0.0629 [0.153]	-0.0689 [0.153]	0.0919 [0.328]	0.0802 [0.328]	0.0721 [0.330]
Northern	0.0137 [0.152]	0.0139 [0.152]	0.0063 [0.153]	0.0186 [0.365]	0.009 [0.366]	-0.0132 [0.371]
Control function variables						
Reduced form wealth index residuals	0.0381 [0.266]	0.0299 [0.271]	-0.0487 [0.415]	0.791 [0.603]	0.8541 [0.608]	0.6841 [0.785]
Interaction of wealth index residuals and wealth index		0.0073 [0.048]	0.0225 [0.051]		-0.0607 [0.071]	-0.033 [0.074]
Interaction of mother’s primary education and wealth index residuals			0.1045 [0.176]			-0.1837 [0.317]
Interaction of mother’s secondary education and wealth index residuals			0.0254 [0.203]			-0.2382 [0.351]
Interaction of mother’s post-secondary education and wealth index residuals			-0.1749 [0.250]			0.6127 [0.672]
Interaction of mother’s age and wealth index residuals			0.0003 [0.009]			0.0074 [0.014]
Constant	-9.4793*** [1.218]	-9.4603*** [1.225]	-9.4066*** [1.231]	-6.8437** [2.878]	-7.1851** [2.906]	-7.3409** [2.957]
Observations	1,770	1,770	1,770	483	483	483
R-squared	0.156	0.156	0.157	0.215	0.217	0.221
F/Wald Chi	F(21, 1748) = 15.41***	F(22, 1747) = 14.71***	F(26, 1743) = 12.52***	F(21, 461) = 6.03***	F(22, 460) = 5.78***	F(26, 456) = 4.97***

Note: Standard errors in parenthesis, *** significant at 1%, ** significant at 5%, and * significant at 10% respectively.

Table A8: Descriptive Statistics for Fertility Variables for Full and Area of Residence

Variables	*Full Sample Statistics*		*Area of Residence Statistics*			
			Rural Sub-Sample		*Urban Sub-Sample*	
	Observations	Mean§	Observations	Mean§	Observations	Mean§
Fertility (children ever born)	8421	3.54 [3.21]	7044	3.80*** [3.27]	1377	2.21*** [2.48]
Wealth index	8421	1.74 [1.08]	7044	1.43*** [0.75]	1377	3.31*** [1.16]
Current age of woman (years)	8421	28.14 [9.49]	7044	28.50*** [9.62]	1377	26.33*** [8.53]
Current age of woman squared (years)	8421	882.10 [580.96]	7044	904.76*** [591.11]	1377	766.20*** [510.67]
Woman's education level						
No education	8421	0.21 [0.41]	7044	0.24*** [0.43]	1377	0.06*** [0.24]
Primary	8421	0.58 [0.49]	7044	0.61*** [0.49]	1377	0.39*** [0.49]
Secondary	8421	0.17 [0.38]	7044	0.13*** [0.33]	1377	0.41*** [0.49]
Post-secondary	8421	0.04 [0.19]	7044	0.02*** [0.14]	1377	0.13*** [0.34]
Marital status						
Never married	8421	0.24 [0.43]	7044	0.22*** [0.41]	1377	0.36*** [0.48]
Currently married	8421	0.63 [0.48]	7044	0.66*** [0.47]	1377	0.48*** [0.50]
Divorced/separated/widowed	8421	0.13 [0.34]	7044	0.12*** [0.33]	1377	0.16*** [0.37]
Religion						
Catholic	8415	0.45 [0.50]	7038	0.47*** [0.50]	1377	0.33*** [0.47]
Protestant	8415	0.33 [0.47]	7038	0.33 [0.47]	1377	0.32 [0.47]

Muslim	8415	0.11 [0.32]	7038	0.10*** [0.29]	1377	0.21*** [0.40]
Pentecostals/SDA/others	8415	0.11 [0.31]	7038	0.10*** [0.30]	1377	0.15*** [0.36]
Proxies of market access						
Distance to NGO health facility (kilometers)	8412	23.36 [36.16]	7037	22.75*** [35.36]	1375	26.44*** [39.88]
Distance to most common agricultural input market (kilometers)	8412	7.94 [14.77]	7037	8.23*** [15.19]	1375	6.47*** [12.27]
Time to water source (minutes)	7959	59.49 [61.91]	6684	65.79*** [62.90]	1275	26.47*** [43.42]

***, **, * show that the difference in the means of variables by area of residence is significant at 1%, 5% and 10% respectively.
§: Standard deviations are in square parenthesis.

Table A9: Descriptive Statistics for Child Nutritional Status Variables for Full and Area of Residence

Variables	*Full Sample Statistics*		*Area of Residence Statistics*			
			Rural		*Urban*	
	Observations	Mean®	Observations	Mean®	Observations	Mean®
Height-for-age (HAZ)	2356	-1.54 [1.56]	2108	-1.60*** [1.52]	248	-0.99*** [1.74]
Probability of being stunted (<-2 = 1, zero otherwise)	2356	0.38 [0.49]	2108	0.40*** [0.49]	248	0.26*** [0.44]
Wealth index	2500	1.20 [0.86]	2233	1.03*** [0.65]	267	2.64*** [1.07]
Sex of child (Male = 1, zero otherwise)	2500	0.50 [0.50]	2233	0.50 [0.50]	267	0.51 [0.50]
Child of multiple birth	2500	0.02 [0.15]	2233	0.02 [0.15]	267	0.01 [0.12]
Birth order	2500	4.36 [2.60]	2233	4.49*** [2.61]	267	3.33*** [2.25]
Age of child (months)	2500	27.92 [17.20]	2233	27.77 [17.13	267	29.15 [17.75]
Age of child squared (months)	2500	1075.27 [1029.37]	2233	1064.70 [1025.57]	267	1163.71 [1058.46]
Mother's height (centimeters)	2473	159.01 [6.46]	2210	159.03 [6.55]	263	158.92 [5.68]
Sex of household head (Male = 1, zero otherwise)	2500	0.77 [0.42]	2233	0.78*** [0.41]	267	0.70*** [0.46]
Mother's age (years)	2500	28.98 [6.65]	2233	29.19*** [6.69]	267	27.24*** [6.02]
Mother's age squared (years)	2500	884.21 [408.47]	2233	896.93*** [412.39]	267	777.88*** [357.42]
Household size	2500	6.70 [2.70]	2233	6.76*** [2.66]	267	6.20*** [2.10]
Age of household head	2500	36.96 [11.76]	2233	37.19*** [11.89]	267	35.02*** [10.35]
Education level of mother						

No education	2500	0.24 [0.43]	2233	0.25*** [0.44]	267	0.10*** [0.30]
Primary	2500	0.63 [0.48]	2233	0.65*** [0.48]	267	0.45*** [0.50]
Secondary	2500	0.11 [0.31]	2233	0.08*** [0.27]	267	0.38*** [0.49]
Post-secondary	2500	0.02 [0.15]	2233	0.02*** [0.13]	267	0.07*** [0.26]
Marital status						
Never married	2500	0.03 [0.16]	2233	0.02*** [0.15]	267	0.071*** [0.26]
Currently married	2500	0.89 [0.31]	2233	0.90*** [0.30]	267	0.824*** [0.38]
Divorced/separated/widowed	2500	0.08 [0.27]	2233	0.08 [0.27]	267	0.105 [0.31]
Professional care at birth (Nurse/Midwife)	2500	0.39 [0.49]	2233	0.35*** [0.48]	267	0.77*** [0.42]
Proxies of market access						
Distance to feeder roads (kilometers)	2495	3.32 [8.15]	2230	2.97*** [7.76]	265	6.23*** [10.47]
Distance to telephone facility (kilometers)	2400	1.44 [2.99]	2137	1.43 [2.91]	263	1.46 [3.68]
Time to water source (minutes)	2405	60.02 [57.26]	2157	63.53*** [57.67]	248	29.42*** [42.80]

***, **, * show that the difference in the means of variables by area of residence is significant at 1%, 5% and 10% respectively.
®: Standard deviations are in square parenthesis.