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Maternal Education and its Impact on Child Health Outcomes

Bachelor thesis

Author: **Miriama Tóthová**

Supervisor: **PhDr. Julie Chytilová, Ph.D.**

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Signature

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Abstract

The aim of the presented thesis is to examine the relationship between maternal educational attainment and child health outcomes. The study attempts to distinguish between child's nutritional status and mother's health-seeking behaviour which is measured by child's immunization status. Hypotheses are tested using a probit regression model based on the Demographic and Health Surveys data from two Sub-Saharan countries, namely Ethiopia and Kenya. The empirical results suggest that there is a strong significant relationship between maternal education and child's chronic malnutrition, while the maternal education effect attenuates after inclusion of possible channels in the regressions explaining child's acute malnutrition and child's immunization status. The education effect on the probability of having diarrhea has shown to be insignificant. Furthermore, the effect does not differ either by the sex of the child nor by the place of residence. Lastly, we observe that secondary education represents the most important influence on the child health quality.

Keywords maternal education, child health, malnutrition, immunization, model of household behaviour

Abstrakt

Cieľom prezentovanej práce je skúmať vzťah medzi dosiahnutým vzdelaním matky a zdravím jej dieťaťa. Štúdia sa pokúša rozlišovať medzi výživovým stavom dieťaťa a matkiným úsilím o zdravie, ktoré je tu merané stavom imunizácie dieťaťa. Hypotézy sú testované použitím probit modelu na základe údajov z demografického a zdravotného prieskumu v dvoch krajinách subsaharskej Afriky, konkrétne v Etiópii a Keni. Empirické výsledky naznačujú, že existuje silný signifikantný vzťah medzi matkiným vzdelaním a chronickou podvýživou dieťaťa, zatiaľ čo edukačný efekt matky je zmiernený zahrnutím možných mechanizmov do regresií vysvetľujúcich akútnu podvýživu a imunizáciu dieťaťa. Vplyv vzdelania na pravdepodobnosť hnačky sa ukázal ako zanedbateľný. Okrem toho, účinky sa nelíšia na základe pohlavia dieťaťa ani miestom bydliska. Nakoniec pozorujeme, že stredoškolské vzdelanie má najzásadnejší vplyv na kvalitu zdravia detí.

Kľúčové slová vzdelanie matky, zdravie dieťaťa, podvýživa, imunizácia, model správania domácností

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Acronyms

AIDS Acquired Immune Deficiency Syndrome

DHS Demographic and Health Survey

ESDP Education Sector Development Program

FAL Functional Adult Literacy

GDP Gross Domestic Product

GNI Gross National Income

GPE Global Partnership for Education

HIV Human Immunodeficiency Virus

HSDP Health Sector Development Programme

MDG Millennium Development Goal

ODA Official Development Assistance

OLS Ordinary Least Squares

PPP Purchasing Power Parity

SD Standard Deviation

SDG Sustainable Development Goal

TVET Technical Vocational and Education Training

UNDP United Nations Development Programme

USAID United States Agency for International Development

WHO World Health Organization

Bachelor Thesis Proposal

Author	Miriama Tóthová
Supervisor	PhDr. Julie Chytilová Ph.D.
Proposed topic	Maternal Education and its Impact on Child Health Outcomes

Topic characteristics The aim of my bachelor thesis is to examine the impact of parental (particularly maternal) education on children's health outcomes. What determines child health is an important question, since it is considered to be a key indicator of the quality of life in developing countries. I would like to distinguish between children's nutritional status and parental health-seeking behaviour measured by children's immunization status. Firstly, I will describe the theoretical framework, the measurement of health and the issues regarding education and health in both examined countries. Hypotheses about the role of maternal education are empirically tested using Demographic and Health Surveys data from two Sub-Saharan countries, namely Ethiopia and Kenya, and the empirical results are presented. In summary, I will analyze the differences between these countries and also compare results with the evidence from the relevant literature.

Hypotheses The thesis will aim at answering these core questions:

1. Does maternal education affect child health outcomes and immunization decisions?

2. Does the education effect differ by the sex of the child or the place of residence?

3. What are the channels through which mother's education contributes to child health?

4. Which level of mother's education is the most important in promoting her children's nutritional and immunization status?

Methodology Probit regression model

Outline

1. Introduction
2. Theoretical Background
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Author Supervisor

Introduction

Child health has become a key determinant of the quality of life in the developing world. In 2000, The Millennium Development Goals were created to achieve eight targets fighting poverty and hunger all over the world by 2015. At least four of them were associated with child health and nutrition.[1] Despite the fact that incredible progress has already been made, the Sustainable Development Goals were adopted to ensure that *"no one is left behind"* (UNDP, 2015). The aim is to achieve the target of 17 new SDGs by the year 2030, to finish the job of MDGs and to end poverty permanently.

Despite its importance, there is a lack of evidence about what causes poor child health. A number of economists point to parental education as the primary determinant of child health and nutritional status in developing countries. In fact, another goal of the SDGs is directly linked to the improvement of education - *Goal 4: Quality of education.* In particular, mother's education was found to be notably significant. Why do we expect mother's level of education to promote better child health? More educated women may be better able to benefit from the health-related information in media, to use health care facilities and preventive services, and to maintain their environment more hygienic. (Engle *et al.*, 1996)

In this thesis, we will examine four core questions. Does maternal education affect child health outcomes and immunization decisions? Does the education effect differ by the sex of the child or the place of residence? What are the channels through which mother's education contributes to child health? Which level of mother's education is the most important in promoting her children's nutrition? In order to test these hypotheses, a probit model will be used.

[1] These four goals are, namely, *Goal 1: Eradicate hunger, Goal 4: Reduce child mortality, Goal 5: Improve maternal health, and Goal 6: Combat HIV/AIDS, malaria and other diseases.* (UNDP, 2000)

The effect of maternal education on child health will be examined in two Sub-Saharan countries, particularly Ethiopia and Kenya based on data from the most recent Demographic and Health Surveys. The reason is that malnutrition, a major cause of under-five deaths in both countries, still remains a fundamental health challenge. Both countries have characteristics of developing countries in terms of modest education levels and health care utilization.

This thesis will follow the method of using child anthropometric indicators as they provide useful information about standards of living according to nutritionists (Waterlow *et al.*, 1977). Moreover, we will use the prevalence of diarrhea which indicates acute morbidity and it is one of the illnesses primarily causing under-five deaths in both examined countries. We will implement a research on the immunization status as well, to include mothers' health-seeking behaviour.

The thesis is organized as follows. Chapter 1 briefly outlines the theoretical model, reviews the relevant literature and describes the determinants used for measurement of child health. In Chapter 2 we elaborate on the situation in each of two chosen countries, in particular, we describe the health and education system and state differences between these two countries. Chapter 3 describes data and their source, and defines the variables of interest. Moreover, this chapter reports a methodology for analysis used in the thesis and states the hypotheses to be tested. Chapter 4 empirically tests the effect of maternal education on child health and possible mechanisms behind this relationship. Chapter 5 summarizes the regression results, compares them with findings from previous studies and gives ideas for further research. Within the results, chosen countries are compared, and the occurring differences are explained. The last chapter concludes. The Appendix includes additional information, figures and complete tables of estimates in detail.

Chapter 1

Theoretical Background

In this chapter, firstly the theoretical framework is outlined. The empirical analysis of this thesis is underpinned by a basic one-period model in the tradition of Becker (1981) in which a household maximizes a utility function subject to several constraints. Furthermore, some key studies regarding the topic are presented, and the determinants of child health are described in the last section.

1.1 Theoretical framework

This section briefly lays out a model that integrates a biomedical health technology into the theoretical model of family allocation decisions (health being a key component of human capital). The thesis follows the traditional Becker's model of household behaviour, and refers to its most detailed description by Behrman & Deolalikar (1988).

In this framework, a household consisting of n individuals maximizes a joint utility function of the form

$$U = U(H, F, Z, L) \qquad U' > 0, U'' < 0 \tag{1.1}$$

where H, F, Z and L are, respectively, 1 x n vectors of the health status H^i, consumption of food F^i, non-food consumption Z^i, and leisure time L^i that is available to each family member i, $i = 1...n$. Considering that good health is desirable *per se* and consumption of food is also encouraged by other reasons besides its nutritional value, both are directly included in the utility function (Senauer & Garcia, 1991).

The household maximizes this utility function with respect to several constraints: a budget constraint, a time constraint for each individual and a biological health production function. Production function determining health for the ith child takes the form:

$$H^i = H(N^i, G^i, X_i, X_h, X_c, \nu_i) \tag{1.2}$$

where the H^i at the left-hand side of the equation is the health outcome of the ith child, N^i is a vector of nutrients consumed by child i, G^i is a vector of non-food health inputs (such as medical service), X_h is a vector of the household-level characteristics which affect the ith child's health such as household size, water, toilet facilities as well as the observable parents' characteristics (for instance age and education levels), X_i is a vector of the ith child's observable characteristics, including age and gender, X_c represents community-level characteristics, for instance access to health centre and ν_i is a vector of unobserved individual health endowments[1].

The maximization problem leads to a reduced-form demand function for nutritional status, under the assumption that all underlying functions have desirable properties:

$$H_i = h(X_i, X_c, X_h, \epsilon_i) \tag{1.3}$$

The last equation thus gives the relationship of our primary interest as it is much easier to estimate and has often been estimated in many demographic studies. However, the reduced-form function assumes that inputs in the health function are exogenous. The problem arises while the levels of parents' education are also assumed to be exogenous. Most of the previous studies examining the parental education-child health relationship has ignored possible endogeneity of parental education (such as Barrera, 1990; Thomas *et al.*, 1991; Desai & Alva, 1998).

One way to account for the endogeneity is using the Instrumental Variables IV (Glewwe, 1999). However, it is quite challenging to find a set of truly exogenous instruments, mostly because of the unavailability of such data. An alternative approach is to include control variables in the health function which

[1]We will include mother's BMI to proxy for mother's health endowment, the genetic factors and other unobserved family background to reduce bias.

act as proxies for the unobservable variables. In this thesis we follow the latter approach resulting in the function:

$$H_i = h(X_i, X_c, X_h, controls_i, \epsilon_i) \tag{1.4}$$

$Controls_i$, in this thesis, represents a vector of possible channels through which mother's education could contribute to her child's health outcomes. In particular, these include wealth of the household, whether a mother is literate, her exposure to media and her power within family. These may proxy for the unobservable characteristics such as mother's independence, preferences, or certain values. The channels themselves are also potentially endogenous, thus their impact on child nutritional and immunization status cannot be interpreted as causal (unless we do not control for their endogeneity).

1.2 Literature overview

There exists a number of economic and demographic studies examining the effect of parental education on child health, nutrition and survival[2]. Even though many scholars have investigated this relationship in a context of a developed country[3], this section is rather limited to the studies considering developing countries. Majority of them have found significant positive relationship between child health outcomes and parents' education, and that mother's education level has a stronger effect. In particular, the effect of mother's level of education is about twice as large as the one of father's education. (Cochrane 1982, Caldwell 1982, Alderman 2001). This finding has been suggested as an argument to target public expenditures into educational sector towards girls. Moreover, mother plays a bigger role in taking care of her children in most households, indicating that maternal schooling may probably matter more than paternal schooling. (Maïga, 2011)

Why do we expect maternal education to promote better child health? More educated women may be better able to benefit from the health-related information in media, to use health care facilities and preventive services, and to maintain their environment more hygienic (Engle *et al.*, 1996). Moreover, mothers with higher level of education may have high-paying jobs and therefore

[2]Strauss & Thomas (1995) provides an extensive summary of the relevant literature.
[3]For instance, Lindeboom *et al.* (2009)

take better care of their children.

The paper written by Caldwell (1979), which is also considered to be "a pioneering study", claims that maternal education is significantly associated with child survival in Nigeria, even more than other household-level factors. There is a considerable amount of literature documenting on many demographic variables and indicators of child health, such as child mortality (Caldwell, 1979; Breierova & Duflo, 2002; Bicego & Boerma, 1993; Hobcraft, 1993), however this review will focus primarily on the anthropometric measures and immunization status, since these are used in our analysis. Height, given age and sex, and weight conditional on height and sex of a child are considered by nutritionists to be valuable indicators of child long-term and short-term nutritional status respectively and are used by many development economists in their surveys. (Cochrane *et al.*, 1982; Barrera, 1990; Thomas *et al.*, 1991; Behrman & Wolfe, 1987; Strauss, 1990).

Furthermore, fewer studies have attempted to examine potential mechanisms by which mother's and father's years of education improve child health and nutrition (Glewwe, 1999; Thomas *et al.*, 1991; Webb & Block, 2003; Desai & Alva, 1998; Aslam & Kingdon, 2012). Authors of these empirical studies believe that the findings of their analysis may have important policy implications.

The study by Thomas, Strauss and Henriques (1991) has been one of the first papers examining possible channels underlying the link between maternal education and child health. In particular, four channels have been considered: income, access to mass media, literacy and numeracy. Using DHS data from Brazil, it shows that nearly the whole influence of maternal education on child height in Brazil can be explained by access to mass media, that the income explains only a small proportion and that schooling and community health services are substitutes.

Glewwe (1999) has used data from Morocco to show that maternal education contributes to child health (measured by child's height) primarily through her nutrition and health knowledge. The study suggests that maternal health knowledge depends on the literacy skills taught in school, although this knowledge is not directly obtained in the classroom.

Additionally, in Java Webb & Block (2003) have proxied for maternal nutritional knowledge using questionnaires where women were asked to list potential benefits of vitamin A. They have found that mothers' nutritional knowledge is positively associated with children's short-term nutrition (weight-for-height), and by contrast mother's education dominates her health knowledge in determining children's long-term nutritional status (measured by height-for-age).

Desai & Alva (1998) examine the relationship between maternal education and child health status measured by infant mortality, children's immunization status and height-for-age based on DHS data for 22 developing countries. After controlling for individual- and community- level variables (such as piped water), the impact of mother's education is still statistically different from zero for several examined countries, however, the estimated magnitudes tend to attenuate. They therefore reject the existence of a strong causal relationship.

Benefits may also differ according to the sex of the child. Shariff & Namkee (1995) show that mother's schooling improves sons' health measure (height-for age) more than the one of girls. Thomas (1994) examines the impact of parental education on child nutritional status measured by child height using the data from three different countries, namely Brazil, Ghana and the United States. In contrast to findings of Shariff & Namkee (1995), the effect of mother's education is larger on the height of her daughter, while the father's level of education appears to have a stronger effect on the height of his son.

With regard to immunization status of a child, Aslam & Kingdon (2012) using the data from Pakistan have found that paternal education is positively linked to the health-seeking behaviour, while mother's education is significantly associated with child health outcomes measured by their height and weight. Wilairat (1987) suggests that the infants of more educated mothers in Thailand enjoy better nutritional status and are also more likely to be immunized.

However, some critics claim that a positive education effect of mothers could be picking up the consequences of the transfer of values among family generations. The main supporters of this critique are Behrman & Wolfe (1987) whose findings in Nicaragua have shown that parents' education is a proxy for unobserved family background as the effect of mother's education disappears after inclusion of maternal endowments.

To sum up, there is considerable evidence that parents' (mothers') years of schooling have positive effect on child health, and some evidence through which mechanisms it occurs. This thesis contributes to the topic by addition of dependent variable *Diarrhea* and also different potential channel - mother's empowerment. Furthermore, the relationship is examined in two countries - Ethiopia and Kenya representing both low-income and middle-income country to find differences (if any).

1.3 Measurement of health

According to WHO's recommendation, the nutritional status is a good measure of child's health. Malnutrition[4] remains a widespread problem in developing countries. There exists a number of studies which have examined both short-term and long-term consequences of child malnutrition. Among the main ones are an increased risk of infection and death, delayed mental development, poorer educational achievement, and lower physical and intellectual productivity in adult life.

The nutritional status of an individual can be assessed using several different methods, for example clinical examination, biochemical indicators or anthropometric measurements. Anthropometry, the measurement of human body, has an important advantage over biochemical or clinical tools as it is non-invasive, inexpensive and relatively easy to obtain.

Given a child's height, weight, and age, the three following indicators are frequently used:

(a) *height-for-age:* Height-for-age measures linear growth relative to age and is frequently used as a proxy for longer run health status. It reflects a child's past or chronic nutritional status, as it is influenced by long-term food shortages, and chronic or frequently returning diseases. A child whose height is too small, given his or her age, is called *stunted*.

[4]In this thesis, the term malnutrition will be used as a synonym for undernutrition rather than overnutrition. The reason is that an undernourishment is the main problem among children under the age of five in Ethiopia and Kenya and also, this term is commonly used in this manner in the relevant literature (Kostermans, 1994)

(b) *weight-for-height:* Weight-for-height reflects more a child's current health status, because weight typically varies in the short run due to acute diseases. Children who are too thin for their height are called *wasted*. Wasting indicates acute malnutrition.

(c) *weight-for-age:* The third indicator reflects body mass relative to age. A child with severe deficits in weight-for-age is considered to be *underweight*. Underweight is the outcome combining both chronic and acute influences.

Since the anthropometric measures are likely to change with the children growing and are closely linked with a child's gender and age, a method of standardization is commonly used, where heights and weights are standardized by age and sex. The standard deviation or z-score method is based on fitting a standard normal distribution to the growth curves of a healthy population of children. The National Center for Health Statistics (NCHS) data for United States children, the so-called NCHS/WHO international reference population, is used as a basis. We follow this method recommended by WHO mainly due to practical purposes as it simplifies comparison between countries and also with previous studies.

The z-score of any mentioned indicators can be calculated by subtracting the median from the index child's health measure, and dividing the difference by the standard deviation of reference population. Mathematically:

$$Z - score = \frac{A_i - A_r}{SD\ of\ reference\ population} \tag{1.5}$$

where A_i represents individual's observed anthropometric value, specifically height or weight, A_r is the median value in reference population and SD is the standard deviation of reference population. Put into words, Z-score of certain indicator can be interpreted as the number of standard deviations a child is away from the median of the children from the reference group.

There is a difference between *moderate* and *severe* malnutrition. The WHO Global Database on Child Growth and Malnutrition uses a Z-score cut-off point of -2 SD. A child with z-score of any anthropometric indicator between minus three and minus two is generally considered to be moderately malnourished, while a child with z-score minus three below the median of the WHO international reference standards is considered to suffer from severe malnutrition.

In this thesis, however, we focus only on two of these indicators - height-for-age and weight-for-height which will be made as binary variables - being stunted and wasted, respectively. Weight-for-age is in fact a measure composed of the two others, making interpretation complicated. Besides, we include the third variable measuring whether a child is fully immunized, as we want to account for maternal health-seeking behaviour. Additionally, the last examined dependent variable will be the prevalence of diarrhea indicating acute morbidity. All dependent variables are more closely explained in the subsection of Chapter 3 - Description of variables.

Chapter 2

Countries Overview

Ethiopia and Kenya are two Sub-Saharan countries that lie on the Eastern part of African continent. Both have their own distinctive characteristics. In this chapter we will describe the current situation and recent development in education and health system in both African countries. We will mention the areas where huge improvements have been made and where some challenges still remain. It also helps to better understand the choice of these two countries. The last part of this section is focused on the comparison of both countries according to the educational attainment and several child health indicators such as nutritional status, vaccination coverage and prevalence of illnesses as these are the examined measurements of child health in this thesis. The access to data about GNI per capita, and total population of examined countries is free and open at the World Bank's website[1]. Moreover, the information regarding Education Index is available at the official website of United Nations Development Programme[2]. Lastly, health financing system indicators are accessed from the database of World Health Organization[3].

2.1 Ethiopia

The first examined country is a low-income country which lags behind the world in both education and health outcomes. Regarding the Education Index, Ethiopia is ranked at the 173^{rd} position out of 187 countries. Ethiopia's total population was enumerated at 96.96 million which makes it the second most populous country on African continent, after Nigeria. Over past two decades,

[1]information available at http://data.worldbank.org
[2]information available at http://hdr.undp.org/en/content/education-index
[3]information available at http://apps.who.int/gho/data/node.main.484?lang=en

the economy of Ethiopia has achieved considerable growth due to its investment in physical infrastructure and human resources. However, it still remains one of the poorest countries in the world with GNI per capita of 1,500 (PPP international $). Currently, Ethiopia is on a long-term trajectory to transform into a middle-income country by 2025, which is inspiring educational reforms.

2.1.1 Educational system

In 1994, The Education and Training Policy (ETP) was implemented in Ethiopia which, among other reforms, issued new 8-2-2 formal structure of the educational system and free education for students attending grades 1 to 10[4]. The Government funds most of Ethiopian schools and universities and contributes 4.7% of GDP into educational sector.

In 1997, the Government introduced the first five year strategic plan, Education Sector Development Program (ESDP I). A number of donors supported the achievement of these goals, such as USAID or the World Bank Group. One of the main targets of ESDP I was to raise primary enrollment in Ethiopia. An enormous progress was made in this area, however, there were still some challenges in adequate improvement in quality of education. That is why the Ministry of Education came with another three plans following ESDP I. The most recent plan, ESDP IV, covered the period 2010-2015. The ESDP IV was implemented in order to realize the sustainability in achieved successes with focus on the quality of teaching and learning conditions, the equitable access and the completion of basic education for unreached and disadvantaged groups or children in emerging regions, the adult education, specifically Functional Adult Literacy (FAL)[5], the strengthening of the domain of science and technology, an increase in access to TVET[6] and to higher education without sacrificing quality of education.

Ethiopia became a part of the Global Partnership for Education in 2004 and has received 3 GPE grants so far to implement its education plans. The latest one of 100 million dollars covers the three-year period 2014-2017 and contributes mainly to improvement in the quality of general education across the country.

[4]In Appendix, the educational systems of both countries are explained in more detail.
[5]FAL is a two-year course, in which 95% of adult illiterates should participate.
[6]Technical and Vocational Education and Training

However, several key challenges still remain, particularly in girls' attendance to schooling. The reasons are specific for developing countries in Sub-Saharan Africa, such as early marriage, gender stereotypes, lack of water services and separate toilets for girls and boys, or the results of sexual violence. Despite the fact that schooling fees were officially abolished in 1994, a financial burden is still put on parents who have to decide if they can afford to send children to school and for how long. There is additional expenditure such as paying for books, uniforms and stationery.

2.1.2 Health system

The WHO (2012) reports that the total expenditure on health is 44 dollars per capita and the total expenditure on health as a percentage of GDP is 3.8. As recommended by World Health Organization (2008), there are a few core indicators used to evaluate health system financing. These are based on the ratios of government and private spending on health to total health expenditures. The information helps us to determine the overall government commitment to health together with the importance of health in proportion to other priorities. Furthermore, we can deduce whether people are willing to pay for health care. The key indicators are summarized in Table B.4 (in Appendix B). The proportion of general government expenditure on health is almost twice more than the proportion of private expenditure. More than 90% of private spending are out-of pocket resources. However, the health sector is mostly financed by donors. Official development assistance on child health is 20 dollars per child (Countdown to 2015, 2012).

In Ethiopia, the very first health policy launched by WHO was adopted in the early 1960s. In the following years, a health policy focused on disease prevention, primarily in rural areas. Today, the Government targets broader issues, for instance population dynamics, sufficient living conditions, availability of food, and other fundamentals of better health. As a consequence, the Health Sector Development Programme (HSDP) was founded by the Government to achieve these targets in the twenty-year period of time. It was initiated in 1996/1997 by its first phase (HSDP I) and currently the HSDP is implementing its forth five-year cycle. So far, the HSDP have shown remarkable achievements in terms of quality of health service and expansion of health facilities. One of its priorities is improving child health. Ethiopia has achieved the MDG Target under-five mortality rate (68) in 2012, currently being at 59. Among the illnesses primarily causing under-five mortality in Ethiopia are pheunomia and diarrhea, however, a major risk factor is malnutrition causing about 50% of under-five deaths (Countdown to 2015, 2015).

2.2 Kenya

The total population of Kenya is 44.86 million. The GNI per capita has grown to 2,940 (PPP international $) despite the adverse effects of drought and high oil prices. Thus, Kenya is considered to be a lower middle-income country. With regard to education, Kenya is ranked at the 147^{th} position out of 187 countries using the Education Index.

2.2.1 Educational system

In 1985, the 7-4-2-3 educational system was replaced by new national education system which is formally structured on an 8-4-4 model. The right to education for all is guaranteed by the Kenya Constitution (2010). Primary education is compulsory and free since the introduction of the Free Primary Education Programme in January 2003. As a result, there has been a great increase in both the number of children enrolled to primary schools and the number of schools established. Moreover, since then the proportion of girls participating in education has significantly increased. Even with an enormous progress in the primary school enrollment, many challenges still remain, particularly to ensure that children complete at least primary school. There are several reasons why children may drop out of schools: their parents cannot afford buying transport tickets, books, uniforms or other school supplies, there are insufficient water services, number of toilet facilities or they are not aware how important the education actually is.

The Government of Kenya considers the education as the most critical element for economic and also for social development. According to this, the Government has implemented a number of programmes to increase the quality of education. Taking as a priority, the Government of Kenya continues to commit high expenditure to the education sector. The Government also supports necessary reforms in order to achieve The Kenya Vision 2030 which emphasizes the importance of quality education for country's achievement of sustainable development. Since 2005, Kenya has been a part of the Global Partnership for Education.

The prime document attempting to improve the schooling in Kenya, The National Education Sector Plan (NESP) 2013-2018, is an all-inclusive, sector-wide programme which builds on the previous achievements and challenges of the Kenya Education Sector Support Programme (KESSP), covering the period of five years from 2005 to 2010. The main goals of the new five-year plan are: to provide quality education, to enroll all children in primary schools, to reduce illiteracy and existing disparities, to increase resources to the education sector and also to ensure the use of these resources the most efficiently. Besides that, a National Council for Nomadic Education (NACONEK) has been established to improve the quality of education also in the regions inhabited by nomadic communities with a focus on primary school enrollment and completion of primary schooling, especially of girls. Low rates of enrollment and attendance for girls may occur specifically in these areas because of cultural practices such as early marriages or female genital mutilation.

2.2.2 Health system

The total expenditure on health is 101 dollars per capita and the total expenditure on health as a percentage of GDP is 4.5. In comparison with Ethiopia, Kenyan inhabitants are more likely to pay for health services which we deduce from considerably higher ratio of private expenses on health. This information, as well as the rest of the core indicators of health financing system, is presented in Table B.5 in Appendix B. Moreover, the Government of Kenya invests also some part of its spending to social security, accurately 13.1%.

Over the past two decades, Kenya's health profile has significantly improved thanks to the implementation of the Kenya Health Policy Framework (KHPF) covering the period 1994-2010. Following the gains achieved so far, the Government of Kenya developed a new policy framework, Kenya Health Policy 2014-2030, the objective of which is to ensure that Kenya attains the highest possible standards of health with respect to the needs of Kenya's citizens. The key ambition is to improve the healthcare system in an equitable, responsive, people-centered and efficient manner. This policy should respect the fundamental human rights provided by the Constitution of Kenya 2010, such as the right to health. The achievement of these goals and targets requires appropriate financing usually dependent on official development assistance (ODA) of donors. ODA to child health is $20 per child in Kenya. Although the under-five mortality rate (deaths per 1000 live births) gradually decreases, currently being at 49, the MDG Target (34) has not been achieved (Countdown to 2015, 2015).

2.3 Comparison of both countries

2.3.1 Education

The Table 2.1 below shows the percentage of women and men aged 15-49 according to their highest level of education in Ethiopia and Kenya. This is of particular importance because the thesis focuses on parents' education as the main explanatory variable. The numbers in the table are based on the DHS data which are also used in the econometric analysis. In general, Ethiopian women and men are significantly less educated. In Kenya, there is seven percent of women and three percent of men without any level of education compared to Ethiopia where more than half of women and about one-third of men have had no education. About one in four of both Kenyan women and men have completed primary school, in contrast to only about 6% of men and 4% of women in Ethiopia. Eleven percent of Kenyan women and 14% of Kenyan men have gone beyond secondary school while only small proportion of Ethiopian men and women, 8% and 5% respectively, have completed secondary school or have gone beyond.

Table 2.1: Percent distribution of women and men age 15-49 by highest level of education attended

	Ethiopia		Kenya	
	Women	Men	Women	Men
No education	51	30	7	3
Incomplete primary education	34	47	27	26
Complete primary education	4	6	25	23
Incomplete secondary education	6	9	16	16
Complete secondary education	1	1	16	19
More than secondary education	4	7	11	14

Source: EDHS 2011, KDHS 2014

2.3.2 Child Health

In Table 2.2, the proportion of children being malnourished, fully immunized and these having diarrhea in the last two weeks preceding the survey are presented. The numbers are computed from the sub-sample of observations selected for the analysis (see detailed description in Chapter 3).

With regard to children's nutritional status, 42.1% of Ethiopian children and 26.97% of Kenyan children aged under 5 years show stunted growth (indicating chronic malnutrition). Only 11.8% and 5.6% of under-five children in Ethiopia and Kenya respectively are too thin for their height (or wasted) which is far less than the proportion of stunted children. This is an indicator of acute malnutrition. Besides, just over 15% of children were ill with diarrhea within two weeks before the survey in both countries. However, 42% of them received no treatment in Ethiopia. 23.4% of children in our sample have received all eight doses of recommended vaccines in Ethiopia and twice higher proportion in Kenya. Vaccination coverage of each vaccine individually is reported in Table B.6 in Appendix B. Children with no vaccines at all represent 15% in Ethiopia and only 3% in Kenya.

Table 2.2: Percentage of under-five children according to four examined health outcomes

	Stunted	Wasted	Fully immunized	Diarrhea
Ethiopia	42.10	11.80	23.40	15.60
Kenya	26.97	5.60	58.00	15.12

Source: EDHS 2011, KDHS 2014

Furthermore, the percent distribution of children being stunted, wasted, fully immunized and having diarrhea in the last two weeks conditional on mother's educational attainment are presented in Table B.2 and Table B.3 in Appendix B for Ethiopia and Kenya, respectively. We observe that with higher level of maternal education, the proportion of stunted and wasted children decreases and the proportion of children that are fully immunized increases. However, for the variable *Diarrhea* it has not shown very clear pattern.

Chapter 3

Data and Methodology

3.1 Data

The analysis uses data from already mentioned Demographic and Health Surveys for two Sub-Saharan countries, in particular Ethiopia and Kenya, to study the determinants of child health with an emphasis on maternal level of education. The DHS Program is an extensive source of data providing accurate data on human fertility, family planning, mortality, health and nutrition, the purpose of which is to understand the health and population trends in more than 90 developing countries all over the world.[1] The project is funded by national governments and by financial support from a host of international donors, such as the United States Agency for International Development (USAID), the United Nations Population Fund (UNFPA), the United Nations Children's Fund (UNICEF), the United Kingdom Department for International Development (DFID), and the World Bank. Moreover, ICF International contributes to the project, and also provides technical assistance.

The studies are cross-sectional and nationally representative. They were implemented by national statistical offices, namely Central Statistical Agency (CSA) in Ethiopia and the Kenya National Bureau of Statistics (KNBS) in partnership with the Ministry of Health in each country. In both studies, three questionnaires, particularly the Household Questionnaire, the Woman's Questionnaire, and the Man's Questionnaire were used. The Woman's Questionnaire also obtains the information about children living in the same household. The Standard DHS Survey of Ethiopia used in the thesis was established in 2011 and the

[1]information available at http://dhsprogram.com/Who-We-Are/About-Us.cfm

data were being collected from the end of December 2010 to June 2011. The sample of 17,817 households was selected for the 2011 EDHS. Besides that, two more surveys have been conducted in 2000 and 2005, and currently the data for ongoing EDHS 2016 are being collected in Ethiopia. The Kenya survey used in our analysis is more recent. It was established in 2014 and follows up five more KDHS surveys that have been conducted since 1989. The collection of data took place from May to October 2014 and a total of 39,679 households were gathered.

For our empirical analysis we use only Children's Recode dataset, which has one record for every child of interviewed women, born in the five years preceding the survey (0-59 months)[2]. Originally, it contained 11,654 observations for Ethiopia and 20,964 for Kenya. Individuals with missing data on the main variables were excluded from the analysis. It left us with the sample of 9,700 children for Ethiopia and 18,691 children for Kenya. This way, the Ethiopia's sample was also narrowed to married women or women living with a partner in order to control for husband's/partner's education in the regression[3]. Unfortunately, in Kenya's dataset a huge proportion of information on husband's education and mother's empowerment within family was missing, so we excluded these variables from the regression, however for simplicity and comparison between countries, we also limited the sample only to married women. Moreover, we estimate the Model 2 without controlling for husband's characteristics using full sample as robustness check[4]. Afterwards, we cleared the dataset from observations that either the respondent answered "I don't know" or the answer was inconsistent with other responses in the questionnaire and it was thought that this response was probably in error (Measure DHS, 2013). We excluded 794 observations with error in the variable height-for-age (and weight-for-height) and 19 such observations regarding diarrhea in Ethiopia. In Kenya, 6, 18 and 271 observations were excluded regarding the variable diarrhea, vaccination variables, and height-for-age respectively, leaving us with the sample of 18,936 children.

[2]information available at http://www.dhsprogram.com/data/Dataset-Types.cfm

[3]This information is missing for unmarried women in the dataset. In total, 8% of observations were excluded to control for husband's characteristics in Ethiopia.

[4]By full sample we mean all eligible women, both married and unmarried. The error and missing data remain excluded. The estimates are in Table B.15 and Table B.22 in Appendix B for Ethiopia and Kenya, respectively. The results do not differ significantly across models using full sample and sub-sample of married women.

The final sample consists of 8,887 children under five, alive at the time of survey in Ethiopia and of 15,820 such children in Kenya (after narrowing the sample to married women only[5]). In the following section, all the variables used in the analyses, both dependent and independent, are presented.

3.2 Description of variables

The choice of variables is guided by the theoretical model described in Chapter 1 as well as the previous literature on the topic. We examine the effect of *Mother's education* on four dependent variables measuring child health outcomes, namely *Stunting, Wasting, Immunization*, and *Diarrhea*. Whereas *Stunting* and *Wasting* are considered to be appropriate indicators measuring child's long-term and short-term nutritional status, respectively, *Immunization* of a child represents parents' health-seeking behaviour. Moreover, we include another explained variable *Diarrhea* indicating acute child morbidity. All four of these variables were created as binary variables. The variables *Stunting* and *Wasting* take value 1 if the child is even moderate or severely malnourished, stunted and wasted respectively. In other words, if the value of child's height-for-age (or weight-for-height) z-score is below -2 SD mean of the WHO international reference standards. The variable *Immunization* is based on eight vaccinations a child should receive. These vaccinations are: BCG (Bacillus Calmette-Guerin) vaccine, three doses of Polio, three doses of DPT (Diphtheria-Tetanus-Pertussis) and Measles vaccine. We consider "received immunization" if a vaccination was recorded on the health card (with or without the date of vaccination), or mother reported that the child had received the vaccination. According to general expectations, all children should have received these eight vaccinations, therefore the variable *Immunization* takes value 1 if a child is fully immunized. Finally, the variable *Diarrhea* takes value 1 if a child was ill with diarrhea within last two weeks prior to survey.

Following the theoretical framework from Chapter 1, we include a set of child's, maternal (parental) and household characteristics explaining child health outcomes. The explanatory variable of our main interest is *Mother's education*. Since we cannot observe the education levels of both parents from our dataset, we control for *Husband's education* (including also partner's education if a

[5]In total, further 14% of observations from Kenya's dataset were excluded in order to limit the sample to children whose mothers are married.

woman is living with her partner). There may be a high probability that mother's husband is also child's father, but we cannot be entirely sure. Besides, mother with no education or low level of education can still benefit from higher level of schooling of her partner. The variable *BMI* is included in the regression as a proxy for mother's biological endowment since there may be unobserved genetic factors affecting child health.

Furthermore, four other controls are added, namely *Wealth, Literate, Media* and *Empowerment* representing four possible channels behind the mother's education-child health relationship. The fourth one, *Empowerment* is based on the question from the DHS Woman's questionnaire asking the respondent about the final say within the family on the three following decisions: mother's health care, making large household purchases, and what to do with money earned. Thus the variable *Empowerment* takes value 3 if a woman decides alone or jointly with her husband in all three decisions; values 2 and 1, if she decides alone or jointly with her partner at least in 2 or 1 decisions respectively, 0 otherwise. All variables used in the analysis, both dependent and explanatory are described in Table 3.1. Moreover, descriptive statistics of the variables for each examined country are presented in Table B.6 in Appendix B.

Table 3.1: Description of variables

Dependent variables:	
Stunting*	1 if a child is stunted, 0 otherwise
Wasting*	1 if a child is wasted, 0 otherwise
Immunization*	1 if a child is fully immunized, 0 otherwise
Diarrhea*	1 if a child had diarrhea in the last two weeks, 0 otherwise
Explanatory variables:	
Child's characteristics:	
Age	age of the child alive at the time of the survey in months (0-59)
Girl*	sex of the child, 1 if a child is a girl, 0 otherwise
Twin*	1 if a child was born as a twin, 0 otherwise
Birth order	gives the order in which the children were born
Number of siblings	total number of living children
Mother's characteristics:	
Mother's age	in years
BMI	mother's Body mass index (defined as mother's weight in kilograms divided by the square of her height in meters)
Mother's education	highest level of education in single years
Literate*	1 if a woman can read at least parts of the sentence, 0 if she cannot read at all
Husband's education	highest level of education in single years
Husband's age	in years
Media*	1 if a mother listens to radio or watches TV or reads newspaper regularly (at least less than once a week), 0 otherwise
Empowerment	final say in the household, values 0-3 according to the number of decisions a woman reported to decide alone or jointly with her partner
Household characteristics:	
Wealth	wealth index with values 1-5, five wealth quintiles: 1 = poorest, 2 = poorer, 3 = middle, 4 = richer, 5 = richest
Urban*	the place of residence, 1 if urban, 0 if rural
Household size	total number of household members
Water*	1 if a household has access to piped water, 0 otherwise
Toilet*	1 if a household has access to any type of toilet facilities, 0 otherwise
Mother as head*	1 if a mother is the head of household, 0 otherwise

*binary variable

3.3 Methodology

According to the fact that all of our dependent variables take the value 0 or 1, a probit regression model is used for the analysis. The probit model is non-linear regression model, and the estimation of such binary choice model is usually based on the method of maximum likelihood (MLE). Each observation is treated as a single draw from a Bernoulli distribution (binomial with one draw). The probit model (Greene, 2012) is of the form:

$$\text{Prob}(Y = 1|\mathbf{x}) = \int_{-\infty}^{x'\beta} \phi(t)\,\mathrm{d}t = \Phi(x'\beta) \tag{3.1}$$

where the function $\phi(t)$ is a commonly used notation for the standard normal distribution function:

$$\phi(t) = (2\pi)^{-1/2} exp\left(\frac{-t^2}{2}\right) \tag{3.2}$$

However, the parameters of any non-linear regression model are not necessarily the marginal effects that we are accustomed to analyze in linear regression models such as OLS. To estimate the effect of the marginal changes in independent variables on the event probability, we need to premultiply the coefficients (betas) by the value of probability density function at particular levels of $\mathbf{x}$. For the probit model it is:

$$\frac{\partial E[y|\mathbf{x}]}{\partial \mathbf{x}} = \phi(x'\beta) \times \beta \tag{3.3}$$

For interpreting the estimated model, we evaluate the value of $\mathbf{x}$ at the sample means of the data. To estimate the model and compute marginal effects, the statistical program R is used. These values can be interpreted as changes in the probability of the outcome holding other variables constant. Since the $\mathbf{x}$ in our case includes also several dummy variables, it should be noted that the output from R reflects the discrete change for these variables (change from 0 to 1) rather than simply taking the derivative with respect to the binary variables as if they were continuous. The estimates reported in all tables in the next chapter and also in Appendix present the marginal effects.

The thesis will aim at answering these core questions:

1. Does maternal education affect child health outcomes and immunization decisions?
2. Does the education effect differ by the sex of the child or the place of residence?
3. What are the channels through which mother's education contributes to child health?
4. Which level of mother's education is the most important in promoting her children's nutritional and immunization status?

3.4 Models

Firstly, we simply document the association between maternal education on one hand and child health outcomes on the other by estimating "the baseline model":

$$H_i = \beta_0 + \beta_1 age + \beta_2 age^2 + \beta_3 girl + \beta_4 MEduc + \epsilon_i \tag{3.4}$$

where H_i is the outcome of interest for ith child, *MEduc* stands for *Mother's education*, and ϵ_i is the error term. The equation 3.4 will be called Model 1 throughout the thesis. It is the most simple and straightforward model including only exogenous variables and explains so-called "total" education effect. This thesis treats mother's education as exogenous following most scholars examining maternal education child health relationship (for instance Thomas, Strauss and Henriques (1991), Barrera (1990), Alderman and Garcia (1994), Desai and Alva (1998)). It could be a strong assumption if unobservable characteristics correlated with education such as mother's independence, preferences, or certain values also influence child nutritional or immunization status causing "omitted variable bias". Therefore results must be interpreted with caution. Model 2 includes also endogenous variables (individual- and household-level controls):

$$\begin{aligned} H_i = \beta_0 + \beta_1 age + \beta_2 age^2 + \beta_3 girl + \beta_4 MEduc + \beta_5 urban + \beta_6 twin \\ + \beta_7 birth\ order + \beta_8 number\ of\ siblings + \beta_9 mother's\ age + \beta_{10} BMI \\ + \beta_{11} husband's\ education + \beta_{12} husband's\ age + \beta_{13} water + \beta_{14} toilet \\ + \beta_{15} household\ size + \beta_{16} mother\ as\ head + \epsilon_i \end{aligned} \tag{3.5}$$

To test the first hypothesis, Model 1 and Model 2 will be estimated for both countries and the coefficient on *Mother's education* will be analyzed. Unfortunately, because of unavailability of data for Kenya, three variables are excluded from Model 2, in particular *Husband's education, Husband's age* and *BMI*. Therefore, the results will be interpreted carefully and the differences between countries will be stated.

Secondly, in order to find whether the impact of mother's years of schooling on child health differ depending on the child's gender or its place of living, we add two interaction terms to Model 2, namely *Mother's education*Girl* and *Mother's education*Urban*. Therefore to analyze the second hypothesis we will estimate following regression for Ethiopia and Kenya:

$$H_i = \beta_0 + ... + \beta_{17} MEduc * girl + \beta_{18} MEduc * urban + \epsilon_i \tag{3.6}$$

Regarding the third hypothesis, several controlling variables (which may be causing omitted variable bias) are introduced to Model 2 in order to identify possible channels through which the maternal education promotes improved child health outcomes. In particular, these controls are *Wealth, Literate, Media* and *Empowerment*. Each of them is added by itself to a separate regression and after that, the fifth regression is run including all four variables. If the education effect translates entirely through any of these mechanisms, including them into regression should cause that the coefficient on *Mother's education* goes to zero.

First controlling variable is *Wealth*. It has been commonly argued by many development economists that education effect simply translates through the household economic welfare (income effect) (Strauss & Thomas, 1995). We use the wealth index from DHS data as a proxy of household permanent income. Information regarding other economic variables, such as prices or wages are not collected by the DHS Program. Besides, there is an evidence that a wealth index may perform better than measures of current income and current expenditures in explaining health outcomes since it represents a more permanent economic status (Rutstein & Johnson, 2004). *"The wealth index is a composite measure of a household's cumulative living standard."* [6] It is based on

[6] The information is cited from the DHS Program's official website: `http://www.dhsprogram.com/topics/wealth-index/Index.cfm`

easy-to-collect data from the Household Questionnaire related to household's possession of several consumer assets, such as bicycles, cars and televisions; materials used for housing construction such as flooring materials; source of water and types of toilet facilities.

Second potential mechanism which we include is the variable *Literate* representing mother's ability to read and write. The idea is that the education may be valuable only through the mother acquiring literacy skills in school. It has been argued that these skills may help mother to better understand health information and importance of immunization, and therefore improve her abilities to prevent or treat child illnesses such as diarrhea. Moreover, one of the assumptions in promoting free primary education in Africa is that improved literacy skills would lead to better nutritional status and health-seeking behavior for the African population (Makoka, 2013). Table B.1 in Appendix B presents literacy rates of women aged 15-49 depending on their highest level of education. It may partly reflect the quality of education.

Additionally, we control for the variable *Media*. However, we need to take into consideration the fact that this variable does not reflect which kind of programmes are being viewed, or listened to. Specific nutritional programmes may be more effective than general information provided by media (Thomas *et al.*, 1991). Lastly, we introduce fourth possible mechanism - mother's empowerment within family. This has received little attention in the previous literature, however, the construction of our variable *Empowerment* is completely different (explained in the section Description of variables).

Finally to examine the fourth hypothesis, we split mother's years of schooling into four dummies, namely *Incomplete primary education, Complete primary education, Incomplete secondary education* and *Complete secondary education or higher* according to the education system of both countries described in Chapter 2 and the highest level of education attained that a mother reported.

Chapter 4

Empirical Results

In this chapter, the results of the econometric analysis examining the impact of mother's level of education in both chosen countries will be presented. To test four hypotheses set out in the previous chapter, a probit model will be used. Because of that, the significance and signs of coefficients will be emphasized and the marginal effects will be used while interpreting the results. We will compare the empirical results with the theoretical model and findings obtained by scholars in the previous literature. We will start with the hypothesis that examines overall education effect. Secondly, we will test for differential impact of maternal education depending on the sex of the child and the place of residence. In addition, we will focus on four potential mechanisms whereby mother's education could improve child health outcomes. In the last section of this chapter, we will also mention another interesting results that either support or refute the evidence from the related literature. In particular, we will take a closer look at the variable *Husband's education*. In each section of this chapter dedicated to one hypothesis, there is a table which summarizes the maternal education effects on *Stunting, Wasting, Immunization* and *Diarrhea*. Besides, we will refer to detailed tables in Appendix B, which contain the complete results of the analyses.

4.1 Does maternal education affect child health outcomes and immunization decisions?

In this section, we will focus on the first hypothesis which examines the role of maternal education on child health outcomes. As a starting point, a baseline model - Model 1 is estimated. It regresses child health outcome on child age,

age squared, and sex dummy in addition to maternal education. This could be explained as "total" education effect. Additionally, to test the first hypothesis Model 2 is estimated as well. The marginal effects of the variable *Mother's education* on all four dependent variables for both Sub-Saharan countries are presented in Table 4.1. All detail information are stated in Tables B.7-B.22 in Appendix B. As already mentioned, Model 2 includes also endogenous variables therefore the results must be interpreted very carefully.

Table 4.1: Mother's education effect (Model 1 and Model 2)

		Dependent variable:			
		Stunting	Wasting	Immunization	Diarrhea
Ethiopia	Model 1	-0.024^{***}	-0.009^{***}	0.023^{***}	-0.004^{***}
		(0.002)	(0.001)	(0.001)	(0.001)
	Model 2	-0.014^{***}	-0.006^{***}	0.012^{***}	-0.002
		(0.002)	(0.001)	(0.002)	(0.002)
Kenya	Model 1	-0.011^{***}	-0.007^{***}	0.019^{***}	-0.001^{*}
		(0.001)	(0.0004)	(0.001)	(0.001)
	Model 2	-0.004^{***}	-0.005^{***}	0.012^{***}	-0.0002
		(0.001)	(0.0005)	(0.001)	(0.001)

Note: *p<0.1; **p<0.05; ***p<0.01

A number of studies examining the relationship between mother's level of education and child health has shown significant positive effect of maternal education. Our results are no different, however, the effect is not that large. With regard to Model 1, the explanatory variable *Mother's education* has shown to be significant at 1% level explaining *Stunting, Wasting* and *Immunization* in both countries. *Mother's education* is significant in Model 1 explaining *Diarrhea* in Ethiopia and Kenya at 1% and 10% level, respectively. Moreover, the effects are in the expected direction, negative for explaining *Stunting, Wasting, Diarrhea* and positive for explaining *Immunization.* A child's probability to be stunted decreases by about 2.4 percentage points with additional year of mother's schooling in Ethiopia and by about 1.1 percentage points in Kenya. The mother's schooling is weakly related to the child's prevalence of diarrhea. Higher level of mother's education lowers the probability of having diarrhea only by 0.4 and 0.1 percentage points in Ethiopia and Kenya, respectively. On the other hand, it raises the child's probability to be fully immunized by 2.3 in Ethiopia and by 1.9 percentage points in Kenya. We cannot, however, entirely trust these results as unobservables may be biasing the coefficients and we also cannot interpret this relationship as causal since there is potential endogeneity of maternal schooling.

After including individual-level and household-level factors (Model 2), *Mother's education* remains strongly significant in the regressions predicting *Stunting, Wasting* and *Immunization.* Although the education effect attenuates across the models, this decline is relatively small. Moreover, the significant effect of mother's education completely diminishes in the regression explaining *Diarrhea* in both countries, it is not statistically different from zero even at 10% significance level, therefore the maternal education effect was probably capturing some impact of household factors. These findings are consistent with the previous study by Bicego & Boerma (1990) examining symptoms of respiratory illness in Bolivia.

Results between countries do not differ much. The direction of the education effect is the same in both countries. Moreover, the explanatory variable *Mother's education* lost its significance in case of *Diarrhea* after including endogenous variables. The only difference is in the magnitude. It seems that the education effect is slightly stronger in Ethiopia. However, closer look at the significance and the effect of different levels of educational attainment will be taken while examining the last hypothesis.

4.2 Does the education effect differ by the sex of the child or the place of residence?

Living in the urban areas in the emerging countries is generally assumed to be advantageous, mostly because of easy access to health facilities, and information. Therefore, children living in such areas are expected to be better-off in terms of their health (Shariff & Namkee, 1995). Besides, the effect of maternal schooling may also differ depending on the place of residence and it may be different depending on the sex of the child as well, due to a preference for boys over girls in many developing countries.

To find whether the impact of education on child health is different, we added interaction terms as regressors to Model 2. In the following table, the marginal effects of the variable *Mother's education* and of both interaction terms are presented.

Table 4.2: Mother's education effect and interaction terms

		Dependent variable:			
		Stunting	Wasting	Immunization	Diarrhea
Ethiopia	MEduc	−0.011*** (0.004)	−0.009*** (0.002)	0.013*** (0.003)	0.001 (0.002)
	MEduc*girl	−0.001 (0.004)	0.003 (0.003)	−0.002 (0.003)	−0.004 (0.003)
	MEduc*urban	−0.005 (0.004)	0.004 (0.003)	−0.0003 (0.003)	−0.002 (0.003)
Kenya	MEduc	−0.004*** (0.001)	−0.006*** (0.001)	0.012*** (0.002)	0.0003 (0.001)
	MEduc*girl	−0.0004 (0.002)	0.001 (0.001)	0.00001 (0.002)	−0.002 (0.001)
	MEduc*urban	−0.001 (0.002)	0.002** (0.001)	−0.001 (0.002)	0.0005 (0.001)

Note: 1. *p<0.1; **p<0.05; ***p<0.01
2. MEduc = *Mother's education*

The full interaction effect in non-linear models is the cross-partial derivative of the expected value of the dependent variable and therefore it may have different signs for different values of covariates (Norton *et al.*, 2004). Thus we cannot interpret the results in any direct way. Following most applied researchers, we simply look at the significance of the interaction terms to make some conclusions. Neither the interaction *Mother's education*Girl*, nor *Mother's education*Urban* has shown to be significant in any of chosen countries. The results signalize that there are no gender differences in the benefits of mother's education in these two countries. Furthermore, the coefficient on the interaction between *Mother's education* and dummy variable *Urban* in the regression predicting *Wasting* in Kenya has shown to be the only exception, statistically significant at 5% level. This implies that maternal education effect explaining acute malnutrition differs depending on the place of living.

However, it does not indicate anything about the magnitude of these coefficients. A plot produced by function *'interplot'* in R easily and clearly answers this question and provides convenient way to visualize marginal effects of variables in interaction terms, even in non-linear models, such as probit (Solt & Hu, 2016). Therefore, the Figure B.1 in Appendix B shows how the impact of mother's education on the probability of being wasted changes between a child living in urban (1 on the x axis) and rural area (0 on the x axis). We can see that the education effect varies depending on whether a child is living in urban area and the difference is approximately 0.2 percentage points.

4.3 What are the channels through which mother's education contributes to child health?

In the first section we documented the association between maternal level of education and child health, however, confirming a causal relationship is more complex. In this section, we aim to understand the mechanisms through which mother's education translates into better child's nutritional status and immunization decisions. Firstly, we include each of four possible channels by one in a separate specification and examine the change in the education effect as well as its direct effect on child health. Then we estimate the "full model" with all four explanatory variables. The marginal effects of the variable *Mother's education* are presented in Table 4.3.

Table 4.3: Mother's education effect after inclusion of channels

		Dependent variable:			
		Stunting	Wasting	Immunization	Diarrhea
Ethiopia	Model 2	−0.014***	−0.006***	0.012***	−0.002
		(0.002)	(0.001)	(0.002)	(0.002)
	+ wealth	−0.013***	−0.005***	0.010***	−0.002
		(0.002)	(0.001)	(0.002)	(0.002)
	+ literate	−0.019***	−0.003*	0.005**	−0.002
		(0.003)	(0.002)	(0.002)	(0.002)
	+ media	−0.015***	−0.005***	0.010***	−0.002
		(0.002)	(0.001)	(0.002)	(0.002)
	+ empowerment	−0.015***	−0.006***	0.011***	−0.001
		(0.002)	(0.001)	(0.002)	(0.002)
	+ all four	−0.019***	−0.003	0.004*	−0.002
		(0.003)	(0.002)	(0.002)	(0.002)
Kenya	Model 2	−0.004***	−0.005***	0.012***	−0.0002
		(0.001)	(0.0005)	(0.001)	(0.001)
	+ wealth	−0.004***	−0.005***	0.011***	0.001
		(0.001)	(0.001)	(0.001)	(0.001)
	+ literate	−0.010***	−0.002***	0.004**	−0.002**
		(0.002)	(0.001)	(0.002)	(0.001)
	+ media	−0.004***	−0.004***	0.009***	−0.001
		(0.001)	(0.001)	(0.001)	(0.001)
	+ all three	−0.005***	−0.002**	0.003*	−0.002
		(0.002)	(0.001)	(0.002)	(0.001)

Note: *p<0.1; **p<0.05; ***p<0.01

After including the first potential mechanism, *Wealth*, the effect of mother's education still remains statistically significant at 1% level in regressions for *Stunting, Wasting* and *Immunization* in Ethiopia and in Kenya as well. The coefficient on mother's education explaining *Diarrhea* remains insignificant. Therefore the maternal education effect does not work through permanent income of the household. The same evidence has been observed in past studies (Glewwe 1999, Thomas et al. 1991). Adding *Wealth* into regression does not change the education effect in Kenya at all, however in Ethiopia the coefficient on mother's years of schooling goes down by approximately 0.1 percentage points on average across the models. Furthermore, the variable *Wealth* itself is statistically significant explaining almost all dependent variables in both countries, except *Diarrhea* in Ethiopia and *Immunization* in Kenya. The direction of the wealth effect has shown to be as expected. Children from wealthier households fare better in terms of their nutritional and immunization status. The probability of being stunted and wasted decreases for a child living in a household which belongs to a higher wealth quintile. In Ethiopia, *Wealth* significantly improves health-seeking behaviour measured by child's immunization status. Small, but significant effect of *Wealth* is found in Kenya explaining the incidence of diarrhea. Living in a wealthier household lowers the probability of having diarrhea by roughly 1 percentage point.

Mother's literacy and numeracy skills may act as another possible mechanism. In our regressions, we control only for literacy, simply because of unavailability of data for numeracy in the DHS dataset. The results are very similar to the previous case. The coefficient on mother's education is statistically different from zero explaining *Stunting, Wasting* and *Immunization* in both examined countries. Still, the effect of education on prevalence of diarrhea remains insignificant. Again, the effect of maternal level of education on child health outcomes and health-seeking behaviour does not translate exclusively through mother's ability to read and write. Interestingly, the marginal effects more than halved in *Wasting* and *Immunization* regressions, therefore the education effects may be at least partially mediated through improved literacy skills. On the other hand, the probability to be stunted of a child with more educated mother decreases, ceteris paribus, by 1.9 rather than by 1.4 percentage points after including the variable *Literate* in Ethiopia. Same situation happens also in case of Kenya where after controlling for literacy skills, the education effect increases by 0.6 percentage points. More interestingly, maternal education has shown to be significant at 5% level explaining *Diarrhea* in Kenya after controlling for mother's literacy skills. This could possibly imply that mother with higher level of education may better enhance her literacy skills and therefore better understand the health information. The variable *Literate* in itself is also statistically significant at least at 10% level in all estimated regressions, except *Diarrhea* in Ethiopia. Although it seems that literate mothers generally improve their children's health outcomes analyzing the coefficient on *Literate* explaining *Wasting* and *Immunization* in both countries, surprisingly in the case of *Stunting* we have got opposite results. A probability of being stunted for children of literate mothers increases. This result is in contrary with most of findings reported in the previous literature, for instance Handa (1999). On the other hand, the direct effect of mother's literacy skills on immunization decisions is fairly strong. The probability of receiving all eight doses of vaccinations increases by 7.5 in Ethiopia and by 8.7 percentage points in Kenya for children whose mother is able to read and write.

Mother's exposure to media is the next controlling variable added in the estimates which will be also analyzed as one of the possible channels. Including the variable *Media* seems reasonable as more educated mother may better understand information from radio, television or newspaper possibly acting as sources of her health knowledge. The direct effect of maternal years of schooling continues to be significant at 1% level, however it does change very slightly in magnitude with the presence of the variable *Media*. The marginal effect of the *Mother's education* does not change at all in the regression predicting (*Stunting* in Kenya. Once again, maternal education does not promote better child health through her exposure to media. Thomas *et al.* (1991), however, have found opposite results. Nevertheless, the explanatory variable *Media* has shown to be significant by itself explaining *Wasting* and *Immunization* in both countries and *Diarrhea* in Kenya. The probability to be acutely malnourished (wasted) of a child whose mother watches TV, listens to radio or reads newspapers on regular basis is lower by 2.6 percentage points in Ethiopia and by 3.6 percentage points in Kenya. Mother's access to media increases the probability of her child to be fully immunized as well. These are the results we expected. In Ethiopia, there is a radio programme educating to improve health, so there may be a link between listening to radio and maternal health knowledge. Such TV or radio programmes educating parents on child preventive care and nutrition should be sponsored and promoted. Besides, listening to radio does not depend on mother's literacy skills, but it could be associated with mother's education as more educated women may better process the health information. We should also take into consideration the fact that we do not know which kinds of programmes are being viewed or listened to and which articles are being read.

The last variable which we include in a separate regression is *Empowerment*. Firstly, it needs to be stated that this variable is analyzed only for one country, Ethiopia. Unfortunately, the DHS dataset for Kenya does not allow us to control for the mother's power within home because of missing data for more than 60% of the sample on the questions concerning final say in the household. Although this variable appears to be highly significant explaining all four dependent variables in Ethiopia, the maternal education effect does not change its significance, once control is made for mother's bargaining power. Therefore the education effect does not work through mother's power within family. Furthermore, the direct effect of *Empowerment* on child health is positive only in the regression predicting *Stunting* while it negatively affects *Wasting, Immunization* and *Diarrhea*. However, the measure of mother's empowerment is not perfect since we work only with decisions available in DHS core questionnaire and none of them is related to child care. Thus the results may be because of poor measure.

Finally, we estimate "full model" including all four (three in case of Kenya) potential mechanisms in one regression. Introduction of possible channels has not shown to have significant effect in the regression explaining *Stunting*. The magnitudes of education effect go significantly down with inclusion of four potential mechanisms in *Immunization* regressions. More interestingly, the maternal education effect completely diminishes in Ethiopia in *Wasting* regression. In that case, all four channels have shown to be jointly significant at 1% significance level (using Wald test).

In sum, maternal education *per se* has generally significant positive effect on child health status and health-seeking behaviour even after controlling for potential channels. However at least a part of this effect on immunization decisions and acute malnutrition works through different channels (either individually or jointly) which significantly attenuate the magnitude of the coefficient on mother's education.

4.4 Which level of mother's education is the most important in promoting child health?

In this section, we attempt to identify any non-linearities in the relationship between mother's education and health of her children. We will try to answer the question "Which level of mother's education does affect her child's health?" This question is important and still often missed while examining maternal education-child health relationship. It could then imply up to which level it is beneficial to invest in education to promote better child health. In order to address the non-linear relationship, we split mother's years of schooling in Model 2 into four dummies with no education as the reference group. The coefficients on each of dummy variables are presented in the following table.

Table 4.4: The education effect of four levels of mother's education

		Dependent variable:			
		Stunting	Wasting	Immunization	Diarrhea
Ethiopia	Incomplete primary	−0.040***	−0.032***	0.039***	0.010
		(0.013)	(0.007)	(0.011)	(0.009)
	Complete primary	−0.039	−0.006	0.153***	0.054*
		(0.042)	(0.023)	(0.040)	(0.032)
	Incomplete secondary	−0.112***	−0.061***	0.127***	−0.005
		(0.037)	(0.015)	(0.036)	(0.026)
	Secondary or higher	−0.217***	−0.054***	0.202***	−0.041*
		(0.033)	(0.018)	(0.039)	(0.024)
Kenya	Incomplete primary	0.071***	−0.037***	0.092***	0.061***
		(0.011)	(0.003)	(0.012)	(0.009)
	Complete primary	0.019	−0.043***	0.137***	0.025***
		(0.012)	(0.004)	(0.013)	(0.010)
	Incomplete secondary	−0.023	−0.037***	0.122***	0.036***
		(0.015)	(0.004)	(0.017)	(0.014)
	Secondary or higher	−0.058***	−0.040***	0.150***	0.002
		(0.013)	(0.004)	(0.015)	(0.011)
Note:					*p<0.1; **p<0.05; ***p<0.01

Although the results are different for Ethiopia and Kenya and also for different dependent variables, we can claim that non-linearity is present in every case. The idea behind it is that the magnitude of the effect of different level of education is much greater or smaller while these levels are both significantly important. In the regression predicting dependent variable *Immunization*, every level of education is statistically significant at 1% level in both countries which means that even some years of schooling improve child health measured by its immunization status. In Ethiopia, we observe huge jump in the magnitude of the effect between incomplete primary and complete primary education and then again between incomplete secondary and complete secondary education or higher. Similar situation is observed in Kenya, where jumps are not that big but still higher education seems to have the strongest effect. Children born to mothers with secondary or higher education are more likely to be fully immunized by about 20.2 percentage points in Ethiopia and 15 percentage points in Kenya comparing to the ones born to mothers without any education.

For long-term nutritional status, the results differ between countries. In Ethiopia, the largest effect is again observed after completion of secondary education. Children born to mothers with secondary or higher education have probability to be stunted lower by about 21.7 percentage points. In Kenya, interesting results have been observed. Although the coefficient on incomplete primary education is significant at 1% level, it seems to have negative impact on child's chronic malnutrition suggesting these are students with low innate ability (Maïga, 2011). It starts to be positive and significant after secondary education is complete.

Explaining the model with dependent variable *Wasting*, all levels of education are significant in both countries, except complete primary education in Ethiopia. Nevertheless, the differences in magnitudes between them are not as large as in the case of immunization status. In Ethiopia, the incomplete secondary education effect is the largest in magnitude and decreases the probability of children being wasted by 6.1 percentage points comparing with reference category. In Kenya, the marginal effects of all four examined levels of education are almost the same while completing eight years of education seems to have the largest effect. Lastly, and very surprisingly, all levels of schooling in Kenya have positive significant effect on the probability of having diarrhea. In Ethiopia, the effect is negative at least after completion of secondary education.

To sum up the results, the effect is slightly stronger in Ethiopia for all levels of education. We probably cannot do any general conclusions from these results. What we can say is that in Ethiopia even incomplete primary education is statistically important, however the strongest positive impact has (almost) always complete secondary education. In Kenya, on the other hand, there exists different situations. Incomplete primary education has shown to have negative impact on some of child health outcomes and therefore it should be invested more into quality of secondary education or higher. (Maïga, 2011)

4.5 Other results

In this section, we will analyze coefficients on additional explanatory variables included in Model 2, besides mother's education. We find it important to highlight other child, maternal or household factors that may influence child health. However, we will describe them very briefly as they are not of prime concern of this thesis.

Considering the variables *Age* and Age^2, we have found mixed results. Although both variables have shown to be significantly important in all estimated regressions, the signs are different explaining different dependent variables. Child's age and its square have positive and negative effect, respectively, predicting probability of being stunted and having diarrhea in both countries. This is in line with common pattern that child is initially more malnourished and then its nutritional status improves at later age (Barrera, 1990; Shariff & Namkee, 1995). On the other hand, we observe opposite results for variables *Wasting* and *Immunization* in both countries. For further research, we could split the variable *Age* into several dummies reflecting different age groups and then examine the age-specific differences. However, it is not the aim of this thesis. Interestingly, being a girl lowers the probability of being stunted, wasted and having diarrhea, even though strong son preference is commonly observed in the studies from most of developing countries (for instance Shariff & Namkee (1995)). The girl dummy is insignificant explaining child's immunization status.

Among other child's characteristics included in the regression, there are: *Twin, Birth order* and *Number of siblings*. Children born as twins have significantly higher probability of being stunted in both countries. The same effect has been found for explanatory variable *Birth order* explaining *Stunting* and *Diarrhea*. Later born children are more likely to be stunted. Earlier born children may be at a advantage if parents decide to invest in their health more while expecting earlier returns on these health investments (Holmes, 2006). In contrast, a child born as a twin has higher probability of being fully immunized and lower probability of being acutely malnourished in Kenya. The variable *Number of siblings* has significant negative impact on *Diarrhea* in both countries. Additionally, *Household size* seems to matter only while predicting immunization decisions. The more household members, the lower probability of being fully immunized. In Kenya, we observe the same negative effect of the independent variable *Number of siblings*. The reason may be that parents cannot afford to pay for the vaccinations for the whole family because of their budget constraint.

It is surprising to observe that *Husband's education* does not prove to be statistically different from zero in almost any regression in Ethiopia. If we take into account the possibility that husband may be also a child's father, our result is in contrary with the study by Desai & Alva (1998). On the other hand, we find significant importance of husband's level of education in the regression predicting *Wasting*. The effect is really small, roughly 1 percentage point. This may imply that mothers are more important in promoting all examined child health outcomes.

The effects of mother's age and her BMI are reasonable and same in both countries. Mother's age decreases the probability of her child to be stunted, wasted and to have diarrhea, and increases probability of receiving all eight vaccinations. Older mothers may have probably acquired more information and experience regarding child nutrition through years. In addition, mother's BMI has shown to significantly lower only the probability of malnutrition and acute morbidity. It does not affect health-seeking behaviour since BMI acts here as a proxy for typically unobserved genetic endowments and these are unlikely to have any impact on parents' immunization decisions. In general, the variable *Mother as head of household* has negative impact on short-term nutritional and immunization status of children in both chosen countries. In the previous literature, this variable was used as a proxy for maternal bargaining power within family (Thomas *et al.*, 1991). Their results are in contrary with ours, however, we have observed the same effect while examining mother's empowerment as a potential channel.

Children living in households with piped water have lower probability of being stunted and being sick with diarrhea, and higher probability to be fully immunized. Availability of any kind of toilet seems to have stronger positive effect in Kenya explaining *Stunting, Wasting* and *Immunization*. These two variables are used in the regression to control for standard of living. Lastly, children living in urban areas generally fare better than their rural counterparts, although in our analysis the effect is significant in only half of cases (particularly dependent variables *Stunting* and *Immunization*).

Chapter 5

Summary

This thesis has applied a probit model to the data conducted by DHS program to explore the effect of mother's schooling on child health outcomes to the extent possible, and the underlying channels that mediate these effects. The education effect has been examined for under-five children in two Sub-Saharan countries, namely low-income country Ethiopia and lower middle-income country Kenya. For indicating child's malnutrition, we have used stunting and wasting considered as appropriate measures of long-term and short-term malnutrition, respectively. We included child's immunization status as a measure of parents' health-seeking behaviour. The last dependent variable was diarrhea indicating acute morbidity.

The results suggest that maternal level of education significantly influences children's nutritional and immunization status, whereas some other factors, for instance environmental conditions, are more likely to influence the incidence of diarrhea. Thus, even more educated mothers may not be able to do much to limit the risk of having diarrhea. Moreover, we have not observed any evidence of differentiated treatment depending on the sex of the child and the education effect does not differ by the place of living either. The only exception has been observed in Kenya. There is lower probability to be wasted for children living in urban areas compared to their rural counterparts.

We have followed the approach of introducing different channels to isolate the "true" education effect from the effect of other factors. These are wealth, literate, media, and mother's empowerment. Despite controlling for possible channels, maternal schooling continues to exert a significant and independent influence on child health. The child's probability to be stunted decreases by 1.9 and 0.5 percentage points in Ethiopia and Kenya respectively with additional mother's year of education. The education effect has significantly attenuated in the regression predicting *Immunization*. Additional year of mother's education increases the probability to receive all eight doses of vaccination by 0.4 percentage points in Ethiopia and 0.3 percentage points in Kenya. However, it can be argued that the effect potentially captures unobserved values or traits that mothers have acquired through their parents and have been transferred across generations (Behrman and Wolfe, 1987). Forasmuch as we have limitations in the data available for the thesis, we cannot control for other channels through which maternal education may translate into better child health (for instance, access to health services, maternal health knowledge, or participation in labour market). On the other hand, the maternal education effect explaining *Wasting* in Ethiopia has completely collapsed to zero after inclusion of all four possible channels. In that case, all four channels are jointly significant at 1% level.

Lastly, there is no clear pattern in finding the minimum level of mother's education. In general, the secondary education has the strongest effect. There are several possible explanations. For instance, mothers who completed at least secondary education could more probably participate in labour market. Children of mothers with complete secondary education have probability to be fully immunized higher by 20.2 and 15 percentage points in Ethiopia and Kenya, respectively. In Ethiopia, even incomplete primary education is statistically important, however, the strongest positive impact has always complete secondary education. In Kenya, on the other hand, incomplete primary education has shown to have negative impact on some of child health outcomes and therefore it should be invested more into quality of secondary education.

There are few other determinants significantly affecting child health. Mother's age, living in urban area, access to pipe water and any kind of toilet are all related to improved child health outcomes. Besides, boys are more likely to be malnourished than girls. Children of multiple births and later born children are worse-off in terms of health as well. Children living in wealthier households and children whose mothers are literate have lower probability to be malnourished and higher probability to be fully immunized. Interestingly, husband's education significantly improves only child's acute malnutrition, however this effect is very small.

Conclusion

The thesis has examined the impact of mother's level of education on child health outcomes in two African countries using data from Demographic and Health Surveys for children under five years. As indicators of child health we used stunting, wasting, and the incidence of diarrhea. In order to differentiate between longer-term and one-off health decisions, we added also another dependent variable - child's immunization status measuring mothers' health-seeking behaviour.

Firstly, we simply analyzed the total education effect. In addition, we examined the differential education effects depending on the sex of the child or the place of residence. The most important part of the analysis consisted in identifying the potential mechanisms through which mother's education may translate into better health of her children. We chose to include wealth, literacy skills, exposure to media and mother's power within household. Lastly, we split maternal education into four binary variables according the highest educational attainment in order to test for non-linearity of this relationship and thus investigate the minimum level of mother's educational attainment that is needed to improve child health in Africa.

In summary, this study has identified that maternal education is inversely and significantly related to the probability of chronic and acute malnutrition, stunting and wasting respectively. Besides, the child's probability to be fully immunized increases with higher level of mother's education. On the other hand, mother's years of schooling has shown to be insignificant in explaining the incidence of diarrhea after controlling for individual-level and household-level characteristics, indicating no direct effect. In general, the results suggest that maternal education effect does not differ depending on whether child is living in urban or rural areas. Moreover, the effect is not different for boys and girls either. After controlling for possible channels, the analysis has shown that mother's education effect attenuates in the regressions explaining *Wasting* and *Immunization* in both countries. Therefore, the relationship is partly mediated through some of these channels. Maternal schooling has been found strongly significant, even after inclusion of all examined channels, in the regression predicting *Stunting*. This evidence suggests that there is a strong causal relationship between mother's level of education by itself, and child long-term malnutrition, or there exist some other channels that we are not allowed to examine due to unavailability of the data. Furthermore, the role of mother's education is more important than the education of her husband or partner.

Examining the effect of different levels of education, we have found that secondary education is the most important in improving children's nutritional and immunization status. Moreover, in Kenya incomplete primary education is positively associated with child long-term malnutrition and prevalence of diarrhea which may be a sign of low quality of education in early years. It may have several important implications for developing education policies and programs in emerging countries like Ethiopia and Kenya with high percentage of malnourished children. The Government of both countries currently focus on the free primary education as the main target. However, our results suggest that if maternal education significantly reduces child malnutrition and increases immunization status, investing in quality secondary education (for girls, in particular) should be more promising goal. Additionally, in order to attain better child health outcomes, offering several nutritional and health education programs, especially for women with low education levels should be taken into consideration in low-income and middle-income countries.

In spite of very little differences between Ethiopia and Kenya, the analysis seems to be consistent in findings, so the significant maternal education effect is present in both low-income and middle-income countries. However, the effect in Ethiopia has been noted slightly stronger. Further research may be of help to support or possibly refute conclusions reached here and to examine additional potential channels, for instance access to health facilities. Another issue which should be taken into account in more in-depth examination of the topic is the quality of education. Unfortunately, we cannot address this matter because of the nature of the data used for the analysis.

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Appendix A

Additional information

A.1 Education in Ethiopia

Children in Ethiopia officially start primary education at the age of seven. Eight years of primary education are divided into two cycles, grades 1 to 4 are called primary first cycle, while grades 5 to 8 are called primary second cycle. The number of students in class is around 50 but often it is even more. Secondary schooling is split into two cycles as well. Moreover, each of these two cycles has its own aim. In particular, lower secondary cycle, including grades 9 to 10, brings general secondary education to its students. The Ethiopian General Secondary Education Certificate Examination is taken by students at the end of the tenth grade. Upper secondary cycle consisting of grades 11 to 12 aims to prepare students for higher levels of education, and leads up to another national examination, The Ethiopian Higher Education Entrance Examination (EHEEE). University education may have duration from three to six years, according to the choice of course. There is also possibility of private fee-paying preschool education for children between four to six years of age.

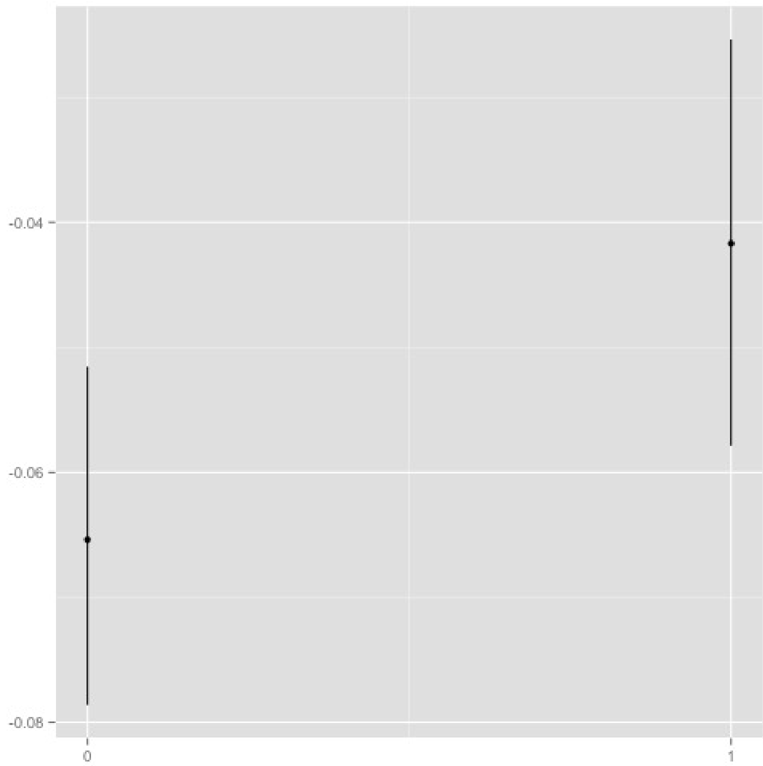
A.2 Education in Kenya

Children in Kenya start primary education at the age of six and it usually runs for eight years. After primary school, Kenyan children continue on to four years of secondary education. There are two cycles which form secondary education: lower secondary education includes grades nine and ten, and upper secondary consists of grades eleven and twelve. The secondary schooling was also made free in 2008, however, it is no longer compulsory.

Appendix B

Additional figures and tables

Figure B.1: interplot: The effect of interaction term



Note: 0 = maternal education effect in rural areas, 1 = maternal education effect in urban areas

Table B.1: Literacy rates depending on the highest level of education

	Years of schooling								N
	1	2	3	4	5	6	7	8	
Ethiopia	3.19	9.36	18.28	31.80	46.80	56.70	70.13	74.34	6,548
Kenya	14.77	37.62	50.00	66.75	80.00	89.82	93.89	97.86	28,544

Source: EDHS 2011, KDHS 2014 (Individual Recode)
Note: N = number of respondents (women)

Table B.2: Ethiopia: Percentage of under-five children according to examined health outcomes conditional on the level of mother's education

	Stunted	Wasted	Immunized	Diarrhea
No education	45.33	13.11	20.22	15.53
Incomplete primary education	37.93	9.09	25.90	16.13
Complete primary education	32.14	11.90	41.67	20.83
Incomplete secondary education	22.82	5.34	44.17	14.08
Complete secondary education	11.59	2.90	68.12	11.59
Higher education	15.13	4.61	53.29	8.55

Source: EDHS 2011

Table B.3: Kenya: Percentage of under-five children according to examined health outcomes conditional on the level of mother's education

	Stunted	Wasted	Immunized	Diarrhea
No education	29.08	12.22	45.75	12.76
Incomplete primary education	34.10	4.43	57.95	18.90
Complete primary education	26.13	3.25	63.90	14.60
Incomplete secondary education	21.64	3.11	62.11	16.40
Complete secondary education	16.85	3.64	65.35	13.27
Higher education	13.66	1.88	68.72	10.32

Source: KDHS 2014

Table B.4: Health financing system in Ethiopia

Total expenditure on health as a percentage of GDP	5.1
General government expenditure on health as a percentage of total expenditure on health	61
Private expenditure on health as a percentage of total expenditure on health	39
Private prepaid plans as a percentage of private expenditure on health	1.9
General government expenditure on health as a percentage of total government expenditure	16.4
External resources for health as a percentage of total expenditure on health	32.3
Social security expenditure on health as a percentage of general government expenditure on health	0
Out-of-pocket expenditure as a percentage of private expenditure on health	90.6
Source: WHO, 2013	

Table B.5: Health financing system in Kenya

Total expenditure on health as a percentage of GDP	4.5
General government expenditure on health as a percentage of total expenditure on health	41.7
Private expenditure on health as a percentage of total expenditure on health	58.3
General government expenditure on health as a percentage of total government expenditure	5.9
External resources for health as a percentage of total expenditure on health	45.2
Social security expenditure on health as a percentage of general government expenditure on health	13.1
Out-of-pocket expenditure as a percentage of private expenditure on health	76.6
Private prepaid plans as a percentage of private expenditure on health	9.3
Source: WHO, 2013	

Table B.6: Descriptive statistics

	Ethiopia		Kenya	
Statistic	Mean	St.Dev.	Mean	St.Dev
age	29.230	17.290	29.265	16.949
birth order	4.006	2.548	3.583	2.298
girl*	0.491	0.500	0.494	0.500
twin*	0.023	0.148	0.025	0.155
number of siblings	3.828	2.134	3.692	2.137
mother's age	29.113	6.536	29.075	6.399
mother's education	1.478	3.045	6.374	4.401
incomplete primary*	0.230	0.421	0.277	0.447
complete primary*	0.019	0.136	0.247	0.431
incomplete secondary*	0.023	0.150	0.083	0.276
secondary or higher*	0.025	0.156	0.160	0.366
husband's education	3.850	10.401	-	-
husband's age	37.195	10.453	-	-
wealth	2.711	1.481	2.492	1.428
urban*	0.156	0.363	0.312	0.463
mother as head*	0.113	0.317	0.196	0.397
water*	0.250	0.433	0.303	0.459
toilet*	0.982	0.133	0.755	0.430
household size	6.217	2.308	5.886	2.331
empowerment	1.234	1.218	-	-
radio*	0.438	0.496	0.706	0.456
TV*	0.294	0.456	0.335	0.472
newspaper*	0.073	0.261	0.234	0.423
media*	0.524	0.499	0.744	0.436
literate*	0.188	0.390	0.704	0.456
stunting*	0.421	0.494	0.270	0.444
wasting*	0.118	0.322	0.056	0.230
diarrhea*	0.156	0.363	0.151	0.358
fully immunized*	0.234	0.424	0.583	0.493
height-for-age z-score	−1.599	1.765	−1.170	1.425
weight-for-height z-score	−0.627	1.219	−0.131	1.195
weight-for-age z-score	−1.355	1.272	−0.751	1.161
immunized BCG*	0.620	0.485	0.940	0.237
immunized DPT1*	0.584	0.493	0.931	0.253
immunized Polio1*	0.748	0.434	0.934	0.249
immunized DPT2*	0.483	0.500	0.898	0.303
immunized Polio2*	0.648	0.478	0.889	0.314
immunized DPT3*	0.354	0.478	0.823	0.382
immunized Polio3*	0.467	0.499	0.756	0.429
immunized Measles*	0.482	0.500	0.730	0.444
number of vaccinations	4.384	3.062	6.902	1.980
BMI	20.292	2.956	-	-
N	8,887		15,820	

*binary variable

Table B.7: Ethiopia: Model 1

	Dependent variable:			
	Stunting	Wasting	Immunization	Diarrhea
	(1)	(2)	(3)	(4)
age	0.035***	−0.003***	0.021***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0005***	0.00002*	−0.0003***	−0.0001***
	(0.00002)	(0.00001)	(0.00002)	(0.00002)
girl	−0.031***	−0.033***	0.001	−0.014*
	(0.011)	(0.007)	(0.009)	(0.007)
mother's education	−0.024***	−0.009***	0.023***	−0.004***
	(0.002)	(0.001)	(0.001)	(0.001)
Observations	8,887	8,887	8,887	8,887
Log Likelihood	−5,475.451	−3,122.352	−4,456.491	−3,700.097
Akaike Inf. Crit.	10,960.900	6,254.705	8,922.981	7,410.194
Note:				*p<0.1; **p<0.05; ***p<0.01

Table B.8: Kenya: Model 1

	Dependent variable:			
	Stunting	Wasting	Immunization	Diarrhea
	(1)	(2)	(3)	(4)
age	0.018***	−0.001***	0.050***	0.003***
	(0.001)	(0.0004)	(0.001)	(0.001)
age^2	−0.0003***	0.00001*	−0.001***	−0.0001***
	(0.00001)	(0.00001)	(0.00002)	(0.00001)
girl	−0.069***	−0.007**	−0.007	−0.009
	(0.007)	(0.003)	(0.008)	(0.006)
mother's education	−0.011***	−0.007***	0.019***	−0.001*
	(0.001)	(0.0004)	(0.001)	(0.001)
Observations	15,820	15,820	15,820	15,820
Log Likelihood	−8,861.231	−3,253.569	−9,042.784	−6,472.483
Akaike Inf. Crit.	17,732.460	6,517.138	18,095.570	12,954.970
Note:				*p<0.1; **p<0.05; ***p<0.01

Table B.9: Ethiopia: Model 2 with interactions

	Dependent variable:			
	Stunting	Wasting	Immunization	Diarrhea
	(1)	(2)	(3)	(4)
age	0.036***	−0.003***	0.021***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0005***	0.00003**	−0.0003***	−0.0001***
	(0.00002)	(0.00001)	(0.00002)	(0.00002)
girl	−0.033***	−0.036***	0.002	−0.008
	(0.012)	(0.007)	(0.010)	(0.008)
twin	0.167***	0.027	0.041	0.048*
	(0.037)	(0.024)	(0.032)	(0.028)
birth order	0.035***	0.005	−0.0002	0.017***
	(0.006)	(0.003)	(0.005)	(0.004)
mother's age	−0.003*	−0.003***	0.005***	−0.001
	(0.002)	(0.001)	(0.001)	(0.001)
MEduc	−0.011***	−0.009***	0.013***	0.001
	(0.004)	(0.002)	(0.003)	(0.002)
HEduc	−0.001	−0.001**	0.0004	0.0005
	(0.001)	(0.0004)	(0.0004)	(0.0003)
husband's age	0.0001	0.001***	−0.0003	0.001**
	(0.001)	(0.0004)	(0.001)	(0.0005)
BMI	−0.009***	−0.015***	0.001	−0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
household size	−0.003	−0.0001	−0.007**	0.003
	(0.003)	(0.002)	(0.003)	(0.002)
n. of siblings	−0.035***	0.002	−0.009	−0.022***
	(0.007)	(0.004)	(0.005)	(0.005)
water	−0.027*	0.010	0.088***	−0.031***
	(0.015)	(0.009)	(0.013)	(0.010)
toilet	−0.136***	0.003	0.030	−0.011
	(0.045)	(0.026)	(0.034)	(0.029)
urban	−0.097***	0.003	0.102***	0.022
	(0.022)	(0.014)	(0.020)	(0.017)
mother as head	0.029	0.040***	−0.084***	0.007
	(0.018)	(0.012)	(0.012)	(0.012)
MEduc*girl	−0.001	0.003	−0.002	−0.004
	(0.004)	(0.003)	(0.003)	(0.003)
MEduc*urban	−0.005	0.004	−0.0003	−0.002
	(0.004)	(0.003)	(0.003)	(0.003)
Observations	8,887	8,887	8,887	8,887
Log Likelihood	−5,383.647	−3,036.915	−4,332.145	−3,662.401
Akaike Inf. Crit.	10,805.290	6,111.831	8,702.290	7,362.801
Note:				*p<0.1; **p<0.05; ***p<0.01

Table B.10: Ethiopia: Model 2 with channels (Stunting)

	Dependent variable: Stunting					
	(1)	(2)	(3)	(4)	(5)	(6)
age	0.036***	0.036***	0.036***	0.036***	0.036***	0.036***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0005***	−0.0005***	−0.0005***	−0.0005***	−0.0005***	−0.0005***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
girl	−0.034***	−0.033***	−0.034***	−0.034***	−0.034***	−0.033***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
twin	0.167***	0.165***	0.169***	0.168***	0.166***	0.165***
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.038)
birth order	0.035***	0.035***	0.035***	0.035***	0.035***	0.035***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
mother's age	−0.003*	−0.003*	−0.003*	−0.003*	−0.003**	−0.003*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
MEduc	−0.014***	−0.013***	−0.019***	−0.015***	−0.015***	−0.019***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
HEduc	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001))
husband's age	0.0001	−0.0001	0.0001	0.0001	0.0002	0.00004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
BMI	−0.009***	−0.008***	−0.009***	−0.009***	−0.009***	−0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
household size	−0.003	−0.003	−0.002	−0.003	−0.002	−0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
n.of siblings	−0.035***	−0.035***	−0.035***	−0.035***	−0.035***	−0.035***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
water	−0.027*	−0.011	−0.029*	−0.028*	−0.029*	−0.012
	(0.015)	(0.016)	(0.015)	(0.015)	(0.015)	(0.016)
toilet	−0.136***	−0.141***	−0.134***	−0.136***	−0.137***	−0.140***
	(0.045)	(0.044)	(0.045)	(0.045)	(0.045)	(0.045)
urban	−0.110***	−0.088***	−0.109***	−0.111***	−0.109***	−0.085***
	(0.019)	(0.020)	(0.019)	(0.019)	(0.019)	(0.020)
mother as head	0.030*	0.026	0.030*	0.030*	0.038**	0.034*
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
wealth		−0.017***				−0.021***
		(0.005)				(0.005)
literate			0.047**			0.051**
			(0.022)			(0.022)
media				0.005		0.012
				(0.012)		(0.012)
empowerment					−0.015***	−0.016***
					(0.005)	(0.005)
Note:						*p<0.1; **p<0.05; ***p<0.01

Table B.11: Ethiopia: Model 2 with channels (Wasting)

	Dependent variable: Wasting					
	(1)	(2)	(3)	(4)	(5)	(6)
age	−0.003***	−0.003***	−0.003***	−0.003***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	0.00003**	0.00003**	0.00003**	0.00003**	0.00003**	0.0003**
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
girl	−0.033***	−0.033***	−0.033***	−0.033***	−0.033***	−0.033***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
twin	0.026	0.024	0.026	0.023	0.027	0.023
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
birth order	0.005	0.004	0.005	0.005	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
mother's age	−0.003***	−0.003***	−0.003***	−0.003***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
MEduc	−0.006***	−0.005***	−0.003*	−0.005***	−0.006***	−0.003
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
HEduc	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
husband's age	0.001***	0.001***	0.001***	0.001***	0.001***	0.001**
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
BMI	−0.015***	−0.014***	−0.015***	−0.014***	−0.015***	−0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
household size	−0.0002	−0.0003	−0.0004	−0.0003	−0.0004	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
n. of siblings	0.002	0.002	0.002	0.002	0.002	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
water	0.010	0.026**	0.012	0.013	0.011	0.026**
	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)
toilet	0.003	−0.002	0.001	0.002	0.003	−0.003
	(0.026)	(0.027)	(0.026)	(0.026)	(0.026)	(0.027)
urban	0.011	0.034**	0.011	0.016	0.011	0.033**
	(0.013)	(0.015)	(0.013)	(0.013)	(0.013)	(0.014)
mother as head	0.039***	0.034***	0.039***	0.038***	0.036***	0.032***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
wealth		−0.015***				−0.012***
		(0.003)				(0.003)
literate			−0.028**			−0.017
			(0.012)			(0.012)
media				−0.026***		−0.017**
				(0.007)		(0.007)
empowerment					0.006**	0.004
					(0.003)	(0.003)
Observations	8,887	8,887	8,887	8,887	8,887	8,887
Log Likelihood	−3,038.342	−3,025.055	−3,035.890	−3,030.875	−3,036.048	−3,019.094
Akaike Inf. Crit.	6,110.684	6,086.110	6,107.779	6,097.750	6,108.095	6,080.189

Note: *p<0.1; **p<0.05; ***p<0.01

Table B.12: Ethiopia: Model 2 with channels (Immunization)

	Dependent variable: Immunization					
	(1)	(2)	(3)	(4)	(5)	(6)
age	0.021***	0.021***	0.021***	0.021***	0.021***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0003***	−0.0003***	−0.0003***	−0.0003***	−0.0003***	−0.0003***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
girl	−0.001	−0.002	0.0002	−0.001	−0.001	−0.002
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
twin	0.041	0.048	0.043	0.048	0.038	0.050
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
birth order	−0.0001	−0.00000	−0.0001	−0.001	0.001	0.0004
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
mother's age	0.005***	0.005***	0.005***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
MEduc	0.012***	0.010***	0.005**	0.010***	0.011***	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
HEduc	0.0004	0.0002	0.0004	0.0003	0.0004	0.0002
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
husband's age	−0.0003	0.0001	−0.0003	−0.00001	−0.0002	0.0003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
BMI	0.001	−0.001	0.001	0.0005	0.001	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
household size	−0.007**	−0.006**	−0.006**	−0.006**	−0.006**	−0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
n. of siblings	−0.009	−0.010*	−0.010*	−0.008	−0.010*	−0.011*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
water	0.088***	0.048***	0.085***	0.081***	0.086***	0.047***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
toilet	0.030	0.042	0.033	0.034	0.031	0.045
	(0.034)	(0.032)	(0.034)	(0.034)	(0.034)	(0.032)
urban	0.101***	0.041**	0.102***	0.088***	0.101***	0.044***
	(0.018)	(0.017)	(0.018)	(0.017)	(0.018)	(0.017)
mother as head	−0.084***	−0.079***	−0.083***	−0.082***	−0.073***	−0.068***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
wealth		0.040***				0.033***
		(0.004)				(0.004)
literate			0.075***			0.044***
			(0.018)			(0.018)
media				0.065***		0.039***
				(0.009)		(0.010)
empowerment					−0.028***	−0.025***
					(0.004)	(0.004)
Observations	8,887	8,887	8,887	8,887	8,887	8,887
Log Likelihood	−4,332.344	−4,279.619	−4,322.891	−4,308.087	−4,303.301	−4,241.904
Akaike Inf. Crit.	8,698.687	8,595.238	8,681.783	8,652.175	8,642.602	8,525.809

Note: *p<0.1; **p<0.05; ***p<0.01

Table B.13: Ethiopia: Model 2 with channels (Diarrhea)

	Dependent variable: Diarrhea					
	(1)	(2)	(3)	(4)	(5)	(6)
age	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0001***	−0.0001***	−0.0001***	−0.0001***	−0.0001***	−0.0001***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
girl	−0.014*	−0.014*	−0.014*	−0.014*	−0.014*	−0.014*
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
twin	0.049*	0.050*	0.049*	0.050*	0.050*	0.051*
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
birth order	0.018***	0.018***	0.018***	0.018***	0.017***	0.017***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
mother's age	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
MEduc	−0.002	−0.002	−0.002	−0.002	−0.001	−0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
HEduc	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
husband's age	0.001**	0.001**	0.001**	0.001**	0.001*	0.001*
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
BMI	−0.006***	−0.006***	−0.006***	−0.006***	−0.006***	−0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
household size	0.003	0.003	0.003	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
n. of siblings	−0.022***	−0.022***	−0.022***	−0.022***	−0.022***	−0.022***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
water	−0.031***	−0.032***	−0.031***	−0.031***	−0.029***	−0.032***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
toilet	−0.011	−0.010	−0.011	−0.010	−0.010	−0.009
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
urban	0.016	0.015	0.016	0.016	0.015	0.012
	(0.014)	(0.015)	(0.014)	(0.014)	(0.014)	(0.015)
mother as head	0.008	0.008	0.008	0.008	−0.001	−0.0003
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
wealth		0.001				0.002
		(0.003)				(0.003)
literate			0.0001			0.002
			(0.015)			(0.015)
media				0.005		0.008
				(0.008)		(0.008)
empowerment					0.017***	0.018***
					(0.003)	(0.003)
Observations	8,887	8,887	8,887	8,887	8,887	8,887
Log Likelihood	−3,663.966	−3,663.904	−3,663.966	−3,663.725	−3,647.750	−3,646.966
Akaike Inf. Crit.	7,361.932	7,363.807	7,363.932	7,363.451	7,331.501	7,335.931

Note: *p<0.1; **p<0.05; ***p<0.01

Table B.14: Ethiopia: Model 2 with four levels of mother's education

	Dependent variable:			
	Stunting	Wasting	Immunization	Diarrhea
	(1)	(2)	(3)	(4)
age	0.036***	−0.003***	0.021***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0005***	0.00003**	−0.0003***	−0.0001***
	(0.00002)	(0.00001)	(0.00002)	(0.00002)
girl	−0.034***	−0.033***	−0.001	−0.014*
	(0.011)	(0.006)	(0.009)	(0.007)
twin	0.170***	0.026	0.042	0.051*
	(0.037)	(0.024)	(0.032)	(0.029)
birth order	0.035***	0.005	−0.00000	0.018***
	(0.006)	(0.003)	(0.005)	(0.004)
mother's age	−0.003*	−0.003***	0.004***	−0.001
	(0.002)	(0.001)	(0.001)	(0.001)
incomplete primary	−0.040***	−0.032***	0.039***	0.010
	(0.013)	(0.007)	(0.011)	(0.009)
complete primary	−0.039	−0.006	0.153***	0.054*
	(0.042)	(0.023)	(0.040)	(0.032)
incomplete secondary	−0.112***	−0.061***	0.127***	−0.005
	(0.037)	(0.015)	(0.036)	(0.026)
secondary or higher	−0.217***	−0.054**	0.202***	−0.041*
	(0.033)	(0.018)	(0.039)	(0.024)
husband's education	−0.001	−0.001**	0.0004	0.0004
	(0.001)	(0.0004)	(0.0004)	(0.0003)
husband's age	0.0001	0.001***	−0.0002	0.001**
	(0.001)	(0.0004)	(0.001)	(0.0005)
BMI	−0.009***	−0.015***	0.001	−0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
household size	−0.003	−0.0003	−0.006**	0.003
	(0.003)	(0.002)	(0.003)	(0.002)
n. of siblings	−0.035***	0.002	−0.009*	−0.022***
	(0.007)	(0.004)	(0.005)	(0.005)
water	−0.029*	0.010	0.089***	−0.032***
	(0.015)	(0.009)	(0.013)	(0.010)
toilet	−0.135***	0.004	0.032	−0.009
	(0.045)	(0.026)	(0.034)	(0.029)
urban	−0.116***	0.009	0.104***	0.012
	(0.019)	(0.012)	(0.018)	(0.014)
mother as head	0.030*	0.039***	−0.084***	0.008
	(0.018)	(0.012)	(0.012)	(0.012)
Observations	8,887	8,887	8,887	8,887
Log Likelihood	−5,384.826	−3,034.884	−4,331.916	−3,660.723
Akaike Inf. Crit.	10,809.650	6,109.769	8,703.833	7,361.445
Note:				*p<0.1; **p<0.05; ***p<0.01

Table B.15: Ethiopia: Model 2 - full sample (Robustness Check)

	Dependent variable:			
	Stunting	Wasting	Immunization	Diarrhea
	(1)	(2)	(3)	(4)
age	0.036***	−0.004***	0.021***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0005***	0.00003***	−0.0003***	−0.0001***
	(0.00002)	(0.00001)	(0.00002)	(0.00001)
girl	−0.039***	−0.030***	−0.003	−0.015**
	(0.010)	(0.006)	(0.009)	(0.007)
twin	0.152***	0.045**	0.026	0.046*
	(0.035)	(0.024)	(0.030)	(0.027)
birth order	0.031***	0.003	−0.001	0.017***
	(0.005)	(0.003)	(0.004)	(0.004)
mother's age	−0.002	−0.001	0.005***	−0.0002
	(0.001)	(0.001)	(0.001)	(0.001)
mother's education	−0.014***	−0.006***	0.012***	−0.002
	(0.002)	(0.001)	(0.002)	(0.001)
BMI	−0.009***	−0.015***	0.002	−0.006***
	(0.002)	(0.001)	(0.001)	(0.001)
household size	−0.003	−0.002	−0.008***	0.004**
	(0.003)	(0.002)	(0.003)	(0.002)
n. of siblings	−0.035***	0.001	−0.009*	−0.023***
	(0.006)	(0.004)	(0.005)	(0.004)
water	−0.036**	0.007	0.082***	−0.029***
	(0.014)	(0.009)	(0.012)	(0.010)
toilet	−0.108***	0.004	0.036	−0.007
	(0.041)	(0.023)	(0.031)	(0.026)
urban	−0.117***	0.004	0.109***	0.011
	(0.018)	(0.012)	(0.017)	(0.013)
mother as head	0.028*	0.032***	−0.069***	0.007
	(0.016)	(0.010)	(0.011)	(0.011)
Observations	9,596	9,596	9,596	9,596
Log Likelihood	−5,833.131	−3,277.756	−4,738.600	−3,959.802
Akaike Inf. Crit.	11,696.260	6,585.513	9,505.199	7,949.604
Note:				*p<0.1; **p<0.05; ***p<0.01

Table B.16: Kenya: Model 2 with interactions

	Dependent variable:			
	Stunting	Wasting	Immunization	Diarrhea
	(1)	(2)	(3)	(4)
age	0.019***	−0.001**	0.050***	0.003***
	(0.001)	(0.0004)	(0.001)	(0.001)
age^2	−0.0003***	0.00001*	−0.001***	−0.0001***
	(0.00001)	(0.00001)	(0.00002)	(0.00001)
girl	−0.066***	−0.012**	−0.006	0.002
	(0.012)	(0.005)	(0.015)	(0.010)
twin	0.217***	0.042***	0.086***	0.022
	(0.026)	(0.015)	(0.026)	(0.019)
birth order	0.021***	−0.004*	0.010	0.030***
	(0.005)	(0.002)	(0.006)	(0.004)
mother's age	−0.008***	−0.0001	0.005***	−0.005***
	(0.001)	(0.0004)	(0.001)	(0.001)
mother's education	−0.004***	−0.006***	0.012***	0.0003
	(0.001)	(0.001)	(0.002)	(0.001)
household size	−0.001	0.002	−0.006**	0.002
	(0.002)	(0.001)	(0.003)	(0.002)
n. of siblings	0.002	0.004	−0.034***	−0.025***
	(0.006)	(0.003)	(0.007)	(0.004)
water	−0.049***	−0.002	0.039***	−0.022***
	(0.008)	(0.004)	(0.010)	(0.006)
toilet	−0.027***	−0.023***	0.080***	0.007
	(0.010)	(0.005)	(0.012)	(0.008)
urban	−0.036**	−0.010	−0.064***	0.001
	(0.015)	(0.006)	(0.019)	(0.012)
mother as head	−0.007	0.019***	−0.031***	0.002
	(0.009)	(0.005)	(0.011)	(0.007)
MEduc*girl	−0.0004	0.001	0.00001	−0.002
	(0.002)	(0.001)	(0.002)	(0.001)
MEduc*urban	−0.001	0.002***	−0.001	0.0005
	(0.002)	(0.001)	(0.002)	(0.001)
Observations	15,820	15,820	15,820	15,820
Log Likelihood	−8,704.055	−3,213.116	−8,941.742	−6,410.163
Akaike Inf. Crit.	17,440.110	6,458.232	17,915.480	12,852.330
Note:				*p<0.1; **p<0.05; ***p<0.01

Table B.17: Kenya: Model 2 with channels (Stunting)

	Dependent variable: Stunting				
	(1)	(2)	(3)	(4)	(5)
age	0.019***	0.019***	0.019***	0.019***	0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0003***	−0.0003***	−0.0003***	−0.0003***	−0.0003***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
girl	−0.069***	−0.068***	−0.069***	−0.068***	−0.069***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
twin	0.217***	0.222***	0.218***	0.218***	0.223***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
birth order	0.021***	0.020***	0.019***	0.021***	0.018***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
mother's age	−0.008***	−0.006***	−0.007***	−0.008***	−0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
mother's education	−0.004***	−0.004***	−0.010***	−0.004***	−0.005***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
household size	−0.001	−0.00002	−0.001	−0.001	−0.0001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
n. of siblings	0.002	−0.002	0.003	0.002	−0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
water	−0.049***	−0.024***	−0.048***	−0.049***	−0.024***
	(0.008)	(0.009)	(0.008)	(0.008)	(0.009)
toilet	−0.026***	0.009	−0.032***	−0.023**	0.004
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
urban	−0.044***	−0.010	−0.042***	−0.043***	−0.009
	(0.008)	(0.009)	(0.008)	(0.008)	(0.009)
mother as head	−0.007	−0.006	−0.005	−0.008	−0.005
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
wealth		−0.044***			−0.043***
		(0.004)			(0.004)
literate			0.059***		0.053***
			(0.012)		(0.013)
media				−0.015	−0.005
				(0.010)	(0.010)
Observations	15,820	15,820	15,820	15,820	15,820
Log Likelihood	−8,704.295	−8,639.441	−8,693.479	−8,703.103	−8,631.039
Akaike Inf. Crit.	17,436.590	17,308.880	17,416.960	17,436.210	17,296.080
Note:					*p<0.1; **p<0.05; ***p<0.01

Table B.18: Kenya: Model 2 with channels (Wasting)

	Dependent variable: Wasting				
	(1)	(2)	(3)	(4)	(5)
age	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
age^2	0.00001*	0.00001*	0.00001*	0.00001*	0.00001*
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
girl	−0.007**	−0.007**	−0.007**	−0.007**	−0.007**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
twin	0.040***	0.040***	0.041***	0.041***	0.041***
	(0.015)	(0.014)	(0.015)	(0.014)	(0.015)
birth order	−0.004*	−0.005*	−0.004	−0.004	−0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
mother's age	−0.00004	0.0001	−0.0002	−0.0001	−0.0002
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
mother's education	−0.005***	−0.005***	−0.002***	−0.004***	−0.002**
	(0.0005)	(0.001)	(0.001)	(0.001)	(0.001)
household size	0.001	0.001	0.002	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
n. of siblings	0.004	0.003	0.003	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
water	−0.001	0.001	−0.001	−0.001	−0.0004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
toilet	−0.026***	−0.023***	−0.024***	−0.019***	−0.016***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
urban	0.003	0.006	0.003	0.005	0.005
	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)
mother as head	0.019***	0.019***	0.018***	0.016***	0.016***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
wealth		−0.003*			−0.001
		(0.002)			(0.002)
literate			−0.032***		−0.023***
			(0.008)		(0.007)
media				−0.036***	−0.033***
				(0.005)	(0.005)
Observations	15,820	15,820	15,820	15,820	15,820
Log Likelihood	−3,217.676	−3,216.163	−3,207.074	−3,187.959	−3,182.286
Akaike Inf. Crit.	6,463.352	6,462.327	6,444.148	6,405.918	6,398.571
Note:					*p<0.1; **p<0.05; ***p<0.01

Table B.19: Kenya: Model 2 with channels (Immunization)

	Dependent variable: Immunization				
	(1)	(2)	(3)	(4)	(5)
age	0.050***	0.050***	0.050***	0.050***	0.050***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
girl	−0.006	−0.006	−0.007	−0.006	−0.007
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
twin	0.087***	0.086***	0.086***	0.086***	0.085***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
birth order	0.010	0.010	0.007	0.009	0.007
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
mother's age	0.005***	0.005***	0.006***	0.005***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
mother's education	0.012***	0.011***	0.004**	0.009***	0.003*
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
household size	−0.006**	−0.006**	−0.006**	−0.006**	−0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
n. of siblings	−0.034***	−0.033***	−0.033***	−0.033***	−0.032***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
water	0.038***	0.035***	0.041***	0.038***	0.038***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
toilet	0.082***	0.076***	0.073***	0.069***	0.060***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)
urban	−0.074***	−0.079***	−0.071***	−0.076***	−0.076***
	(0.010)	(0.011)	(0.010)	(0.010)	(0.011)
mother as head	−0.031***	−0.031***	−0.029***	−0.028**	−0.027**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
wealth		0.006			0.004
		(0.005)			(0.005)
literate			0.087***		0.075***
			(0.016)		(0.016)
media				0.062***	0.049***
				(0.012)	(0.012)
Observations	15,820	15,820	15,820	15,820	15,820
Log Likelihood	−8,941.920	−8,940.941	−8,926.611	−8,927.823	−8,916.775
Akaike Inf. Crit.	17,911.840	17,911.880	17,883.220	17,885.650	17,867.550

Note: *p<0.1; **p<0.05; ***p<0.01

Table B.20: Kenya: Model 2 with channels (Diarrhea)

	Dependent variable: Diarrhea				
	diarrhea				
	(1)	(2)	(3)	(4)	(5)
age	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	−0.0001***	−0.0001***	−0.0001***	−0.0001***	−0.0001***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
girl	−0.008	−0.008	−0.008	−0.008	−0.008
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
twin	0.022	0.022	0.021	0.021	0.022
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
birth order	0.030***	0.030***	0.029***	0.030***	0.029***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
mother's age	−0.005***	−0.005***	−0.005***	−0.005***	−0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
mother's education	−0.0002	0.001	−0.002**	−0.001	−0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
household size	0.002	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
n. of siblings	−0.025***	−0.026***	−0.025***	−0.025***	−0.026***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
water	−0.022***	−0.016**	−0.022***	−0.022***	−0.015**
	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
toilet	0.006	0.014*	0.003	0.001	0.008
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
urban	0.005	0.013*	0.006	0.004	0.015**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
mother as head	0.002	0.003	0.003	0.004	0.005
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
wealth		−0.010***			−0.012***
		(0.003)			(0.003)
literate			0.026***		0.017*
			(0.010)		(0.010)
media				0.026***	0.028***
				(0.007)	(0.007)
Observations	15,820	15,820	15,820	15,820	15,820
Log Likelihood	−6,410.935	−6,404.922	−6,407.346	−6,404.506	−6,394.649
Akaike Inf. Crit.	12,849.870	12,839.840	12,844.690	12,839.010	12,823.300
Note:					*p<0.1; **p<0.05; ***p<0.01

Table B.21: Kenya: Model 2 with four levels of mother's education

	Dependent variable:			
	Stunting	Wasting	Immunization	Diarrhea
	(1)	(2)	(3)	(4)
age	0.019***	−0.001**	0.050***	0.003***
	(0.001)	(0.0004)	(0.001)	(0.001)
age^2	−0.0003***	0.00001*	−0.001***	−0.0001***
	(0.00001)	(0.00001)	(0.00002)	(0.00001)
girl	−0.069***	−0.007**	−0.006	−0.008
	(0.007)	(0.003)	(0.008)	(0.005)
twin	0.224***	0.041***	0.082***	0.023
	(0.026)	(0.015)	(0.026)	(0.019)
birth order	0.015***	−0.003	0.008	0.026***
	(0.005)	(0.002)	(0.006)	(0.004)
mother's age	−0.006***	−0.0004	0.005***	−0.005***
	(0.001)	(0.0004)	(0.001)	(0.001)
incomplete primary	0.071***	−0.037***	0.092***	0.061***
	(0.011)	(0.003)	(0.012)	(0.009)
complete primary	0.019	−0.43***	0.137***	0.025***
	(0.012)	(0.004)	(0.013)	(0.010)
incomplete secondary	−0.023	−0.037***	0.122***	0.036***
	(0.015)	(0.004)	(0.017)	(0.014)
secondary or higher	−0.058***	−0.040***	0.150***	0.002
	(0.013)	(0.004)	(0.015)	(0.011)
households size	−0.0002	0.001	−0.006**	0.002
	(0.002)	(0.001)	(0.003)	(0.002)
n. of siblings	0.004	0.003	−0.033***	−0.024***
	(0.006)	(0.003)	(0.007)	(0.004)
water	−0.042***	−0.002	0.040***	−0.018***
	(0.008)	(0.004)	(0.010)	(0.006)
toilet	−0.049***	−0.023***	0.069***	−0.008
	(0.010)	(0.005)	(0.012)	(0.008)
urban	−0.036***	0.001	−0.069***	0.010
	(0.008)	(0.004)	(0.010)	(0.007)
mother as head	−0.001	0.017***	−0.027**	0.006
	(0.009)	(0.005)	(0.011)	(0.007)
Observations	15,820	15,820	15,820	15,820
Log Likelihood	−8,649.317	−3,205.843	−8,926.129	−6,378.934
Akaike Inf. Crit.	17,332.630	6,445.685	17,886.260	12,791.870
Note:				*p<0.1; **p<0.05; ***p<0.01

Table B.22: Kenya: Model 2 - full sample (Robustness check)

	Dependent variable:			
	Stunting	Wasting	Immunization	Diarrhea
	(1)	(2)	(3)	(4)
age	0.019***	−0.001**	0.051***	0.003***
	(0.001)	(0.0004)	(0.001)	(0.001)
age^2	−0.0003***	0.00001	−0.001***	−0.0001***
	(0.00001)	(0.00001)	(0.00002)	(0.00001)
girl	−0.069***	−0.010***	−0.005	−0.011**
	(0.007)	(0.003)	(0.008)	(0.005)
twin	0.223***	0.043***	0.107***	0.022
	(0.024)	(0.013)	(0.024)	(0.018)
birth order	0.022***	−0.004*	0.006	0.030***
	(0.005)	(0.002)	(0.006)	(0.004)
mother's age	−0.007***	0.00001	0.005***	−0.005***
	(0.001)	(0.0004)	(0.001)	(0.001)
MEduc	−0.005***	−0.005***	0.011***	−0.0003
	(0.001)	(0.0004)	(0.001)	(0.001)
household size	0.002	0.0005	−0.004*	0.001
	(0.002)	(0.001)	(0.002)	(0.001)
n. of siblings	−0.001	0.004	−0.031***	−0.024***
	(0.005)	(0.002)	(0.006)	(0.004)
water	−0.046***	−0.002	0.038***	−0.016***
	(0.008)	(0.004)	(0.009)	(0.006)
toilet	−0.022**	−0.027***	0.080***	−0.003
	(0.009)	(0.005)	(0.011)	(0.007)
urban	−0.037***	0.004	−0.072***	0.007
	(0.008)	(0.004)	(0.010)	(0.006)
mother as head	0.003	0.016***	−0.037***	0.006
	(0.008)	(0.004)	(0.010)	(0.007)
Observations	18,396	18,396	18,396	18,396
Log Likelihood	−10,144.920	−3,673.199	−10,406.880	−7,503.839
Akaike Inf. Crit.	20,317.840	7,374.398	20,841.760	15,035.680
Note:				*p<0.1; **p<0.05; ***p<0.01