Maternal Fertility and Child Health in Ethiopia; A Casual Determination

By

TEFERI, Mulugeta Berie

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Abstract

To determine the casual link between fertility and its impact on child health this paper used an Instrumental variable (IV) estimation method. The Ethiopian Demographic and Health Survey of 2011 and 2016 is used to estimate impact of fertility on child health. Child health as dependent variable is measured by height-for-age Z score for stunting, while fertility stands for the number of children a woman gave birth to. Because of the joint determination nature of child health and fertility Simultaneous Equation Model (SME) with an IV estimation method is used, to deal with the endogeneity problem which arises from simultaneity, twin birth and same sex of the first two children of a woman is used as IV for fertility. The result indicates that there is a significant and strong causation between child health and fertility in Ethiopia. One additional birth of a woman will negatively affect the health of a child by 0.511 standard deviation. In addition to fertility regional places of residence are has strong and significant impact on child health in Ethiopia, while mother specific endowments in birth has lesser impact.

1. Introduction

Human Capital is the most valuable endowment a developing country can depend on at early stage of its development. Countries like Ethiopia invest significant amount of government budget for universal primary education and almost free secondary and tertiary education with the hope that investment in young generation will have a long-run return in improving the national economy. Currently the Ethiopian government aspires to be the third layer of destination for the labor-intensive industries which are relocating out of Asia because of its increasing wage. Few textile, leather and other labor-intensive manufacturing firms have already started moving-in to Ethiopia (UNCTAD 2018).

The hope of getting a return on human capital investment depends on the health and productivity of the labor force, which is referred as quality. Even though it is very difficult to account child health problem which is likely to impact adulthood productivity to high fertility rate, there is an established literature of Quality-Quantity trade-off in child health and fertility (Becker and Lewis 1973, Becker 1960). The quality of the labor force depends on multiple of factors, among those investment in childhood life is believed to impact enduring and multiplicative impact of adulthood productivity. Human capital better improves with law level of fertility, especially when countries undergo through demographic transition (Fernihough 2017). Therefore, one of the possible improvements in quality of human capital may come from because of the decrease in fertility, as decline in fertility is the central characteristics of demographic transition.

In Ethiopia even though there is recent decline in fertility rate, there is critical child health problem which is manifested in high prevalence of malnutrition, and stunting. Using 2011 ad 2016 Demographic and Health Survey (DHS), this paper attempted to estimate the casual link between fertility and child health measured by the prevalence of stunting in Ethiopia.

Fertility and child health have a nature of joint determination, which creates simultaneity and reverse causality problem in the specified model. To deal with such problem Instrumental Variable estimation approach is employed. Twin birth as an additional exogenous shock to fertility which is not likely to be correlated with other determinants of fertility and parent's sex mix preference are used as IVs. Few similar research's in the topic has found causal link between fertility and child health in different circumstances. This paper tried to employ relatively strong IVs to address the endogeneity systematically and try to estimate the causation given the observation. The estimated result shows that child health is significantly affected by one additional birth, child health decrease by 0.511 standard deviation as number of children increase by one.

2. Theoretical Framework and Research Method

2.1. Theoretical Framework

Among multiple of variables which affects Human Capital Development, demographic factors like birth rate and death rate continue to play a significant role as both indicators vary across countries, even with similar level of economic development. Because birth rate is determined by individual choices and household level decisions, understanding the effect of fertility choice on other related aspects like maternal mortality, child mortality has been the center of both health and economic policy studies. Multiple of studies including the most cited Becker (1960), Becker & Lewis (1973) on Quality vs. Quantity substitution children brought the issue of fertility in to the realm of economic analysis. They come up with an economic model which treated child as any durable good a household can generate utility by assigning certain portion of resource. This installs that resource allocation determines quality vs. quality of good, and a child is not differently treated according to their model. Following their work, several papers have come up with evidences on the effect of resource allocation on child outcome. Starting from time to different resources children has more rivalry over household resources which affects their adulthood characteristics.

For example, the first child of a household in America receives twenty up to thirty additional minutes of quality time each day with parents than a second-born child of the same family (Price 2008). Apart from resource rivalry, this even further deepens the discussion into the effect of birth order in interhousehold resources distribution.

Using Becker's Quantity-Quality model (QQ) for framework of analysis, Cáceres-Delpiano (2006) found parents in US who face increase in family size tend to reallocate household resources. The paper investigated an increase of family size because of a later twin birth, in which the family size cannot be adjusted by reducing future birth and found the probability of older children to attend school will be lower, reduces mother labor force participation, increases probability of divorce.

The number of siblings affects child quality in different aspects even though the direction of the effect is not established. Using plausibly exogenous changes in family size in China because of the recent relaxations in One Child Policy, Qian (2009) found that an increase in family size contributed significantly to the increase in school enrollment of firstborn children by approximately sixteen percentage points. The author of the paper states, the result cannot taken in any way as disproof quality-quantity trade-off, rather the effect is may be more on non-economic across sibling or may be because of economies of scale in schooling. Contrary to that, again in China Li et al. (2008) examined the impact of family size on children education, and a negative correlation between the size of the family and the child's learning performance was found. They further studied the issue by using twinning as an exogenous shock of family size variation and the result shows that the negative effect was stronger in rural China where the education system is very poor.

On effects of fertility/number of siblings on education outcome, Kravdal et al. (2013) using DHS data from 26 Sub-Sahara African countries found a mixed result, where having younger siblings increases the likelihood of entering primary school; however, once a child is enrolled, having pre-school aged siblings is negatively associated with educational progression. In the same paper they found a very mixed result based on the order and gender of siblings. Having a greater number of siblings from six to fifteen years is associated with positive outcome for education in Sub-Sahara Africa. They also found that Girls are more adversely affected by having young siblings in their education outcome while they benefit more than boys for positive influence of having older siblings.

Among the child outcome which are determined by number of sibling child health is the first to be mentioned keeping aside the fact that child health in the meantime affects the number of siblings/fertilities. Pitt (1997) used 14 Sub-Sahara African countries DHS data to determine significant relation between fertility choices of a mother and child mortality for all the countries, whereas significant correlation between child height and fertility choice is found for Zambia. On early-mortality and fertility Ager et al. (2018) using the introduction of the smallpox vaccine in Sweden in late 18^{th} and early 19^{th} century, apart from their main findings they provided evidence that the decline in infant mortality has a negative effect on fertility. Using RCT in Bangladesh a maternal and child health program as an intervention Joshi and Schultz (2013) found treated villages experienced 17 % decline in fertility, while other related and jointly determined variables like birth spacing, lower child mortality, improved health status, and greater use of preventive health was registered in the program villages.

2.2. Determinants of Child Health

The impact of child health on adulthood outcomes is one important point which makes it necessary to give due attention to child health studies. Some studies found a strong link between child health and adulthood outcomes in education, health, skill and others. Black, Devereux and Salvanes (2007) used within twin technique to evaluate the impact of birth weight on adult outcomes and found birth weight does matter both in short run and long run effects. The short run basically related to child health and survival, while they found significant link between birth weight and long run outcomes like adult height, IQ, income, and educational achievement.

To explore the determinants to child heath, it is good to know how it is being measured or introduce the variables used in reference to child health in recent literatures. World Health Organization (WHO) adopts anthropometric standard to measure Stunting, Wasting and Overweight. These chronic manifestations of child abnormality are highly correlated to the child's health condition. Stunting, or low height for age, is caused by long-term insufficient nutrient intake and frequent infections. Whereas wasting, low weight for height, is used as a predictor of mortality among children under five by United Nations Children's Fund (UNICEF) because of an established long-term strong correlation between the two variables. Overweight is the final indicator, which in many countries co-exist with childhood undernutrition, leading to a double burden of malnutrition (WHO 2006 , Shariff and Ahn 1995). Standardized scores (Z score) of height-for-age, weight-for-height, and weight-for-age are now most commonly used indicators in literatures of child health and development.

Current literature suggests that there is no one and direction relation between fertility and child health. Rather there exist, reverse causation between the two variables. Now let us try to review the widely agreed upon variables which determine child health as our goal is to determine the effect of fertility on child health. Among all the factors mother's education has been the first to be identified in most of the literatures in positively determining child health. The more the mothers are educated the healthier the children are as the mothers have knowledge of health, nutrition, and sanitation (Olsen & Wolpin 1983 as cited in Zhang 1990, Desaiand & Alva 1998, Gérard & Ngangue 2014,). Chen and Li (2009) went further in their research on what they call a mother's foster effect by using adopted children and found that mother's education is significant determinant of the health of adopted children even after controlling income, number of siblings, health environment and other socio-economic variables. The effect of education on child health is not limited to the mother. Strauss and Thomas (1998) showed there is complementarity of education of both parents for the positive effect of father's education on children's height increases when the fathers' education increases.

Mother's age is additional element which contributes to the child health function (Finlay, O¨zaltin and Canning 2011). Using India National Family Health Survey (INHS) data Raj, et al. (2010) found that children born to mothers who were married below the age of 18 were at a higher risk of stunting and underweight compared to children of women who had married at age 18 or older. Other reproductive behaviors such as maternal age and parity at the time a child is born and birth spacing have long been believed to influence both the health condition of the mother and child. Wang, et al. (1987) used the neighboring determinants of Bongaart's fertility model to assess the huge decrease in Chinese TFR just before a child's policy was officially adopted. Their work demonstrated that among the four proximate determinants (marriage, induced abortion, contraception and postpartum infecundability) non-marriage factors like contraceptive and induced abortion were found to be significant for the TFR decline in 1981 to 2.6 nationwide and to 1.4 in urban areas.

Among the most important resources which contributed to child health function mother's caregiving time is important. Several works on the area implied that parental caring time is critical for child's cognitive development as well as its health, and the issue of working vs. non-working mother has been at the center of the discussion for long time. Long list of literatures stated that non-working mothers are able to allocate more of their time into child care that results good child health outcome and cognitive development (Baum 2003, Bernel 2008). At the same time the working status of mother also affects family resources, hence child health. Corcnan et al. (2005) stated having a child in bad health will affect family resources and impact the working ability of a mother and that aging affects child health, thus the causality runs in all directions. On the other hand, Hsin and Felfe (2014) argued that working mothers tend to spent shorter and quality time which benefits child's development, and in the meantime that they found father's tend to supply more of their time to child care when a mother is working mother than not working.

Medical access and proximity to infrastructure contributes to the wellbeing of child, there for it is important to account for such factor. Prenatal and postnatal treatment is unimaginable without such access, especially in developing countries access to a single immunization or bed net may impact the child health function significantly. Using Kenya's 1990's national representative Shariff and Ahn (1995) found mother's immunization for tetanus during pregnancy contributes to the improvement of child health outcomes like birth weight. In the same paper the researcher found age of the mother at first birth, birth order of a child, mother's birth order is highly associated with anthropomorphic indicators like weight/height, height/age, and weight/age.

Apart from access to medical services and availability of other infrastructures the living condition of families affects child health significantly, as children are more vulnerable to hygiene related infections. Even though its urban residence is associated with better health outcome, there is still disparity within the urban children. Using DHS data for 73 developing countries, Fink et al. (2014) have shown that children living in urban slum areas have poor health outcomes than those of their counterparts in better urban neighborhoods. The same paper indicated that the slum area has negative effect on health outcome of the children compared to the good urban areas, the slum urban area child has still got a health advantage over a child in rural areas of developing countries.

2.3. Determinants of Fertility

A whole range of factors from community economic indicators to individual demographic characteristics impact fertility. As mother specific characteristics are discussed above in relation to child health, it is important to stress specific issues more relevant to fertility decisions. One important point is the theoretical foundation that infant mortality and fertility are positively correlated. Ali (1985) used agricultural productivity and its positive impact on child nutrition to evaluate infant mortality rate in developing countries. It identified that as infant mortality rates and fertility are positively correlated, the decline in infant mortality has led to a decline in fertility in most of the developing countries. The same paper also highlighted one unique characteristics of income/wage increase, when income increase in agricultural activity, fertility was found to be increasing, whereas non-agricultural income increase is associated with decrease in fertility. This is implied to be associated with nature of agricultural sector in employing every member of family in different form, women have got very flexible working environment in agriculture than other sectors.

Parent's preference of child sex may also affect fertility, as parents prefer different sex combination of children. Using a sample of families in Florida, Markle (1974) examined the values, variance and possible determinants of sex ratios for all children in expected and desired families, and found parents has gender preference and among families who had girls for their first child, prefer a first boy in their desired family. Such preferences are likely to impact fertility when both first and second child are female or even male. In agricultural society it is hypothesized that there is a greater preference for male (Kaur 2008, Bardhan 1974).

Other important issue worth of consideration is mother specific genetic endowments which may make some group of women or community more fertile than the other. Even the exogenous factor affecting fertility like twin birth is denoted for having regional trend. Comparing across regions, there is a high twin birth in Nigeria (one in twelve), one in thirty in in US and Europe, and very low rate in Asia with one in seventy. Again across time the fertility of had increased 1980s and continues to decline starting from 1990s (Hoekstra, et al. 2008, Derom R 1995, W Eriksson 1995). There can be other mother specific genetic factors which affects fertility. Some researches on twin birth indicated that the probability of having a fraternal twin is high for those who has similar ancestral fertility trend, while identical twin is not something related to genetic factors (Gilles Pison 2002).

2.4. Child Health and Fertility in Ethiopia

Ethiopia had one of the highest death rates for children under five at the beginning of the millennium. Compared with the period up to the year 2000, which followed the year 2000, the infant mortality rate in Ethiopia decreased by 35% in the period 2000–2005; infant mortality has decreased by 21%, and mortality of children under five years old by 26% (Sibanda, et al. 2003) . However, the mortality rate is still high. According to the Federal Ministry of Health (2005), 472,000 children die in Ethiopia a year before they turn five, and they account for more than 30% of neonatal mortality. In view of the above, Ethiopia ranks sixth in the world among countries in terms of the absolute number of child mortality cases. The adoption of the fourth Millennium Development Goal (MDG) has provided the Ethiopian Government with a good opportunity to use the universal task of meeting urgent national needs. It facilitated inexpensive interventions to reduce child mortality and coordinate national resources with external development assistance. Government's priority policy documents emphasized importance of meeting the MDG targets, and the need for reduction of under-five mortality by expanding family planning and ensuring pre-natal and post-natal cares and support. To meet the specific targets related to child and maternal health as well as general health improvements the National Children Health Strategy targeted to expand access to health and improve health service for consecutive years since 2000 (Ministry of Finace & Economic Development 2010).

Despite improvements, there is still a long way to go in terms of access to general health and child health services, which significantly affects child health in the meantime, the fertility rate of a mother. Right after the introduction of the MDGs in 2001 the number of health centers doubled from 282, and the number of hospitals rose from 96 to 115, physicians from 1,415 to 1,888, nurses increased from 4,774 to 12,838 within almost three years. Despite access to the medical infrastructure, health education and access to information has increased through government planning. During this time, hygiene and sanitation improved, as well there was a reduction of major infectious diseases (Ambel, et al. 2015). Such interventions by the government does not only reduced infant mortality, but also helped to achieve another health outcomes. Despite such progress, the health sector remains overloaded. One doctor serves 58,000 patients and one midwife attends 3,756 deliveries (Gessesse and Aberra 2014). When it comes to mother's health, the maternal mortality rate in Ethiopia is one of the highest. Although there is a diversity of numerical data in many sources, it is suggested that approximately 24,000 mothers lose their lives each year due to complications related to pregnancy (AbouZahr and Wardlaw 2004). Additionally, approximately another 480,000 Ethiopian women and girls sustain long-time injuries because of pregnancy and childbirth complication in each year (Ibid).

The general socio-economic situation of the country is not so good for the health of children and mothers. Although the country has been experiencing economic growth for fifteen years, its beginnings from low base and population growth continue to discourage it from achieving significant changes in children's health outcomes. Among the critical problems is the high prevalence of stunting in majority of the children who live in less favorable circumstances. Official reports indicated that among one thousand children who are under five years of age 5,291 are stunted, 1,156 Wasted and 334 are severely wasted (UNICEF 2013). Early childhood malnutrition is likely to impact latter life even though the nutritional impact is higher in lower ages. Even for school aged children the number is very high in Ethiopia, using sample of school aged children and WHO indicators of stoutness and software developed for same purpose Tariku, Abebe and Melketsedik (2018) found that there is 41.9% prevalence of stunting among children who are above five years of age. The malnutrition was so chronic that in most case it significantly contributes to child mortality. With improved awareness in breastfeeding it was possible to reduce the morality slightly. Using 2000 and 2005 Ethiopia DHS data Susuman (2012) found childhood mortality decline parallel with the increase in breastfeeding time.

In Ethiopia fertility started to decline from 2000 onwards, though slowly. Total Fertility Rate (TFR) was lowered from 5.5 to 4.8 within ten years, and 4.2 in 2016. One unique thing in the first ten years of the millennium is the urban TFR has increased from 2.4 to 2.6, this needs a separate study to identify specific factor. According to (Lailulo and Susuman 2018) in general the changes are mostly determined by role of women in society, women education, access to information and family planning facilities, society's tendency to use children as latter age security, preference for sex of a child, perception to ideal facility size, and the prevalence of sexually transmitted teases. According to Olson and Andrew (2013) the combination of factors such as the development of a health extension network in Ethiopia, political will, high donor participation and public-private partnership has enabled the use of contraceptives in Ethiopia to increase in nine-fold between 1990 and 2011. In the same period, the birth rate in the country has fallen from 7.0 to 4.8.

The Ethiopian Government has been working hard for a universal family planning program to reach the health of children and mothers and to reduce the environmental impact of the population's dependence on subsistence agriculture. For a country of more than 100 million people and 83 percent of people living in the countryside and dependent on agriculture, allocating land to the new generation was a problem that has not been solved by the government. The new generation continues to divide small pieces of land among family members from generation to generation which less fertile and productive land. To address the population and environmental problem government and NGOs coordinated efforts and implemented Integrated Population, Health, and Environment Program which enabled wide distribution on contraceptives using community level networks and structures (Gonsalves, et al. 2015).

The general socioeconomic condition of the country is also important to consider, as it significantly affects both child health and fertility. Despite the recent growth Ethiopia is still ranked at the bottom of the Human Development Index (HDI), ranking 173 out of 189 in 2017. Access to health and education has improved the ranking and in part contributed to the reduction of infant mortality in recent years. In particular, the formation of the mother has contributed to the decline in mortality under five years (UNDP 2018). Half of the population has no access to dependable and clean potable water, among children who are under one years of age about 34 % doesn’t have immunization gains measles, 170 thousand children live with HIV and more than four million children are orphans because of different reasons, only less about a quarter of births are attained with health professionals (Ibid).

However, the economy is mostly dependent on persistent agriculture which makes it prone to drought and related natural disasters, with long-term consequences on children's and mother's health. With internal displacements starting in 2017, socio-economic conditions have worsened despite promises of improvement. In the same year the drought hit the arid eastern areas of the country due to the Indian Ocean Dipole. The number of people who needs humanitarian assistance has risen from around 6 in the past three and four years to 10.5 million in 2017. With more than 3 million internally displaced people outbreak of acute watery diarrhea (AWD), including the measles and scabies, and the drought-induced surge in under nutrition created an additional pressure on the few and understaffed health facilities in the rural areas. The health conditions of women and children in areas such as Somali, Afar, Oromia of Easter and Gedio (mass displacement), affected by natural disasters and man-made disasters which are at the same time difficult to reach, are even worse (UNICEF 2017).

The nutritional status of children is determined by food consumption, general health conditions and health practices for both mother and children. Use only the WHO standard, although there is a decrease in the number of children that stinting continues to be the main problem of Ethiopia, especially in some regions such as Amhara, Tigray and Afar where the portion of children that has a height below the age of 52, 21 and 50% (Gessesse and Aberra 2014). A new UNCEF report on multidimensional childhood deprivation has adopted a composite indicator to assess the deprivation situation, indicating that in 2018 deprivation is significantly higher in rural areas and unequally distributed among the regions of Ethiopia. Ninety-four percent of children living in rural areas, twice their peers in urban areas (42%), are deprived in three or more dimensions. The index varies from 18% in the capital Addis Ababa to 91% in the regions of Afar, Amhara and SNNPR. Even the other regions are not so different, the index stood at 90% in the regions of Oromia and Somalia and 89% in Benishangul Gumuz (CSA 2016).

2.5. Research Methods

2.5.1. Data

The paper used Ethiopia Demographic and Health Survey (EDHS) data. DHS data series has already established itself as a better survey data source in most of the developing countries. In Ethiopia it has conducted four series of surveys starting from 2000 up to 2016. In Ethiopia the survey is conducted by the Central Statistics Agency (CSA) with the Support of USAID, UNFPA and other bilateral and multilateral cooperation agencies. The data includes different indicators including topics such as: household and respondent characteristics, fertility and family planning, maternal and child health, nutrition, and HIV/AIDS.

The paper used 2011 and 2016 EDHS data, as pooled cross-sectional data. The 2011 collected the data using questionnaires from16, 650 households, and the 2016 EDHS covers 16,702 households the case identification is based on women age 15-49 and all men age 15-59 in these households. The DHS data is readily available for public access in the World Bank micro-database. The DHS survey may consist from 6 up to 8 data sets with different records. This paper used the Birth Record dataset, as the unit of analysis is individual child.

Regarding the variables DHS has introduced WHO standardized anthropometric indicators like child height-for-age, weight-for-age, and weight-for-height. These are standardized scores of each ratio which can serve as a reference to malnutrition with a certain level of cut for malnutrition. As the purpose of the paper is not to classify children in their nutrition status the standard score which ranges from -6 to 6 for stunting (height-for-age) is used as the dependent variable to measure child health. From the total of 20,843 children who are included in the two surveys, only for 18,304 children the height-for-age (dependent variable) is recorded, and there is a missing value for 2,539 children in the sample. The reason for not reporting the Z-score is unknown, such imbalances need to be taken to account not to bias the estimate if they follow some kind of trend.

2.5.2. Methodology

Child Health is highly linked with the number of children a woman would have and at the same time, the health status of a child determines the Maternal Fertility. These two equations are jointly determined as a system of equation, therefore the link between the two can take the form of system of linear equations (J. M. Wooldridge 2002, Baye and Sitan 2016).

$$CH = m_1\, \alpha_{ch} + \omega_1 F + \varepsilon_1 \qquad (1)$$

$$F = m_2\, \alpha_f + \omega_2 CH + \varepsilon_2 \qquad (2)$$

Where;

CH[1] - Health status of a child; measured by age-for-height z-scores,

F - Fertility; total number a woman ever gave birth to,

m_1 - A vector of exogenous variables which determines Health of a Child (CH),

m_2 - A vector of exogenous variables which determines Fertility choice of a mother (F),

α *and* ω are parameters to be estimated, while ε_1 *and* ε_2 are the error terms for the two equations.

Estimating coefficient parameters using Ordinary Least Square (OLS) method without considering the endogeneity which arises from of the simultaneity, fertility in the child health equation, problem make the estimated parameters biased and inconsistent in the sometime. Even though the two explained variables (CH & F) are also explanatory variable for one another in the two equation, here the objective in this paper is to estimate CH using F as an explanatory variable. Adopting a

1 HC is an endogenous explanatory variable in Fertility Equation and F is also an endogenous explanatory variable in Health of a Child Equation.

strategy to deal with endogeneity is important. The above system of equation can be solved using a substitution.

Therefore, with the aim of estimating the reduced equation, we can plug equation (1) into equation (2), replacing CH,

$$F = m_2\, \alpha_f + \omega_2 (m_1\, \alpha_{ch} + \omega_1 F + \varepsilon_1\ ) + \varepsilon_2 \tag{3}$$

We assume that $\omega_2\omega_1 \neq 1$ to solve for F, which leads us to the following;

$$(1 - \omega_2\omega_1)F = \omega_2 m_1 \alpha_{ch} + m_2 \alpha_f\ + \omega_2 \varepsilon_1 + \varepsilon_2 \tag{4}$$

$$F = m_1 Z_{ch} + m_2 Z_f\ + \varepsilon_3 \tag{5}$$

Where; $Z_{ch} = (\omega_2\, \alpha_{ch})/(1 - \omega_2\omega_1)$; $Z_f = (\alpha_f)/(1 - \omega_2\omega_1)$ and $\varepsilon_3 = \omega_2\, \varepsilon_1 /(1 - \omega_2\omega_1)$. Equation 5 expresses the F (fertility) with vector of exogenous variables m_1 and m_2, in the same equation ε_3 is error term from the reduced equation for fertility. The vector of parameters in equation 5, Z_{ch} and Z_f, are reduced from parameters, they are non-linier functions of the structural parameters in the first two SME (equation 1 & 2). Therefore ε_3, reduced form error, is a linear function of structural error terms in equation 1 & 2 (ε_1 & ε_2). Because ε_3 is the residual of fertility when it is regressed on m_1 & m_2, it is uncorrelated with the vector of explanatory variables in the CH estimation.

To address the reverse causality problem between fertility as an endogenous explanatory variable and child health as explanatory variable, the conventional strategy will be the use of instrumental variables (Thomas and Frankenberg 2002, Wooldrige 2006). The instrumental variables will be exogenous shocks which influence only fertility to help us estimate the uncorrelated part of fertility with the error term, therefor the effect of the instrumental variables will be through the fertility rather than directly affecting the outcome variable.

2.5.3. Model Identification

According to (Baye and Sitan 2016, Schultz 2010) fertility and child health are not independent of one another, at the same time the relation between the two variables are not one direction. It is stressed that OLS regression of child health on fertility will give some result, which cannot be taken as causation. Therefore, one needs to develop a compelling strategy to identify causation of one on the other. The appropriate strategy to use in such Simultaneous Equation Model (SEM) is to use at least two exclusion restrictions to simultaneously estimate the two models, but here we wanted to estimate the child health equation only. On the child health equation fertility is an endogenous independent variable which correlates with the error term and leads to biased and inconsistent estimator. One of the established ways for dealing with such problem is to use the Instrumental Variable (IV) method for estimating fertility and child health.

2.5.4. IV Identification

According to (Wooldridge 2002, 2006) appropriate implementation IV leads to the estimation of casual relation between the dependent and the independent variable. Fertility to be estimated effectively Twin Birth, and Sex of the First Two Children of a mother is used as IVs. Based on the literature instrumental variable ‘Z’ (twin or same sex in this context) has to fulfil three criterions; 1) It does not appear in the regression, 2) It has to have high correlation with the endogenous variable, and 3) It has to be uncorrelated with the error term. Both IVs are highly correlated with fertility as they affect the probability of a mother to give additional birth or not on the other hand IVs are less likely to be correlated with child health unless through fertility (Angrist and Evans 1998). The over identification of one endogenous variable using two ivies makes it possible to conduct Housman exclusion restriction test to partially evaluate the strength of one of the IVs.

2.5.5. Heterogeneity and Sample Selection Issues

Mother specific genetic endowments may result non-linear correlation between fertility and the error term. This time invariant maternal endowment results a mother specific heterogeneity. One conventional strategy to solve time invariant heterogeneity because of mother specific fertility endowments is to interact the residual of fertility $\hat{\varepsilon}_3$ in reduced equation (5) with fertility and run it as one control in the child health estimation equation (Ibid). The other important point for the issue of unreported Z_score may cause a sample selection bias if the unreported value are non-random. For this reason, it is important to correct for the sample selection issue by generating the Invers Millis Ratio (IMR) form a Probit regression for the Z_score reported and or unreported (J. M. Wooldridge 2002).

Therefore, the final Child Health equation needs to consider all the above-mentioned concerns. After considering the endogeneity, potential heterogeneity, and sample selection Child Health (equation 1) will be transformed into the following form;

$$CH = \beta_0 + m_1\alpha + \omega_1 F + \beta_1 \hat{\varepsilon}_3 + \theta(\hat{\varepsilon}_3 F) + \boldsymbol{\lambda} IMR \qquad (6)$$

$\hat{\varepsilon}_3$ is the error tem from the reduced equation (equation 5), in which fertility is regressed on the vector of variables. The coefficient β_1 if significant indicates that it will indicate that fertility is of course endogenous in child health equation and OLs cannot give unbiased and consistent estimate, there is need for the endogeneity to be addressed using strategies like IV. At the same time the inclusion of the error term in the reduced equation helps to control the unobserved variables which are correlated with fertility, this is what is referred as control function approach (Baye and Sitan 2016, J. M. Wooldridge 1997, Guo and Small 2000). θ Is the control for nonlinear interaction of fertility into child health equation. If θ is statistically insignificant there is no need to control/include it in regression, the coefficient of key variable can be estimated consistently without it. The $\boldsymbol{\lambda}$ coefficient controls for selection bias, if it is found to be statistically insignificant we may assume there is no sample selection and the coefficient can be estimated only through the IV without including IMR, on the other hand if **λ** is statistically different from zero controlling for sample selection is essential to get unbiased estimator of fertility.

3. Descriptive statistics

The following table /Table 1 presents the main statistical description of variables used for all the regressions. The main variable of interest, the dependent variable/height-for-age z-score is reported for 18,304 among the 20,843 children who are included in the two surveys. The average z-score is -1.5, which is 0.5 plus form the - 2.00 cutoff line for stunting. The WHO Global Database on Child Growth and Malnutrition uses a Z-score cut-off point of less than -2 standard deviation to classify the population to low level of nutrition. The average fertility rate is 4.3, but there is high regional disparity within the country. The average age of mothers is 29, which is very young. The average age for the children is 29 months, the sample seems to be balanced as the maximum is 60 months. The sample also has a balanced age structure, it has comprised of equal percentage of male and female children.

Table 1. Descriptive Statistics for selected variables for regression

Summery statistics of listed variables for regression					
Variables	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
1. Dependent variable					
Height for Age standard deviation (WHO Z score)	18,304.0	-1.5	1.8	-6.0	6.0
Z reported (1 & 0, probit regression to generate IMR)	20,843.0	0.9	0.3	0.0	1.0
2. Explanatory variables					
Total number of children (endogenous)	20,843.0	4.3	2.6	1.0	18.0
Mother's education	20,843.0	1.4	2.6	0.0	12.0
Father's education	20,843.0	2.3	4.2	0.0	99.0
Mothers' times Father's education	20,843.0	6.2	19.4	0.0	1,176.0
Mother's age	20,843.0	29.1	6.6	15.0	49.0
Mother's age squared	20,843.0	892.6	407.5	225.0	2,401.0
Mother's weight	20,843.0	51.1	8.8	25.8	125.3
Mother's weight squared	20,843.0	2,684.5	1,029.7	665.6	15,700.1
Mother's age at first birth	20,843.0	19.0	3.7	10.0	40.0
Child's sex	20,843.0	0.5	0.5	0.0	1.0
Child's age	20,843.0	29.6	17.3	0.0	59.0
Child's age squared	20,843.0	1,176.2	1,047.0	0.0	3,481.0
Mother's Ideal number of children	20,843.0	18.8	31.5	0.0	99.0
Tetanus injection before and after birth	20,843.0	0.9	1.5	0.0	9.0
Access to media	20,843.0	0.3	0.5	0.0	1.0
Mother has no formal job	20,843.0	0.6	0.5	0.0	1.0
Access to medical center	20,843.0	0.4	0.5	0.0	1.0
Child has diarrhea	20,843.0	0.1	0.3	0.0	1.0
3. Control variables for regional and income group variations					
Addis Ababa City	20,843.0	0.1	0.3	0.0	1.0
Tigray Region	20,843.0	0.1	0.3	0.0	1.0
Afar Region	20,843.0	0.1	0.3	0.0	1.0
Amhara Region	20,843.0	0.1	0.3	0.0	1.0
Oromia Region	20,843.0	0.2	0.4	0.0	1.0
Somali Region	20,843.0	0.1	0.3	0.0	1.0
Benishangul Region	20,843.0	0.1	0.3	0.0	1.0
SNNPRS Region	20,843.0	0.1	0.3	0.0	1.0
Gambela Region	20,843.0	0.0	0.2	0.0	1.0
Harari Region	20,843.0	0.0	0.2	0.0	1.0
Dire Dawa City	20,843.0	0.0	0.2	0.0	1.0

Table 1. Descriptive Statistics for selected variables for regression

Poorest	20,843.0	0.3	0.5	0.0	1.0
Poorer	20,843.0	0.2	0.4	0.0	1.0
Richest	20,843.0	0.2	0.4	0.0	1.0
Middle	20,843.0	0.2	0.4	0.0	1.0
Richer	20,843.0	0.1	0.4	0.0	1.0
Richest	20,843.0	0.2	0.4	0.0	1.0
Urban	20,843.0	0.2	0.4	0.0	1.0
4. Instrumental variables					
The first two children has got same sex	20,823.0	0.8	0.4	0.0	1.0
Mother has twins	20,823.0	0.0	0.2	0.0	1.0
5. Control for unobserved variables					
Residual from reduced equation of fertility	20,843.0	0.0	0.4	-4.7	5.7
fertility times its residual	20,843.0	0.1	2.2	-17.7	73.6
Inver Mills Ratio for sample selection IMR	20,843.0	0.0	0.2	-2.5	0.5
Source: Compiled by author using 2011 and 2016 Ethiopian DHS data					

There is no income data in the DHS but the quintile grouping of households in the population based on income classification starting from the poorest (1st group) to the richest(5th group). In addition to income groups the dummies for 11 administrative regions of the country is included in the regression as the child health problem in Ethiopia has got regional variation and characteristics, the inclusion of regional dummies also help us to cross check the regression results against administrative reports and data reported by authorities.

Among the children who are included in the sample more than 2000 are twin births, given twin birth can be rare in some circumstances this looks reasonable figure to impact fertility as an exogenous factor. Some papers used the cluster mean of twins, which makes it very rare to find twin and result a weak instrument.

Table 2. Reduced and probit regression

VARIABLES	(1) (Reduced equation to)	(2) (Probit Z reported 1 otherwise 0)
Mother's education	-0.064***	-0.002
	(0.004)	(0.007)
Father's education	-0.003**	0.009**
	(0.002)	(0.004)
Mother times F education	-0.002***	-0.001
	(0.001)	(0.001)
Mother's age	0.565***	0.101***
	(0.007)	(0.014)
Mother's age squared	-0.004***	-0.002***
	(0.000)	(0.000)
Mother's weight	0.039***	-0.002
	(0.004)	(0.008)
Mother's weight squared	-0.000***	0.000
	(0.000)	(0.000)
M age at first birth	-0.279***	-0.006
	(0.002)	(0.004)
Child sex	-0.027**	
	(0.012)	
Child age	-0.003***	-0.010***
	(0.000)	(0.003)
Child age squared	-0.000***	0.000
	(0.000)	(0.000)
Ideal number of children	0.004***	
	(0.000)	
N tetanus injection	-0.061***	0.075***
	(0.008)	(0.010)
Access to media	-0.060***	-0.060**
	(0.013)	(0.027)
M not working	0.145***	0.074***
	(0.013)	(0.026)
Access to medical center	-0.191***	-0.054*
	(0.014)	(0.028)
Child had diarrhea	-0.064*	0.916***
	(0.035)	(0.062)

Table 2. Reduced and probit regression

VARIABLES	(1) (Reduced equation to)	(2) (Probit Z reported 1 otherwise 0)
Tigray regional state	-0.028	0.261***
	(0.026)	(0.057)
Afar regional state	0.593***	-0.186***
	(0.028)	(0.053)
Amhara regional state	-0.281***	0.123**
	(0.025)	(0.055)
Oromia regional state	0.497***	0.043
	(0.024)	(0.049)
Somali regional state	1.342***	-0.301***
	(0.027)	(0.050)
Benishangul regional st.	0.272***	-0.084
	(0.027)	(0.055)
SNNPRS reg. state	0.475***	0.011
	(0.024)	(0.050)
Gambela regional state	-0.330***	-0.345***
	(0.040)	(0.072)
Harari regional state	0.363***	-0.303***
	(0.045)	(0.077)
Dire Dawa city	0.453***	-0.368***
	(0.043)	(0.080)
Poorest-1	0.548***	-0.058
	(0.027)	(0.057)
Poorer-2	0.423***	0.007
	(0.028)	(0.059)
Middle-3	0.346***	0.056
	(0.028)	(0.060)
Richer-4	0.391***	0.024
	(0.027)	(0.057)
Urban resident	-0.633***	0.026
	(0.026)	(0.054)
F agriculturalist	0.176***	-0.011
	(0.015)	(0.030)
M age1st marriage	-0.004*	
	(0.002)	
Place of delivery		-0.037
		(0.036)
Constant	-5.115***	-0.053
	(0.167)	(0.327)
Observations	20,172	20,172
R-squared	0.641	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.

Table 3. First Stage Regression

VARIABLES	(1) (Frist stage regression)	(2) Z_score
Mother has a twin	0.735***	
	(0.065)	
Same sex (for first two child)	0.349***	
	(0.024)	
Mother’s education	-0.012***	0.0266***
	(0.004)	(0.00666)
Father’s education	-0.000	0.00873**
	(0.003)	(0.00366)
M times F education	0.000	-0.000791
	(0.001)	(0.000900)
Mother’s age	0.416***	0.208***
	(0.012)	(0.0397)
Mother’ s age squared	-0.002***	-0.000543*
	(0.000)	(0.000292)
Mother’s weight	-0.003	0.0500***
	(0.006)	(0.0106)
Mother’s weight squared	0.000	-0.000163*
	(0.000)	(9.27e-05)
M age at first birth	-0.309***	-0.166***
	(0.003)	(0.0261)
Child sex	0.122***	-0.0895***
	(0.021)	(0.0245)
Child age	-0.020***	-0.134***
	(0.002)	(0.00336)
Child age squared	0.000***	0.00171***
	(0.000)	(4.95e-05)
Ideal number of children	0.001***	0.000304
	(0.000)	(0.000415)
Number of tetanus injection	-0.115***	-0.0645***
	(0.005)	(0.0129)
Access to media	0.012	-0.0280
	(0.018)	(0.0272)
Mother not working	0.043**	0.0189
	(0.017)	(0.0267)
Access to health	-0.087***	0.00467
	(0.018)	(0.0289)
Child had diarrhea	-0.047**	-0.152***
	(0.022)	(0.0377)

Table 3. First Stage Regression

Tigray regional state	-0.351***	-0.694***
	(0.030)	(0.0563)
Afar regional state	0.209***	-0.217***
	(0.035)	(0.0612)
Amhara regional state	-0.586***	-0.899***
	(0.033)	(0.0698)
Oromia regional state	0.224***	-0.112**
	(0.029)	(0.0510)
Somali regional state	0.819***	0.621***
	(0.036)	(0.0872)
Benishangul reg. state	0.072**	-0.543***
	(0.036)	(0.0549)
SNNPRS regional state	0.072**	-0.334***
	(0.029)	(0.0498)
Gambela regional state	-0.306***	-0.0260
	(0.046)	(0.0830)
Harari regional state	0.086*	-0.0979
	(0.049)	(0.0820)
Dire Dawa city admin.	0.160***	-0.117
	(0.057)	(0.0893)
Poorest (1^{st} group)	0.155***	-0.188***
	(0.038)	(0.0572)
Poorer (2^{nd} group)	0.137***	-0.199***
	(0.039)	(0.0582)
Middle (3^{rd} group)	0.066*	-0.0879
	(0.039)	(0.0575)
Richer (4^{th} group)	0.104***	-0.0479
	(0.037)	(0.0554)
Urban resident	-0.328***	-0.186***
	(0.034)	(0.0570)
Ehat	1.095***	0.496***
	(0.022)	(0.113)
EhatFertility	-0.027***	-0.0157
	(0.004)	(0.0124)
IMR	-1.818***	-0.947***
	(0.109)	(0.267)
Fertility		-0.511***
		(0.0809)
Constant	-0.641***	-1.434***
	(0.242)	(0.383)
Observations	18,304	18,304
R-squared		0.126

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4. Results

Table 4. Regression Result

VARIABLES	-1 (OLS selection uncorrected & with heterogeneity)	-2 (IV selection uncorrected & with heterogeneity)	-3 (Heckman heterogeneity and section corrected)	-4 (Heckman robust standard errors)
Fertility	-0.023**	-0.403***	-0.511***	-0.511***
	-0.01	-0.063	-0.081	-0.081
Mother's education	0.032***	0.020***	0.027***	0.027***
	-0.007	-0.007	-0.007	-0.007
Father's education	0.008**	0.008**	0.009**	0.009**
	-0.003	-0.003	-0.003	-0.004
Mothers times Father's education	-0.001	-0.001	-0.001	-0.001
	-0.001	-0.001	-0.001	-0.001
Mother's age	-0.015	0.165***	0.208***	0.208***
	-0.015	-0.033	-0.04	-0.04
Mother's age squared	0.000*	0	-0.001*	-0.001*
	0	0	0	0
Mother's weight	0.052***	0.051***	0.050***	0.050***
	-0.008	-0.009	-0.009	-0.011
Mother's weight squared	-0.000***	-0.000**	-0.000**	-0.000*
	0	0	0	0
Mother's age at first birth	-0.010**	-0.131***	-0.166***	-0.166***
	-0.005	-0.02	-0.026	-0.026

Table 4. Regression Result

VARIABLES	-1 (OLS selection uncorrected & with heterogeneity)	-2 (IV selection uncorrected & with heterogeneity)	-3 (Heckman heterogeneity and section corrected)	-4 (Heckman robust standard errors)
Child's sex	-0.086***	-0.093***	-0.089***	-0.089***
	-0.023	-0.024	-0.024	-0.024
Child's age	-0.124***	-0.132***	-0.134***	-0.134***
	-0.003	-0.003	-0.003	-0.003
Child's age squared	0.002***	0.002***	0.002***	0.002***
	0	0	0	0
Ideal number of children	0	0	0	0
	0	0	0	0
Tetanus injection	-0.006	-0.056***	-0.064***	-0.064***
	-0.008	-0.012	-0.013	-0.013
Access to Media	-0.031	-0.038	-0.028	-0.028
	-0.026	-0.027	-0.028	-0.027
Mother not working	-0.002	0.026	0.019	0.019
	-0.025	-0.026	-0.027	-0.027
Access to medication	0.047*	0.015	0.005	0.005
	-0.027	-0.028	-0.029	-0.029
Child had diarrhea	-0.132***	-0.147***	-0.152***	-0.152***
	-0.034	-0.035	-0.036	-0.038
Tigray regional state	-0.516***	-0.636***	-0.694***	-0.694***
	-0.05	-0.055	-0.061	-0.056
Afar regional state	-0.319***	-0.240***	-0.217***	-0.217***
	-0.053	-0.057	-0.059	-0.061

Table 4. Regression Result

VARIABLES	-1 (OLS selection uncorrected & with heterogeneity)	-2 (IV selection uncorrected & with heterogeneity)	-3 (Heckman heterogeneity and section corrected)	-4 (Heckman robust standard errors)
Amhara regional state	-0.604***	-0.823***	-0.899***	-0.899***
	-0.051	-0.064	-0.073	-0.07
Oromia regional state	-0.218***	-0.130***	-0.112**	-0.112**
	-0.046	-0.05	-0.051	-0.051
Somali regional state	0.220***	0.534***	0.621***	0.621***
	-0.052	-0.074	-0.086	-0.087
Benishangul regional state	-0.577***	-0.543***	-0.543***	-0.543***
	-0.053	-0.056	-0.057	-0.055
SNNP regional state	-0.366***	-0.344***	-0.334***	-0.334***
	-0.047	-0.049	-0.05	-0.05
Gambela regional state	0.125*	-0.011	-0.026	-0.026
	-0.075	-0.081	-0.083	-0.083
Harari regional state	-0.141*	-0.108	-0.098	-0.098
	-0.081	-0.084	-0.086	-0.082
Dire Dawa city admin.	-0.189**	-0.119	-0.117	-0.117
	-0.084	-0.088	-0.089	-0.089
Poorest (1st group out of 5)	-0.271***	-0.180***	-0.188***	-0.188***
	-0.054	-0.058	-0.059	-0.057
Poorer (2nd group out of 5)	-0.271***	-0.191***	-0.199***	-0.199***
	-0.056	-0.059	-0.06	-0.058
Middle (3rd group out of 5)	-0.126**	-0.073	-0.088	-0.088
	-0.056	-0.059	-0.06	-0.058

Table 4. Regression Result

VARIABLES	-1 (OLS selection uncorrected & with heterogeneity)	-2 (IV selection uncorrected & with heterogeneity)	-3 (Heckman heterogeneity and section corrected)	-4 (Heckman robust standard errors)
Richer (4th group out of 5)	-0.106**	-0.034	-0.048	-0.048
	-0.054	-0.057	-0.058	-0.055
Urban residents	-0.02	-0.145***	-0.186***	-0.186***
	-0.05	-0.056	-0.06	-0.057
Residual from reduced equation			0.496***	0.496***
			-0.115	-0.113
Fertility times its residual			-0.016	-0.016
			-0.011	-0.012
IMR (control for selection)			-0.947***	-0.947***
			-0.285	-0.268
Constant	-1.032***	-1.497***	-1.434***	-1.434***
	-0.328	-0.348	-0.355	-0.384
Observations	18,304	18,304	18,304	18,304
R-squared	0.216	0.156	0.126	0.126

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

5. Discussion

Table 3 shows the result for child health equation regression, using four deferent models. The first OLS regression is run for comparison, while starting from the second-row additional controls for non-leaner relation and sample selection are added. In all cases the result shows that the main interest variable, fertility, has significant causation on child health outcome. The OLS regression as expected (see Basu (2015)), gives upwardly biased estimate with 0.023 stranded deviation to the left side of the mean.

First on the coefficient estimate of the error term from reduced equation (equation 5), it is significant, and it assures that fertility is endogenous explanatory variable in child health equation, and the OLS is biased. The use of IV estimate gives more unbiased and consistent estimate, in the meantime including the error helps to control for heterogeneity which arises from mother specific genetic endowment in fertility. The coefficient estimates for the interaction term of fertility and error term, which is included to control for non-linear relation between child health and fertility is insignificant. There is no need to worry about non-leaner relation. In the meantime, sample selection is found to be significant, and it was important to include the IMR in the regression.

The use of the two instrumental variables in the second column gives an improved estimate than column one, very different from the OLS estimate. The Third and the fourth models are the same, as the third controls for sample selection, heterogeneity, and non-linear relation of fertility the fourth adds control for unknown form of heteroscedasticity.

Based on the result an increase in fertility negatively affects the child health by 0.511 standard deviation at 1 % significance level. As child health is measured by stunting (height-for-age), an additional birth in Ethiopia is likely to cause children under 5 years of age in the family to decrease their average height-for-age by 0.511 standard deviation. The third and fourth model has almost similar result, gives a confidence that there is less probability of having heteroscedastic error term in our child health regression equation. The same kind of relation is found by Baye and Sitan (2016) using Cameron DHS data, with less 0.153 standard coefficient for fertility. In the case of the Cameron the authors used Z score of weight-for-age. The same study used cluster level means of twin birth, mother's age mother's age at first marriage, and mother's age at first intercourse as instrumental variables.

When it comes to parent's education both father's and mother's education is found to be significant and positively related with child health outcome. Like in the case of fertility the OLS estimate gives upwardly biased estimate, while the IV estimate gives lower estimate. One-year increase in mother's education help to improve child health by 0.027 standard deviation at 1% significance level, while an increase of a father's education by one year improves child health by 0.009 at 5 % significance level. Mother's age is also found to be positively and strongly related with child health by 0.208 standard deviation, this is the highest coefficient next to fertility among mother and child specific demographic characters.

The most interesting aspect of the result is related to child age being negatively related to child health by 0.134 standard deviation at 1 % significant level in the first ages of the child, while it shows very little bust positive improvement with squared term by 0.002 standard deviation. This makes the total effect still negative with 0.130 standard deviation. Considering all mother specific factors and the big coefficients related to region of residence, one can understand that child is likely to be impacted more by living condition after the birth than mother specific endowment before and during birth. The coefficient estimates on child health related to mothers' weight is significant statistically but at very low standard deviation level. Compared to mother's age mother's weight doesn't impact child health that much, mothers age becomes more important because it is the experience of mother on baby care and nutrition which improves child health than endowment from mother during birth.

When we see the coefficient estimates of regions of resident, all compared to the capital city, the mean standard deviation is left to that of the capital for all regions. In the meantime, there are worse regions for child health based on the result child in Amhara and Tigray regional states of Ethiopia have lower mean health status by 0.899 and 0.694 standard deviation at 1 % significance level respectively. This estimate is consistent with the higher prevalence of stunting in booth regions which is reviewed in the child health and fertility in Ethiopia section of this paper.

The other control was for five different income group categories, compared with the riches group (5th category). The coefficient estimate shows that from the lowest to the highest income group child health improves. When it comes to child health urban residence has a negative and significant effect, which is seems odd at a glance, given that all the indications from other variables like region of residence, mother's age, and also the strong and significant affection of diarrhea infection with and stunting child health in urban residents are more likely to be affected by poor living condition than rural people. This argument becomes even stronger that access to medical care is not making any difference, which is supposed to be the advantage of the urban residents.

To check the consistency of the result using weight-for-age z score as dependent variable, the IV estimation of also gives relatively close estimate, an increase in one child decreases the health status of a child by 0.485 standard deviation (see APENDEX I). All the signs for the control variables and the coefficient estimates are comparable to the main estimate. This can be taken as one sign for the robustness of the result.

6. Conclusion

Given the data and the methodology employed the results shows that there is significant trade-off between child quality and quantity in Ethiopia. As the number of siblings in a family increases by one, child is likely to be shorter/stunt to its age below the mean. When it comes to other variables region of residence significantly affects child health status even more than fertility for some regions. As expected, parent's education improves child health outcomes. More nurturing effect of a mother is found be significant that genetic endowments which may be transmitted from child to health by birth.

7. Recommendation

Of course, family planning and reduction in fertility improves child health. Given that the current trend in birth rate is declining and the fact that it takes time to reduce fertility in a society the policy makers may also need to focus on things which may improve child health in short run. As more of the significant factors are related to place of residence than fertility; improvement of sanitary and hygiene, access to pure drinking water, provision of adequate home in urban centers may improve child health outcome sin Ethiopia. Other demographic factors to consider in policy making is increase age for marriage and birth spacing. These two factors are likely to improve as the mother become more experienced and her age increases to acquire more knowledge on nutrition and health status of a child, in the meantime the siblings grow older not to take too much resource like mother's time from a child less than 5 years.

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Appendices

Appendix I: Result with similar depend variables

Table 5 Result with similar child health indicator dependent variables

VARIABLES	(1) (weight-for-age Z score)	(2) (weight-for-height Z score)
Fertility	-0.485***	-0.309
	(0.078)	(0.285)
Mother's education	0.012**	0.008
	(0.006)	(0.033)
Father's education	0.002	-0.009
	(0.003)	(0.009)
M times F education	-0.001	0.002
	(0.001)	(0.003)
Mother's age	0.218***	0.129
	(0.035)	(0.143)
Mother's age Sq	-0.001***	-0.000
	(0.000)	(0.001)
Mother's weight	0.070***	0.038
	(0.012)	(0.055)
Mother's weight Sq	-0.000***	-0.000
	(0.000)	(0.000)
M age at First Birth	-0.155***	-0.069
	(0.026)	(0.091)
Child's sex	-0.069**	-0.051
	(0.031)	(0.101)
Child's age	-0.064***	-0.068***
	(0.004)	(0.018)
Child' age Sq	0.001***	0.001***
	(0.000)	(0.000)
Ideal num. children	0.000	-0.001
	(0.000)	(0.002)
Num. of tetanus injection	-0.065***	-0.048
	(0.017)	(0.057)
Access to media	-0.012	-0.270***
	(0.029)	(0.099)
M not working	0.044	0.087
	(0.030)	(0.101)
Access to medical service	0.022	0.035
	(0.032)	(0.119)

Table 5 Result with similar child health indicator dependent variables

Child had diarrhea	-0.312***	-0.587***
	(0.035)	(0.120)
Tigray regional state	-0.425***	0.223
	(0.048)	(0.173)
Afar regional state	-0.210***	0.292
	(0.049)	(0.211)
Amhara regional state	-0.563***	0.323
	(0.066)	(0.214)
Oromia regional state	0.095*	0.678***
	(0.051)	(0.163)
Somali regional state	0.223***	0.360
	(0.077)	(0.308)
Benishangul regional state	-0.198***	0.618***
	(0.072)	(0.186)
SNNPRS regional state	0.113	0.896***
	(0.069)	(0.165)
Gambela regional state	-0.209***	1.228**
	(0.064)	(0.539)
Harari regional state	-0.054	1.098**
	(0.060)	(0.491)
Dire Dawa city admin.	-0.212***	0.023
	(0.066)	(0.275)
Poorest (1st)	-0.275***	-0.022
	(0.050)	(0.259)
Poorer (2nd)	-0.260***	-0.119
	(0.057)	(0.262)
Middle (3rd)	-0.187***	-0.199
	(0.056)	(0.284)
Richer (4th)	-0.048	0.115
	(0.061)	(0.272)
Urban resident	-0.184***	0.046
	(0.047)	(0.287)
Ehat	0.459***	-0.387
	(0.110)	(0.549)
EhatFertility	-0.007	0.136
	(0.010)	(0.121)
IMR	-0.363***	-1.170
	(0.118)	(0.761)
Constant	-3.129***	-1.809
	(0.455)	(1.805)
Observations	18,398	18,418
R-squared	0.011	0.006