To school or not to school -

The impact of child nutrition on school participation in Northern Ethiopia.

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Abstract

This paper investigates determinants of school participation in northern Ethiopia using cross-sectional data from 2010, giving particular attention to the role of health and nutrition. It attempts to solve the problem of endogeneity in child health, and by doing so compliments on many of the previous studies which have failed to consider this. Instrumental variable and recursive bivariate probit models are used in order to assess the robustness of the estimates of the effect of child nutritional status, as measured by height-for-age z-score, on school participation. The paper finds that children who are stunted have a statistically higher probability of attending school than children who are not. The findings also suggest that ownership of irrigated land and the amount of livestock holding have a negative effect on the propensity of school participation. Seen together, these findings indicate that child labor and these input factors are complementary, and that parents prefer having the healthy children working on the farm, i.e., that the opportunity cost of schooling decreases with worse nutritional status, since malnutrition adversely affects child labor productivity.

Keywords: Education, child nutrition, child labor, instrumental variables

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1. INTRODUCTION

Education has been defined as a fundamental human right (UN, 2012a). It affects both the individual and the broader society and is critical to the attainment of the Millennium Development Goals (MDGs). Human capital theory, developed by Schultz (1961) and Becker (1964) suggests that there are substantial economic and social benefits of investing in education; investment in education increases an individual's skill level, which in turn increases potential productivity.

The world has seen impressive progress in the area of education during the past decades, with increasing literacy rates, school enrollment and falling dropout rates. Improvements have been particularly marked for girls, with reduced gender gaps worldwide. However, there are still many challenges. One of them is the decrease in quality as a potential consequence of the big increase in enrollment (Plank, 2007). Another is the high prevalence of dropout and out-of-school children. Globally, 61 million primary school age children are still out of school as of 2010, a number that has been stable since 2008. This development is much due to the situation in Sub-Saharan Africa, where the number has increased from 29 million in 2008 to 31 million in 2010 (UNESCO, 2012).

Ethiopia is among the countries that have experienced significant improvements in a number of areas, including access to education in recent decades. In 1994/95 approximately 3 million children were in primary school, and by 2008/09, primary enrollment had risen to 15.5 million, which is an increase of over 500 per cent (MoE, 2010). The region of Tigray, which will be the area of focus in this thesis, is one of the regions that have succeeded the most regarding education over the past two decades in Ethiopia. It has experienced high growth in school enrollment and managed to reduce the gender inequality, although some challenges still remain.

In Ethiopia 2.4 million children are out of school, which represents 18 per cent of the country's primary age school population. Even though this number has successfully been reduced from 6.3 million in 2000, it is still the second highest in Sub-Saharan Africa and number six on a world basis (UNESCO, 2012).

There are many reasons for children not attending or dropping out of school. One of them is poor health and nutrition, which has received increasing attention as a key determinant of schooling. Malnutrition in early childhood has been shown to adversely affect a child's cognitive and behavioral development with long-term and possibly irreversible damage to the brain (Victoria et al., 2008). Across the world, 27 per cent of children under the age of five are stunted, i.e., they are too short for their age (de Onis et al., 2012). Many studies have confirmed an association between malnutrition, in particular stunting, and poor schooling outcomes; it has been estimated that a 10 per cent increase in stunting will lead to 7.9 per cent fewer children reaching the final grade of primary school (Grantham-McGregor et al., 2007). The share of stunted children below the age of five in Ethiopia is alarmingly high, 51 per cent (UNICEF, 2012).

Inadequate nutrition and health care are more likely to have life-long consequences for children growing up in a poor environment, where risk factors often co-occur, possibly leading to a life characterised by poor health and low schooling outcomes followed by reduced future income and high fertility (Grantham-McGregor et al., 2007). The role of education becomes crucial as a way to escape this "intergenerational cycle of poverty" and poor health (Engle et al., 2007). In addition to being important for children and their families, young children's health and development is also important for a country's development as a whole, for example in relation to the distribution of wealth and economic productivity. In fact, the low level of health has been proposed as the most important human capital constraint that has slowed development in Africa over the past decades (Schultz, 1999).

As stated, there are high social and individual returns to schooling (Psacharopoulos and Patrinos, 2004). This, combined with low enrollment and completion rates in Ethiopia, highlights the importance of understanding the determinants of school participation. The objective of this study is therefore to examine factors that may influence the household's investment decision regarding school enrollment.

In order to address these problems, the following research question is raised:

Given the extensive effort to increase school enrollment, why are so many children still not attending school – what are the factors associated with non-participation and what is the role of nutrition?

Acknowledging that poor schooling outcomes are influenced by a wide range of determinants, my focus will be on examining some specific factors that may influence school participation. These factors will be investigated through a set of hypotheses including such as the child's nutritional status, parental education, the number of siblings living in the household, ownership of irrigated land and size of livestock holding.

I will be drawing upon representative cross-sectional data collected in Tigray in 2010, in addition to data collected during an individual fieldwork in 2011. Gaps and limitations in the literature will be identified and some of the hypotheses will examine this.

The thesis is structured as follows: In section 2 I will present background information on Ethiopia's education system in addition to a brief background on its history and economic situation. Also, the malnutrition situation in the country will be outlined. In section 3 I will review relevant literature in the field of school participation, giving nutrition extra attention. Section 4 presents the research question and hypotheses, while section 5 focuses on data and methods and provides some descriptive statistics based on the data being used. Results and discussions will be given in section 6, and a conclusion is provided in the last section.

2. BACKGROUND

2.1 Ethiopia

Ethiopia is a land-locked country in the north-east of Africa, bordering Eritrea in the north, Djibouti and Somalia in the east, Kenya and South Sudan in the south and Sudan in the west, see Figure 1.1. It is presently the second most populous country in Africa, with a total population of 84.7 million where more than 41 per cent of the population is under 15 years old (World Bank, 2012). Furthermore, given the relatively high fertility rate, estimated at 4.2 children per woman (UNICEF, 2012), the population is expected to continue growing fast in the future. This indicates that the number of school age children in Ethiopia is currently very high, and will continue to grow in the future, because of the demographic momentum.

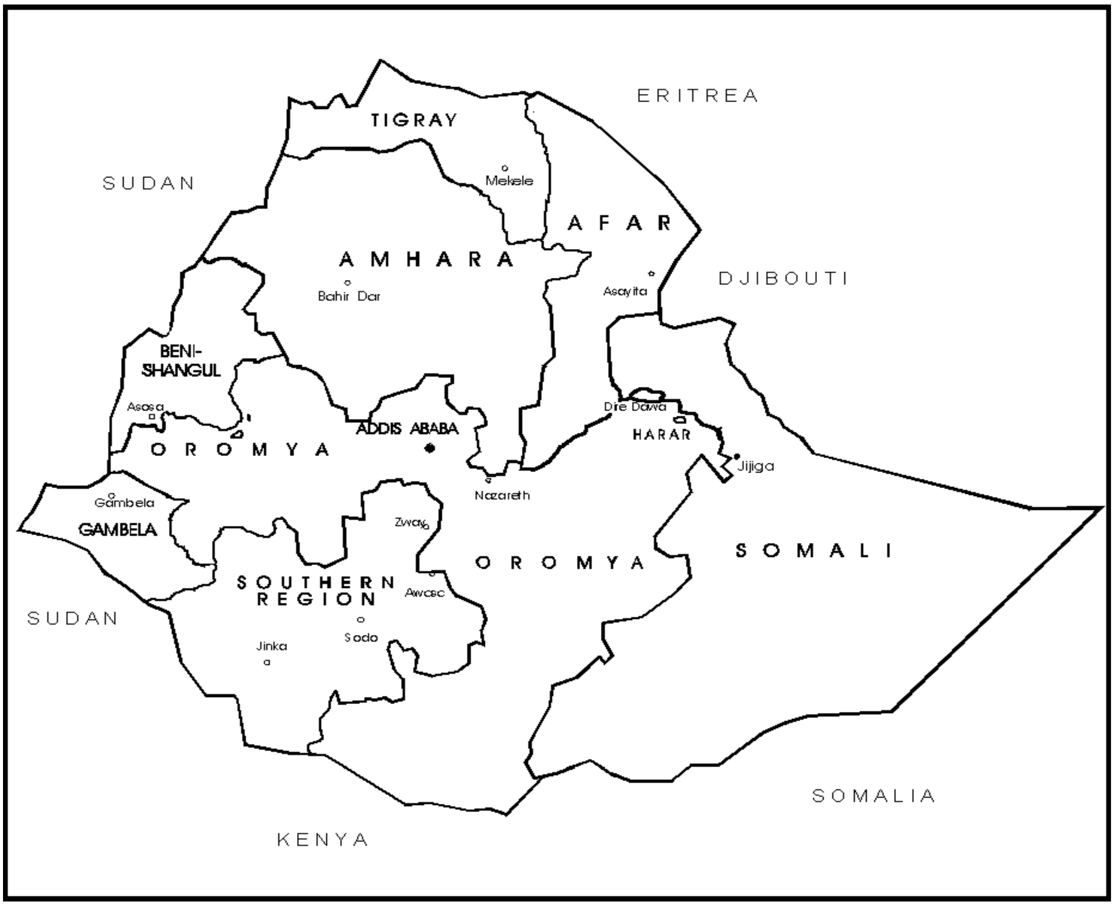


Figure 1-1: Map of Ethiopia

Being one of Africa's fastest growing economies the last years (Ncube et al., 2010) Ethiopia is still among the poorest six countries in the world (World Bank). However, poverty has been reduced from 49.5 per cent in 1994/95 to 38.7 per cent in 2004/05 (MoFED, 2010). Despite the still elevated poverty rate, there are favorable indications that Ethiopia is on track on reaching the Millennium Development Goal of halving the proportion of people living in poverty by 2015 (ibid). Being one of two countries in Africa that were never colonialized, Ethiopia still has a history characterised by instability. The devastating civil war from 1974–1991 left much of the society in ruins, including the educational sector. The region of Tigray has particularly been severely affected by this.

2.2 The study site: Tigray

Ethiopia is divided into nine ethnicity-based administrative regions, where Tigray is the northernmost region. Each region is divided into zones which are further divided into *woredas* (district), see Figure 1.2. Each woreda is divided into different *tabias* (community) (Araya and Edwards, 2006).

Tigray consists of four zones and according to the housing and population census of 2007 (PSC), more than 4.3 million people reside in Tigray, 80.5 per cent live in rural areas, which is a high rate even by standards of sub-Saharan Africa. Tigrinya are the fourth largest ethnic group in Ethiopia (CIA, 2012). The main income source in Tigray is mixed crop livestock farming, making it a rain-dependent region. Opportunities for income diversification are limited and the region is heavily affected by droughts, making it a highly vulnerable and food insecure region (Holden et al., 2007).

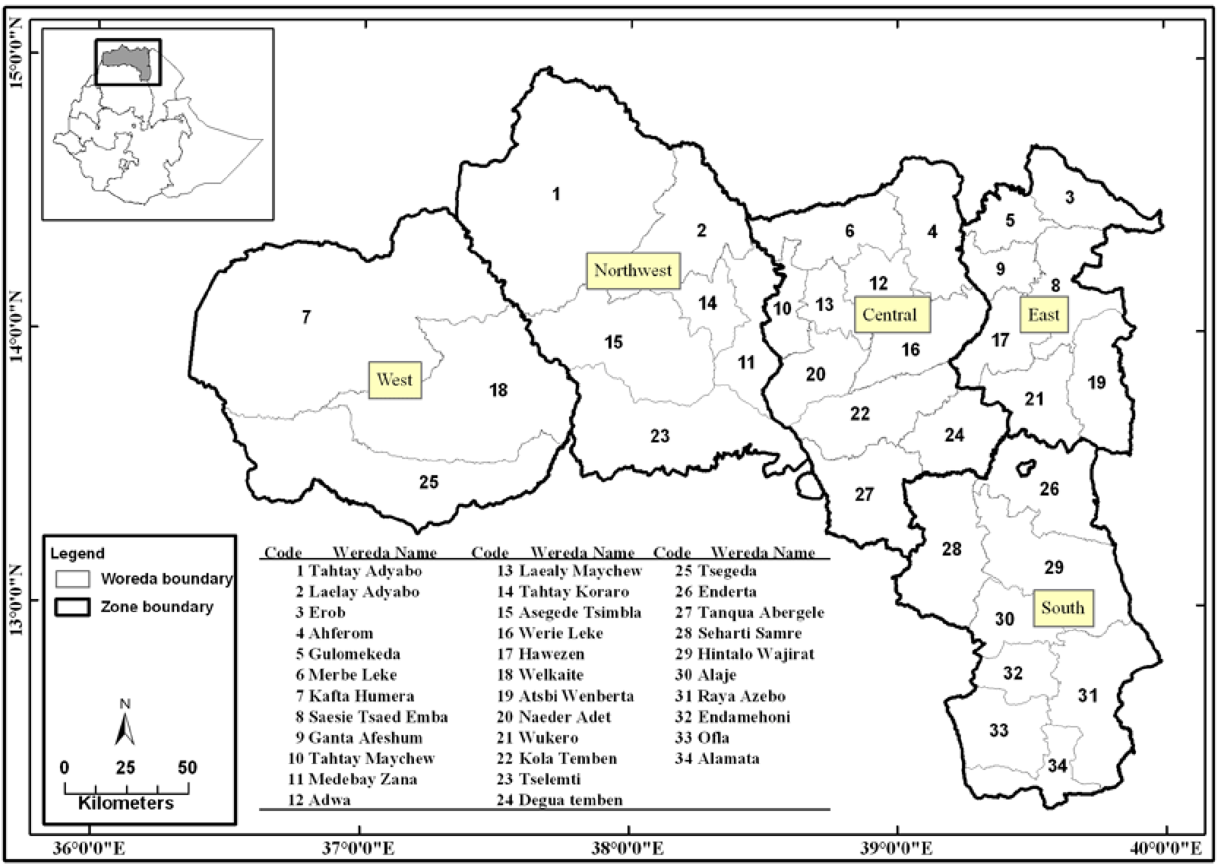


Fig. 1 Geographic location of Tigray region, Ethiopia

Figure 1-2: Map of Tigray

According to the Ethiopian 2004 welfare monitoring survey, primary and secondary school net enrollment ratios were estimated to be 46.8 per cent and 17.5 per cent, whereas the dropout rates are 10.1 per cent and 17 per cent, respectively (CSA, 2004). According to this survey, the most important reasons for dropping out of school in Tigray were: need to work (29.4%), sickness (17.3%) and formal marriage (10.7%), and the most important reason for not attending school at all, was: “family not willing” (39%).

However, primary school enrollment has been increasing over the past two decades in Tigray, especially in the rural areas. According to Chaudhury, et al. (2006), Tigray is one of the regions in Ethiopia that have witnessed the most marked improvements both related to primary school enrollment and a closing gender gap. One reason for this might be the restoration of peace and order after the civil war with the Derg regime (1974–1991). Another is the government's foundation of the National Education and Training Policy Strategy (NETP). This was adopted in 1994 in order to overcome some of the problems regarding enrollment and dropout rates. Primary and secondary schools were among the priorities, and a part of this was to abolish school fees in government schools and to implement food-aid programs in primary schools. Compulsory primary education was also increased from grades 1-6 to grades 1-8.

2.3 Education system in Ethiopia and recent trends

The education system in Ethiopia, following the above mentioned Education and Training Policy (ETP), consists of a 4-4-2-2 structure, with the first eight years constituting two four-year cycles of primary school and the following four years of two cycles of secondary school (World Bank, 2005).

The official school entry age is seven, but some start at six, and many start later (Lindstrøm, 2011). Even though primary education is compulsory in Ethiopia, grade repetition is increasing and the survival rate of the first cycle in primary school, considered as a good indicator of a sustainable literacy level, was on average 48.1 per cent in 2007/08–2009/10 (MoE, 2011). See table 1.1 and 1.2 below. The adult (above 15 years) and youth (15 to 24 years) literacy rate in 2008 was 30 and 45 per cent, respectively, indicating a low overall level of education in the country (World Bank, 2012).

In 1997, the Ethiopian government launched its first five-year Education Sector Development Programme (ESDP) as a way to achieve universal primary education by 2015. The fourth program is currently running (2010/2011-2015/2016), and it has a particular focus on the quality of education and the challenge of completion (ESDP IV, 2010).

School fees for primary education have been abolished as from the Ethiopian Poverty Reduction Strategy Paper in 2002 (Oumer, 2009). This was followed by a marked increase in enrollment rates with net enrollment rate increasing from 40 per cent in 2000 to 81 per cent in

2011, with a closing gender gap (World Bank, 2012). Tigray is one of the regions that have gained the most in both enrollment and gender parity in school (Chaudhury, et al., 2006). However, a surge in enrollment is often followed by a decrease in the quality of education as a consequence of higher student-teacher ratios and a higher prevalence of unqualified teachers (Plank, 2007).

Table 1-1: Completion, repetition and dropout rates for primary school in Ethiopia

Year	Completion rate primary (1–8) %			Repetition rate primary (1–8) %			Dropout rate primary (1–8) %		
	Boys	**Girls**	**Total**	**Boys**	**Girls**	**Total**	**Boys**	**Girls**	**Total**
2006/07	51,3	36,9	44,7	6,6	5,7	6,1	13,1	11,6	12,4
2007/08	49,4	39,9	43,6	7,0	6,3	6,7	15,9	13,2	14,6
2008/09	48,4	40,5	43,6	4,7	5,2	4,9	18,2	19,0	18,6
2009/10	51,0	44,5	47,8	7,2	10,0	8,5	13,1	13,0	13.1
2010/11	51,3	36,9	44,7	6,6	5,7	6,1	13,1	11,6	12,4

Source: Education Statistics, MoE 2011

Table 1-2: Net enrollment and gross enrollment rates for primary school in Ethiopia

Year	Net enrollment primary (1–8) %			Gross enrollment primary (1–8) %		
	Boys	**Girls**	**Total**	**Boys**	**Girls**	**Total**
2006/07	82,6	75,5	79,1	98,0	85,1	91,7
2007/08	86,0	80,7	83,4	100,5	90,5	95,6
2008/09	84,6	81,3	83,0	97,6	90,7	94,4
2009/10	83,7	80,5	82,1	96,6	90,1	93,4
2010/11	87,0	83,5	85,3	99,5	93,2	96,4

Source: Education Statistics, MoE 2011

As we can see from tables 1.1 and 1.2, there have been gradual improvements in net and gross enrollment rates in Ethiopia in the recent years. Net enrollment rate (NER) is the share of children of primary school age that are enrolled in primary school, whereas gross enrollment rate (GER) represents the number of children enrolled in primary school regardless of age, both measured as a percentage of the corresponding population (Unesco, 2009). This indicates that the net enrollment rate cannot exceed 100 per cent and that the gross enrollment rate, as we can see from table 1.2, can exceed 100 per cent which might happen because of the inclusion of overage children, because of children repeating grades, or possibly because of overreporting in the data.

A NER of 80– 85 per cent indicates that 15–20 per cent of primary school age children are out of school. Taking Ethiopia's high number of children aged 7–14 into account this represents a very high number (2.4 million) that currently are not receiving any education in Ethiopia (Unesco, 2012).

2.4 Malnutrition in Ethiopia

Child malnutrition is often caused by a broad range of factors such as pre- and postnatal deficiency of energy and other specific nutrients, access to and utilization of health services, and infections and illness which exacerbates the already deficit in nutrition stores. In addition, the quality of the home environment is often highlighted as a factor that can either protect or exacerbate the effects of child malnutrition. These factors can be family income, parental education, quality of sanitation and water supply, the size of the family, especially the number of siblings competing for limited resources, and the care and stimulation provided to the child (Brown and Pollitt, 1996; Grantham McGregor, 1995; Martorell, 1999).

One of the most commonly used classifications used to measure nutritional status originates from Waterlow (1972) where a deficit in height relative to age (stunting) was separated from a deficit in weight relative to height (wasting). Where the former is a measure of past growth failure and thus represents chronic malnutrition, the latter is a measure of current growth failure and represents recent or acute malnutrition (Shrimpton et al., 2001; Victoria, 1992).

These two are generally not found to be strongly correlated and thus may have some different causes (Victoria, 1992). Underweight, a deficit in weight relative to age, which represents a combination of the two above mentioned measures, and BMI, a short-term measure of malnutrition, are also used as indicators of a child's nutritional status (Grira 2004; Grantham-McGregor et al., 2006). In order to classify individuals as stunted, wasted or underweight, the measurements are converted into Z-scores and compared to a reference mean using the WHO growth standard (WHO, 2006).

Ethiopia has a high prevalence of malnutrition among children. Boys are found to be more malnourished than girls in Ethiopia, and the prevalence is highest in the two regions of Tigray and Amhara, underlining the severity of the problem in Tigray (Christiaensen and Alderman, 2004). Table 1.3 shows different health and nutrition indicators for Ethiopia and neighboring countries and regions.

Table 1-3: Nutrition and health indicators in Ethiopia and other countries

Country or region	Under-five mortality rate (per 1000 live births), 2010	Infant mortality rate (per 1000 live births), 2010	Underweight rate (%)	Wasting rate (%)	Stunting rate (%)
Ethiopia	106	68	33	12	51
Djibouti	91	73	23	10	31
Eritrea	61	42	35	15	44
Kenya	85	55	16	7	35
Somalia	180	108	32	13	42
Sub-Saharan Africa	121	76	20	9	39
Least developed countries	110	71	25	10	41

Source: UNICEF 2012

Even though the numbers are high, Ethiopia compares relatively well with other countries and regional averages regarding under-five and infant mortality rates. However, the indicators of malnourishment are high in Ethiopia: 51 per cent of children less than five years are stunted in the sense that their height-for-age Z-score (HAZ) was more than two standard deviations below the median of the reference population. This is among the highest rates in the world (UNICEF, 2012).

Investments in early child nutrition have historically been low and one of the reasons for this might have been the multi-sectoral responsibility and multifaceted implications of child malnutrition: normally, no single ministry is responsible for early childhood development and the consequences of malnutrition affect several sectors such as health, education and welfare. Engle et al. (2007) argues for a better coordination across different sectors in order to increase efficiency and strengthen linkages within the area of health and nutrition. With this being one of the primary goals, the government of Ethiopia launched its first National Nutrition Strategy in 2008 (Rajkuma et al., 2012). To reduce malnutrition the strategy sets out actions such as strengthening nutrition services, capacity building, and promoting essential nutrition interventions (ibid).

Admitting that there have been great improvements in enrollment rates, gender issues and in the availability of schools over the past 20 years in Ethiopia and in Tigray, there are still many challenges ahead concerning the inefficiencies of repetition, dropout rates and non-completion (Belay, 2008). On average in 2008, only 24.5 per cent of the girls and 33.5 per cent of the boys passed the 10th grade exam in Tigray (Mjaaland, 2010). These challenges may be a result of, or at least further exacerbated by, the prevalence of ill-health and malnutrition as it may result in reduced learning by lowering the daily attendance in school, reduce total years in school or lead to less efficient learning when in school (Glewwe and Miguel, 2008).

3. LITERATURE REVIEW

According to human capital theory (Schultz, 1961; Becker, 1964) parents make investments in their children's education based on the expected future returns in the form of enhanced skills, increased productivity and a belief that this will translate into higher income. However, there are costs associated with these investments, both direct and indirect, which affect the willingness to invest. There are many reasons why children stay out of school, and studies have highlighted factors affecting the investment decision such as individual, household, community and school factors. Investing in the human capital of children includes not only the choice of education, but also child health and nutrition, investments that will affect a child's development and schooling outcomes. All of this will be discussed in this chapter.

3.1 Investments in education and the returns from schooling

According to human capital theory, individuals make investments in child education by evaluating and weighing the expected returns of education and comparing this with the direct and indirect costs (Admassu, 2008). This implies that if these costs exceed the expected benefits, education will not be chosen. Although the benefits of education are shown to be far-reaching, households often fail to consider the long-term and social benefits, or are faced with market imperfections in labor or credit. Therefore they often underinvest in their children's schooling.

One of the benefits of education is improved quality of life through indirect effects such as better health, leading in turn to higher future earning capacity through increased productivity (Admassu, 2008; Arunatilake, 2006). The returns can be divided into private and social returns, where the private generally are found to be the highest (Psacharopoulos and Patrinos, 2004). Estimating the social returns to education is often difficult, however, because of the inherent externalities, which make it hard to identify and measure (ibid).

The returns to education are found to be highest in low-income and middle-income countries, and the returns to primary education are higher for men (Psacharopoulos and Patrinos, 2004). Parents or society may not value the education of their daughters as much as that of their sons, because of the traditional role of women as housewives and not as participants in the wage market. Due to this gender segregation with respect to market opportunities, there are often higher returns to men's schooling which discourages the investment in female education. However, the overall returns to education have been found to be highest for women (ibid), and investing in girls' education has repeatedly been recognized as particularly beneficial with respect to the non-pecuniary benefits it brings: in addition to the economic benefits and potentially reduced gender inequalities in the wage market, increased female education is associated with lower fertility rates and improved child health and nutrition (Glick and Sahn, 2000; Tansel, 1998). These external benefits are likely to positively affect the human capital of the next generation through the previously mentioned intergenerational effects.

In deciding whether or not to educate their children, parents may include their own old-age security and well-being through an increased future consumption realized by education of their children (Quisumbing, 2006). This pattern is confirmed in Tigray where parents stated that sending their children to school is an investment in their future livelihoods (Woldehanna et al., 2006). Parents may also choose to invest based on the future welfare of their children (Glick and Sahn, 2000).

According to models of human capital investment, parents are assumed to make investments where the returns are highest. This suggests a higher probability of making investments in a healthy child as this child might be expected to benefit more from education than an unhealthy child. Parents may, however, compensate unhealthy children by investing more in these children's education (Alderman et al., 2001). This can be done for example by using more time helping less healthy children with school work or by allocating more resources (e.g. food and nutrition) to them than to the more healthy children. Less healthy children may also indicate that the opportunity cost of schooling is lower than for more healthy children who are likely to have a higher labor productivity – particularly in poor and rural areas where households depend on their children's contribution and child labor is abundant.

3.2 Costs of education

As with all other forms of investments the decision on whether to send children to school depends also on the costs. Important to recognize is that while the benefits are uncertain and will come in the future, the costs are immediate. They can be direct in the form of school fees, textbooks, uniforms, and indirect in the form of forgone income accruing from lost labor (Admassu, 2008; Jensen and Nielsen, 1997). These indirect costs, or opportunity costs, are often higher in countries where child labor is prevalent.

Child labor is found to have a significant and negative effect on children's schooling (Amin et al., 2006; Levison and Moe, 1998). According to UNICEF (2012), the prevalence of children aged 5–14 years engaged in child labor in Ethiopia is 57 per cent, which is the highest of all the registered countries. The average for the world and for the least developed countries, respectively, is 17 and 29 per cent, underlining the severity of child labor in Ethiopia. One reason why children are used as labor instead of attending school may be because of imperfect markets, such as in the labor or in the capital market, forcing poor households to borrow across generations in terms of using their children as labor, thus sacrificing their education (Jensen and Nielsen, 1997).

In many developing countries girls have traditionally been given a disproportionally large responsibility in the household, reflecting historical and cultural attitudes towards females as being responsible for household work and child caring. This will increase the marginal cost of girls' time and further lead to a lower demand for educating girls versus boys (Glick and Sahn, 2000). However, the opposite might also be true in a farming setting where the demand for boys' labor is likely to be very high. Haile and Haile (2012) found in a study of child labor in rural Ethiopia that boys are more likely to be engaged in farm activities such as animal rearing, and average time spent per week looking after animals was 31 hours.

Increasing the costs of education affects the household's demand, and likewise, holding the costs constant, a higher return will lead to an increased demand for schooling (Alderman, et al., 2001). This brings me over to examining the factors that may affect the costs and returns to education.

3.3 Determinants of school participation

The determinants of school participation can broadly be classified into demand side factors and supply side factors that together constitute a household's demand for education (Mani et al., 2009). Zhao and Glewwe (2009) expressed this relationship as follows:

$$S = f\,(\boldsymbol{PC}, \boldsymbol{HC}, \boldsymbol{CC}, \boldsymbol{SC}) + \varepsilon, \qquad (1)$$

where ε is a an error term including factors that are not in the data and assumed to be uncorrelated with the explanatory variables, while demand for schooling, *S*, is the dependent variable and a function of four factors affecting the benefits and costs of education. These factors are: child personal characteristics (**PC**), household characteristics (**HC**), community characteristics (**CC**), and school and teacher characteristics (**SC**).

Individual and household characteristics

Included in individual and household characteristics are factors such as the child's age and gender, nutritional status, land size, household income, parental education, and family size and structure.

The child's age is found to have a significant and positive effect on dropping out of school in Ethiopia (Woldehanna et al., 2006). This may be because of the increased opportunity cost of schooling as children get older and usually have more responsibilities in the household. The same result is found in Bangladesh (Amin et al., 2006). Schaffner (2004) notes that the costs of sending very young children to school might also be high as late school entry is commonly observed in Ethiopia.

Woldehanna et al. (2006) found that Ethiopian boys were more likely to stay in school because of the idea that they are supposed to take care of their parents when they grow old. Girls, on the other hand, have their primary responsibility in the household, thus increasing the opportunity cost of girls' schooling. However, this contradicts with the results of Admassu (2008), who found that boys were less likely to stay in school because of higher demand for labor on the farm.

Having a farm and the size of this farm may therefore be of importance, especially in rural areas such as Tigray. According to Arunatilake (2006), ownership of land, and particularly the size of the land, may be a sign of wealth and a positive association has been found between wealth and education. The effect of land holding may also be negatively associated with schooling outcomes, due to an increased demand for labor, as found in Sri Lanka (ibid). Woldehanna et al. (2006) found the same effect in Ethiopia, but only for children residing in female-headed households where the demand for labor may be higher.

This ambiguous effect that land holding is a sign of wealth and has a positive effect on schooling, while it might also mean a higher demand for child labor, hence having a negative effect on schooling, is exemplified by the two axioms proposed by Basu and Van (1998), namely the "luxury axiom" and the "substitution axiom". The first states that the household will engage in child labor only if their income drops below a certain limit, while the latter states that adult and child labor act as substitutes. This can be viewed as a "wealth paradox", which was postulated by Bhalotra and Heady (2003), where the two effects work in opposite directions with respect to school participation: The wealth effect of having more land means that the household will be more likely to bear the costs of education, while the substitution effect pulls in the opposite direction and would lead to an increase in child labor and a decrease in school investment. The same reasoning can be applied for complementarity/substitutability between livestock holding and child labor.

However, a household's income will influence its ability to invest in the education of the children (Woldehanna, et al., 2006). Poorer households may be credit constrained and thus unable to bear the direct and indirect costs associated with schooling. If education is a normal good, higher income should lead to higher investments (Glick and Sahn, 2000; Mani et al., 2009). Admassu (2008) confirms this relationship in Ethiopia, and finds that children in wealthier households are more likely to be enrolled and are 30 and 45 per cent less likely to drop out of school in rural and urban areas, respectively. USAID found that Ethiopian families of higher socio-economic status were more able to send their children to school (USAID, 1994). Household income is also found to have positive effects on completed years of schooling in rural China (Zhao and Glewwe, 2009). Others have found similar results, but only significantly for girls (Glick and Sahn, 2000) or with a larger effect on girls than on boys (Tansel, 1998).

Parents can influence their children's schooling outcomes, for example by the time they devote to school work at home and through their values towards education, which both are found to be positively correlated with parental education (Glick and Sahn, 2000; Tansel, 1998). The education of parents is often reported as one of the most important factors for children’s education. In Ethiopia, a strong and positive relationship is found between parental education and enrollment (Admassu, 2008; Mani et al., 2009). Yelfign, et al. (1995) found similar results, showing that an educated household head has a strong positive effect on attendance and completion. They also found that girls are more likely to attend school if their mother is literate.

Mother's education having a greater impact on children's schooling outcomes compared to father's education corresponds with other results in the literature (Levison and Moe, 1998; Tansel, 1998; Zhao and Glewwe, 2009). According to human capital theory, this may be because mothers are willing to sacrifice more for their children (Mauldin et al., 2001). In Malawi, research has showed that the presence of women in the household decreased the work burden and increased the probability of a child attending school (Nankhuni and Findeis, 2004). However, many studies do not account for the possible upward bias resulting from a correlation between intergenerational unobservables, such as inherent ability and assortative mating, and schooling. Behrman and Rosenzweig (2002), accounting for this, found a positive effect of father's education on children's schooling and a negative effect of mothers education. This may be because more educated mothers spend more time outside the household, thus highlighting the critical role of mothers' presence as a determinant of their child's human capital. Accordingly, Levison and Moe (1998) found that maternal education, conditional on her presence in the household, has a positive effect on girls schooling.

As to family composition and size, the findings have shown mixed results. This may be because of the opposing forces a larger household represents: both a higher earnings potential and a higher resource demand in terms of money and work (Jensen and Nielsen, 1997; Admassu, 2008). The probability of a child attending school was found to be negatively related with the number of siblings below 6 years of age in Sri Lanka (Arunatilake, 2006). Similarly, a significant association is found in Ethiopia between the number of siblings below 5 years of age and schooling outcomes, such as enrollment and drop out. Conversely, a negative relation between dropping out and the number of siblings above 5 years of age and the number of adult household members above 15 years is found (Admassu, 2008, Woldehanna et al., 2006). Particularly girls have been found to be more time constrained with respect to household chores in developing countries (Levison and Moe, 1998). This is confirmed by Glick and Sahn (2000), who find that the presence of siblings below the age of five negatively effects girls' enrollment and grade attainment, and the presence of sisters aged 13–20 years was found to positively affect girls' education. None of these associations were found for boys. This indicates that school aged girls may be responsible for taking care of younger siblings, and that older siblings or adults can act as substitutes for each other's responsibilities.

Community and school characteristics

One reason why parents chose not to invest in educating their children might be because of the large direct and indirect costs or because of the low quality of education, implying an expected return to education being close to zero (Jensen and Nielsen, 1997). Indicators of school quality include such as the number of schools available in the community, the student-teacher ratio, the level of education of the teachers, and the availability of materials such as books, desks and blackboards in addition to water and toilets (Woldehanna, et al., 2006). If the quality of the schools available does not correspond to the parents' expectations and they see that their children are not learning what they should, this may discourage them from sending their children to school and choose to have them to work at home instead. For example, Admassu (2008) found that the quality of schools negatively affects the chance of enrollment, and that shortage of teachers and hygiene facilities such as separate toilets for males and females have a significant and negative impact on enrollment. Tansel (1998) found similar results with respect to an increase in the student-teacher ratio, which represents a decline in school quality.

Distance to school is another factor found to affect children's schooling outcomes. Long distance to school means less hours available for work, thus increasing the opportunity cost of schooling (Rose and Al-Samarrai, 2001). Results from China and Ethiopia indicates that distance to the nearest school have a negative effect on the probability of enrollment (Zhao and Glewwe, 2009; Chaudhury et al., 2006). Admassu (2008) found the same results in rural areas: children living in villages 30 to 60 minutes walking distance were 24 per cent less likely to be enrolled in school compared to those living within 30 minutes walking distance. As the distance to the nearest school exceeded one hour of walking, the probability of enrollment decreased by 47 percent. Arunatilake (2006) found similar results, but only for children less than 9 years old. A long and demanding road could also reduce the child's ability to learn in school through reduced energy level which, in combination with poor nutritional status, affects the quality of learning time. The likely important influence of nutrition on schooling achievements necessitates a closer look at this.

3.4 Nutritional status

Investment in human capital includes the investment made in a child's health and nutrition (Quisumbing, 2006). It is, unlike most investments in physical capital, more long-lived because poor nutrition and growth, both pre- and postnatal, can lead to permanent impairment of the brain which may remain until adulthood, and have adverse effects on school performance (Grantham-McGregor et al., 2007; Victoria et al., 2008). The adverse effects from child malnutrition are also often exacerbated by the increased likelihood of illness and infectious diseases (Moock and Leslie, 1986).

Stunting is often referred to as a crisis of “hidden hunger”, meaning that it is not easy to see whether a child is stunted or not. In fact, Christiaensen and Alderman (2001) found that mothers in Ethiopia were able to correctly diagnose their child as stunted only in 53.7 per cent of all cases, underlining the difficulties in detecting it, and at the same time indicating a need for better health knowledge among care givers. Furthermore, children who are stunted are not necessarily suffering from hunger but they do not get enough proteins, calories, minerals and vitamins needed for healthy growth and development, in which vitamin A, iron and iodine are found to be of particular importance (Brown and Pollitt, 1996). The lack of important nutrients is critical in periods when the body grows and develops faster and thus has a higher nutritional requirement than otherwise. A child’s first 1000 days – from conception in utero until the age of 2–3 years – is found to be the most crucial period (Martorell, 1999). This is often referred to as a “period of vulnerability” or a “window of opportunity”. Either way, it is a critical period because the damage that occurs to the brain during these years has long-term effects that are usually not recovered (Shrimpton et al., 2001). These damages include poor cognitive and motor development, behavioural problems, decreased social skills and reduced motivation, attention and learning capacity, all of which lead to increased risk of poorer educational achievements, lower physical work capacity and an increased risk of morbidity (Martorell, 1999; Mulugeta et al., 2007; Victoria et al., 2008). The consequences may thus be a vicious circle of poverty and poor health: stunted girls most likely grow up to become stunted adolescents and adults and are likely to give birth to low weight infants who grow up to be malnourished or stunted (Ramakrishan, 2004).

3.5 Health and schooling, a two-way relationship

Expenditures on health may affect the value of and the returns from education as healthy children are better able to learn, while expenditures on education may affect health through, for example, the transfer of health knowledge to future mothers, increased capability to treat and correctly diagnose child health problems and through a greater openness towards modern medicine (Appleton, 2000; Glewwe, 1999). Let me first have a closer look at the effect of health on schooling.

Health and the effect on schooling

One of the reasons why we observe high rates of failure, repetition, drop out, and out of school children in many countries may be the adverse effects of malnutrition. As these children reach school age the brain has already been adversely affected and many studies have found a deterrent effect of poor health on schooling outcomes. In fact, it is estimated that a 10 per cent increase in stunting will lead to 7.9 per cent fewer children reaching the final grade of primary school (Grantham-McGregor et al., 2007). Victoria et al. (2008) report a strong relationship between undernutrition and human capital as stunting at 2 years of age is associated with less schooling, reduced economic productivity, and lower adult height. A significant association was found between child malnutrition and poor schooling outcomes such as test scores in Vietnam (Hall et al., 2001) and late enrollment, absenteeism and drop out in the Philippines (Daniels and Adair, 2004; Mendez and Adair, 1999). Research from Nepal and China found strong associations between poor nutritional status and school outcomes such as enrollment and grade repetition (Moock and Leslie, 1986; Jamison, 1986). However, the study from China did not include any variables on the child's home environment, such as household income and parental education, possibly leading to inconsistent estimates resulting from omitted variable bias (Wooldridge, 2009). Another criticism is that many of the previous studies have failed to control for the endogenous nature of child health when estimating its effect on schooling outcomes, leading to statistical problems and bias where the true causal relation may be either larger or smaller (Behrman, 1996; Grira, 2004).

Some have tried to control for this, for example by using instrumental variables. Better child nutrition, measured by height-for-age, has been found to positively and significantly affect completed years of schooling and reduce late enrollment (Glewwe and Jacoby, 1995; Zhao and Glewwe 2009). The cost of delayed enrollment is calculated to be 6 per cent of life-time wealth due to lost post-school earnings (Glewwe and Jacoby, 1995). Grira (2004) did not find that poor health and nutrition affects school enrollment. Once being enrolled, however, she found that nutritional deficiencies substantially retard a child's school progression, possibly caused by the reduced cognitive ability. Similar to this, Glewwe et al. (1999) found that malnourished children enter school later and perform more poorly on tests.

Generally, a positive relation is found between child health and schooling outcomes, but the evidence is somewhat mixed, and also questionable in that many studies have not accounted for the endogeneity in child health and may be substantially biased. What about the effect of education on health?

Schooling and the effect on health

Parental education is often found to be a key determinant of poor child health. In a study on child malnutrition in Ethiopia, Christiaensen and Alderman (2001) find that both maternal and paternal education is associated with better nutritional status but they find that mother's education is twice as important as father's education. In another study from Ethiopia, Mekonnen et al., (2005), however, find that more educated male household members generally have less stunted children. They do not find this for female household members although their qualitative research indicate that female education was important for caregiving practices. Semba et al. (2008) find that both maternal and paternal education are strong determinants of child stunting. They find maternal education to be more important in Indonesia, while paternal education is more important in Bangladesh, implying that contextual and cultural factors such as a mother's socioeconomic status are important.

As indicated above, maternal education is often found to be of special importance regarding a child's nutritional status. Life expectancy at birth is the most common indicator of health status (Schultz, 1999), and according to a study from Nigeria reported life expectancy of children increase from 51.2 years (mothers are uneducated) to 58.5 years (mothers have some education) and finally 65.2 years (mothers have some secondary school) (Appleton, 2000). One possible explanation for this may be that mothers often are the ones responsible for food preparation and for child health care in the family (Schultz, 1999).

The two-way relationship between health and schooling may be explained as a causation running from better health to more schooling, or as a causation running from more schooling to improved health. An alternative explanation is that there is no causation but rather one or more unobserved variables causing the relationships. Such omitted variables may for example be motivation, ability or parental behavior, which affect both relationships in the same direction.

Poor health – a potential source of poverty trap

According to the Convention on the Right of the Child every child has the right to survival and to develop to the fullest (UN, 2012b). However, it is estimated that more than 200 million children under the age of 5 years do not reach their developmental potential due to poverty and poor health (Grantham-McGregor et al., 2007). Poor people may underinvest in health and nutrition compared to what is socially desirable given the extensive positive externalities likely to be concentrated among the poor and the market imperfections which constrain their actions (Behrman, 1996). The same authors have estimated that 219 million children under the age of 5 years are classified as disadvantaged, defined as being stunted plus those who are non-stunted but poor (living on less than US$1 per day). Ethiopia ranks as number five with 8 million disadvantaged children (ibid). These children will most likely grow up to be poor and are likely to carry on this poverty and poor health to their own children, thus giving rise to an intergenerational transfer of poverty. Education, however, is argued to be one of the tools to break this vicious cycle (Semba et al., 2008).

4. RESEARCH QUESTIONS AND HYPOTHESES

4.1 Research question

Based on what I have discussed in the literature review regarding factors that affect school participation, and the fact that 2.4 million children are still out of school in Ethiopia, I will seek to investigate the following:

Given the extensive effort to increase school enrollment, why are so many children still not attending school – what are the factors associated with non-participation and what is the role of nutrition?

The objective of this study is thus to examine factors that may influence the household's investment decision in education for their children. There will be a particular focus on nutrition.

4.2 Hypotheses

Children who suffer from malnutrition such as stunting are more susceptible of illness and infections. Evidently, this may lead to poor educational outcomes such as a higher probability of non-attendance. Given the importance of child health and nutrition in relation to human capital accumulation, the size of research, although increasing, has so far been limited. A child who suffers from malnutrition is likely to be adversely affected in a number of areas, included schooling. Early childhood malnutrition may cause damage to the child's brain resulting in reduced cognitive development which may reduce their learning capacity. I therefore hypothesise that:

H1: Children who are characterised as stunted, i.e. with a height-for-age z-score (HAZ) of less than –2, are less likely to attend school.

One of the reasons why children are not attending school may be their parents' need for their contribution in the household, either working with household chores such as cooking and cleaning or by doing farming activities. One factor affecting the work load for children, particularly in rural areas such as Tigray, is the amount of land owned by the household. On one hand, land is a sign of wealth and, assuming that education is a normal good, a wealthier household should lead to a higher investment in education (wealth effect). In the presence of market imperfections, however, the effect of land is ambiguous, and might even be negative as households have greater incentives to employ their own children as labor (substitution effect). In a poor farming setting like Tigray where child labor is commonly employed, this leads me to hypothesise that:

H2a: The ownership of irrigated land negatively affects the probability of school participation because of the increased demand for labor, thus increasing the opportunity cost of education.

The same logic applies for the household's livestock holding. Children are found to be engaged in animal rearing in rural Ethiopia, with an average time spent per week looking after animals at 31 hours (Haile and Haile, 2012). I therefore hypothesise that:

H2b: The size of livestock holding negatively affects the children's probability of attending school because of the need for looking after animals, thus increasing the opportunity cost of education.

In the literature review I showed that parental education is generally found to positively affect school participation, possibly due to increased awareness of the benefits of education thus spending more time helping their children with school work. I therefore hypothesise that:

H3: Children's school participation is positively affected by their parents' education level.

The probability of attending school will be affected by a number of factors, one of them being the magnitude of responsibilities for the child in the household. The number of young children is likely to increase the work load, therefore I hypothesise that:

H4a: The number of siblings below the age of six years negatively affects a child's probability of attending school.

The work load for a child may, on the other hand, be offset by the number of older household members who can act as substitutes for the child by doing some of the responsibilities.

H4b: The number of siblings 13–18 years positively affects a child's probability of attending school.

5. DATA AND METHODS

5.1 Data collection

In this thesis I will use cross-sectional data collected in June and July 2010 in Tigray. This data is part of a 5-year panel that was initiated in 1998 when 25 households were randomly selected from 16 tabias (communities) in all four zones of Tigray. Selection was based on criteria such as population density, irrigation, and distance to market (Hagos and Holden, 2006). These 400 households have since been tracked during the four following survey rounds, and the data set thus consists of information of over 2000 individuals. The collection of the data from 2003, 2006 and 2010 have been collected and organised with the help from master students at the Norwegian University of Life Sciences.

In addition I will use data collected from an individual fieldwork which took place in May and June 2011, during which I carried out interviews with teachers, NGOs, households and students in seven of the 16 tabias in Tigray. These sites were selected in collaboration with Dr. Hosaena Ghebru at Mekelle University. Dr. Ghebru also provided me with an interpreter. She performed all the interviews in the local language Tigrinya, while I was present to check the answers for errors or misunderstandings. Since information regarding households and children already was included in the 2010 follow-up survey, my main focus was to collect data on school characteristics by interviewing teachers at primary schools. However, I also conducted interviews with students and parents in order to improve my understanding of people’s values and opinions towards education and their view on everyday life in Tigray.

Before I started collecting the data a pre-testing of the questionnaires was performed in one tabia in order to check the quality of the questions and minimize the risk of misreporting accruing from bad formulations. I made sure that the respondent was alone when interviewed so that he or she was not influenced by others or felt restricted in providing their answers. I further tried to equally choose both male and female respondents as well as respondents from a wide range of age in order to avoid age and gender to influence the answers (Angelsen, et al., 2011).

5.2 Variables

Outcome variable

The outcome variable in this paper is current school participation, which is a binary variable taking the value 1 if school is reported as the child's main occupation, and 0 if otherwise. As noted by Glick and Sahn (2000), modelling current school participation has advantages as compared to modelling grade attainment because the former allows for current school decisions to be related to current household aspects.

I restrict the analysis to households with children aged 6 to 18 years. The official age of school entry in Ethiopia is seven years, but knowing that many children might start even earlier I will add one year. Similarly, students following a normal study progression should finish primary school when they are 14 years old. Taking into account the high rate of delayed school entry and relatively high rate of grade repetition, another four years are added and I restrict the upper age to 18 years.

Construction of new variable

Some new variables have been constructed on the basis of what is outlined in the literature review and in the hypotheses.

Height-for-age z-score (HAZ)

Height-for-age z-scores were constructed by using the 2007 WHO reference data which allows to compute the height-for age z-score for children aged 5-19 years.

The formula is:

$$z_i = (Y_i^{s,a} - H^{s,a}) / \sigma^{s,a}, \qquad (2)$$

where z_i is the height-for-age z-score for child *i*; $Y_i^{s,a}$ is the height of child *i* with sex *s* and age *a*; $H^{s,a}$ is the median height of children with sex *s* and age *a* in the reference population; and $\sigma^{s,a}$ is the standard deviation in height for children of sex *s* and age *a* in the reference population.

Height and standard deviation in the reference population are divided into 12 different numbers for each age. For example for the age of six, height and standard deviation are reported for all 12 months. Since I only have data on the child's age in years and not in months, I calculated the z-score using the average of the height and standard deviation for each age.

A child with HAZ< –3 is categorised as "severely stunted", and those with HAZ<– 2 are categorized as "stunted".

5.3 Descriptive statistics

Data from 2010 survey

Before proceeding with the analysis it will be useful to highlight some characteristics about the children and their households in the sample. After dropping outliers and individuals with missing answers, the data set consist of information of 933 children. Dropping observations due to missing information could possibly lead to biased estimations. As mentioned, data collection was performed by local enumerators with the help from Norwegian master students. One disadvantage of this is that their experience in the field might have been small or none. Another is the risk of low quality perhaps due to low motivation among the enumerators. Most likely these missing data have therefore occurred due to personal mistakes by the enumerators, hence I consider them to be random and therefore not affecting the average value of the estimate (Angelsen, et al., 2011).

Tables 5.1 and 5.2 below report some descriptive statistics and some factors are worth noting from these tables. The illiteracy rate at almost 70 per cent among household heads is very high, only 11 per cent has education from elementary school (1^{st} – 6^{th} grade) and almost nobody has any education above that (2 per cent). While the average distance to primary school is only around 30 minutes, the average distance to secondary school is almost 110 minutes. Average age of the children is just above 12 years, and 66 per cent of them are attending school. More than 50 per cent are characterized as stunted in that their height-for-age z-score falls below –2, the number for boys and girls are 57 per cent and 47 per cent, respectively.

Table 5-1: Descriptive statistics of households where the child is between 6–18 years

Variable	Observations	Mean	Std. Dev.	Min	Max
Household size	933	6.44	1.95	2	11
Gender of household head (1=male)	933	1.20	0.40	1	2
Age of household head	924	52.26	12.59	20	100
Education of household head	933	1.67	1.15	1	7
None/illiterate	933	0.69	0.46	0	1
Religious/adult literacy programme	933	0.18	0.38	0	1
Elementary school (1-6th grade)	933	0.11	0.31	0	1
Above elementary (Above 7th grade)	933	0.02	0.14	0	1
Children below 6 years	933	0.75	0.81	0	3
Boys between 13–18 years	933	0.73	0.78	0	3
Girls between 13–18 years	933	0.67	0.73	0	3
Youth 19–24 years	933	0.58	0.74	0	4
Adults 25–60 years	933	1.66	0.74	0	4
Tropical livestock units	933	3.67	3.02	0	19
Farm size (tsimdi^)	933	5.01	3.85	0.25	27.5
Own irrigated plot (dummy)	933	0.31	0.46	0	1
Off-farm income (dummy)	933	0.40	0.49	0	1
Distance to primary school (minutes)	933	31.45	23.44	3	180
Distance to secondary school (minutes)	933	109.98	80.48	1	420
Distance to health centre (minutes)	933	44	35.58	2	210
Height of head of household	803	164.08	7.65	130	180

^1 tsimdi=0,25 hectares

Table 5-2: Individual characteristics of boys and girls 6–18 years[1]

Variables	Observations	Mean	Std. Dev.	Min	Max
Children aged 6–18 years					
Student (1=yes)	933	0.66	0.47	0	1
Age	933	12.11	3.68	6	18
Gender (1=male)	933	0.50	0.50	0	1
Height-for-age z-score (HAZ)	723	-2.05	1.79	-5.99	5.82
Stunting (HAZ<–2)	723	0.52	0.50	0	1
Boys aged 6–18 years					
Student (1=yes)	464	0.65	0.48	0	1
Age	464	12.20	3.69	6	18
Height-for-age z-score (HAZ)	350	-2.14	1.78	-5.99	5.04
Stunting (HAZ<–2)	350	0.57	0.50	0	1
Girls aged 6 – 18 years					
Student (1=yes)	469	0.67	0.47	0	1
Age	469	12.02	3.67	6	18
Height-for-age z-score (HAZ)	373	-1.97	1.80	-5.61	5.82
Stunting (HAZ<–2)	373	0.47	0.50	0	1

[1] As there were many missing values for either height or weight in the data, the number of observations for HAZ is smaller than the others.

Before proceeding with the analyses I will take a closer look at some of the variables in the data set. Figure 5.1 reports school participation separately for boys and girls aged between 6 and 18 years.

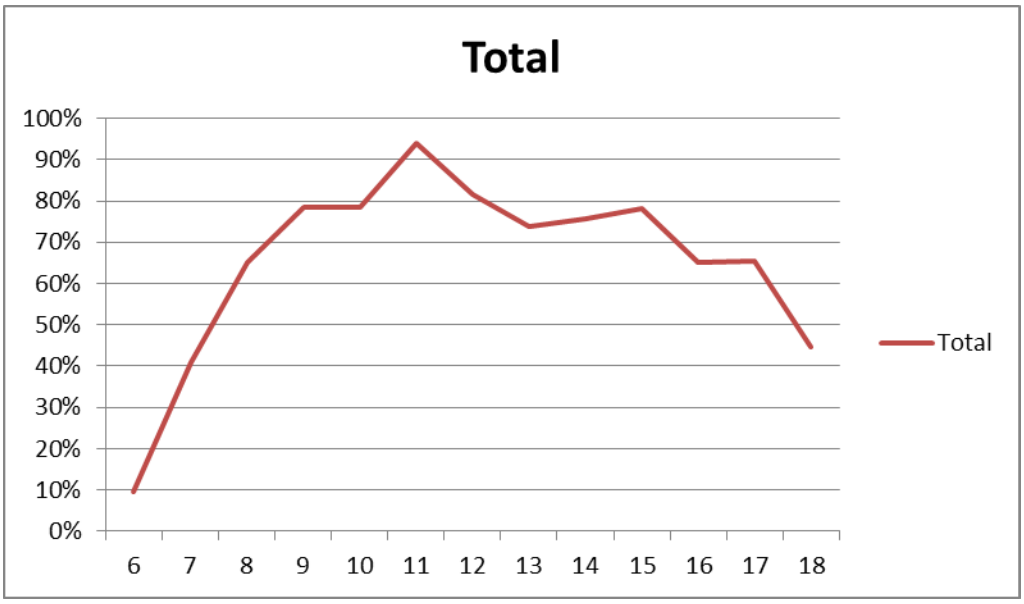


Figure 5-1: School participation by age

Figure 5-2: School participation by gender and age

As can be seen from figure 5.1, school participation steadily increases from age six to age eleven, with an exception from age nine to age ten where it is stable. Participation peaks at age eleven after which it decreases towards the age of eighteen, except a small increase from age thirteen to age fifteen. The greatest number of students is found between the age of nine and fifteen years.

Some gender differences can be seen from figure 5.2. For children aged 6–18 years girls have on average a higher school attendance, 67 per cent vs. 65 per cent, the exception being at age six, fifteen and eighteen, where boys have a higher attendance. After the age of eleven girls' participation rate falls gradually with a sharp fall from age seventeen to age eighteen. Boys experience a sharp drop from age eleven to age thirteen followed by an increase to age fifteen, after which the boys' attendance rate falls gradually. The largest gender gap is found at age thirteen where the participation rate is more than 20 per cent higher for girls.

These findings fall in line with Tigray being a region in Ethiopia with high gender equality in education. School participation is high even among children above the age of fourteen, which marks the end of primary school if we assume that children do not repeat any classes. However, this does not mean that these adolescents are attending secondary school. Only about 5.5 per cent of the children above 14 years are in grades above primary school, indicating a high degree of late entries or grade repetitions.

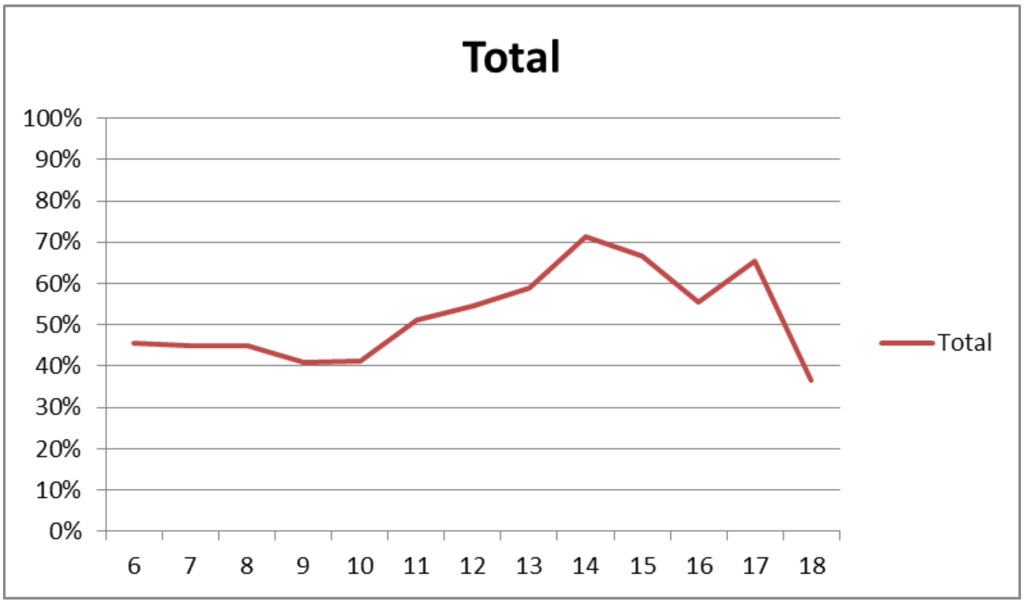


Figure 5-3: Stunting (HAZ<-2) by age

Figure 5-4: Stunting (HAZ<-2) by gender and age

Taking a closer look at the prevalence of stunted children aged 6–18 years, figures 5.3 and 5.4 show a picture of extremely high values and important gender differences. The total share of stunted children aged 6–18 years is 52 per cent, while the share for boys and girls are 57 per cent and 47 per cent, respectively. The prevalence is stable from six to ten years after which it increases and peaks at fourteen years with a rate of 72 per cent. After that it decreases, except a new peak at seventeen years, towards 38 per cent at the age of eighteen.

Until the age of twelve girls are more stunted than boys with a gender gap of 25 per cent at the age of ten. After that, the prevalence increases drastically for boys and stabilizes at more than 80 per cent at the age of fourteen to seventeen years, after which it decreases. Girls have a more stable prevalence at around 50 per cent except falls at the age of nine, sixteen and eighteen.

Data from personal field work

In total 30 teachers, 23 students, and 18 heads of households from seven different tabias were interviewed during my fieldwork in 2011. In addition, four development organisations and one regional office engaged in the field of education were interviewed before starting the fieldwork. This provided me with valuable background information about the topic and good knowledge regarding the field sites. Two of these organisations where located in Addis Abeba; Plan and Save the Children, the other three were located in Mekelle; Relief Society of Tigray, Tigray Development Association and Mekelle Education Office.

Teachers

The average age of the teachers in my sample was 30 years with an average teacher experience of 11 years. 77 per cent of them were male and only 23 per cent were female, which differs from the 2009/10 country average of female teachers of 37.1 per cent (MoE, 2011). Average class size in the sample was 54 students per teacher.

Households

Heads of household were interviewed when possible, otherwise one of the parents. Average age was 42 years and 53 per cent being male while 47 per cent was female. The average education level of the parents was low, consisting of 2 years and 2.5 years of primary education for the mother and father, respectively. The most cited occupation was farmer (59%) and household wife (18%), and the average number of children was 3.8 per household.

Almost 90 per cent reported that their children were doing some sort of work, with average working time per week at 17 hours. Most commonly reported work activities were fetching water, herding animals, collecting firewood and any kind of in-door house work.

Students

Average age of the students interviewed was 12.7 years, 61 per cent of them male and 39 per cent female. Only two thirds of the children in the sample started school on time, and the average grade attained was 5th grade. Average distance to school was 31.5 minutes. All the 23 students reported that they were working, and the average working time per week was 16.5 hours.

5.4 Data weakness and limitations

This thesis rests to a large extent on the primary data that was collected by master students in 2010. As is often the case, the data is of varying quality. First of all, there is a problem of missing data and errors in the reported data. This resulted in extreme values in some of the variables, like height and weight, for example, measures being used to construct HAZ. The extreme outliers were dropped in line with the WHO recommendation cutoff points (WHO, 2006) in order to avoid misleading results. Some of the individuals also had to be dropped because of missing information in some of the key variables. Most likely this measurement error has occurred randomly, so that the exclusion will not affect the estimates. It is, however something to have in mind when interpreting the results. Secondly, education and nutrition was not of specific focus during the data collection which leaves me with varying quality and lack of valuable information. The choice of dependent variable, for example, is limited to current school participation, which only gives a rough estimate of the child’s schooling outcome. This represents a weakness in the study, since it assumes that past choices are not relevant and thus fails to account for the cumulative nature of a child’s education (Glick and Sahn, 2000). Ideally, I would have had data on such as age of enrollment, grade repetition and dropout, as these have been found to be an increasing problem in Ethiopia. Particularly when examining the role of child health and nutrition, which has been found to adversely affect the age of enrollment and the progression in school (Grira, 2004).

Acknowledging the lack of school characteristics in the data I did collect some information of this kind during my own field work. Being valuable both as an experience and as additional information for the thesis, conducting an individual fieldwork in Tigray also offered various challenges.

Because of practical reasons I collected the data during the summer of 2011, and in some places this coincided with school holiday in Ethiopia. It was possible for me to visit some schools in order to assess the condition of the facilities and interview some teachers, but at some schools the teachers had already left since they were not originally living in that specific community. Another limitation for me was the challenge associated with language, and I needed an interpreter whom I could trust and work well with. I was lucky and was assigned with a highly professional interpreter with several years of experience as an enumerator in the area. However, valuable information may have been lost during the translations. Many of the respondents, especially the teachers, had a lot of information they wanted to share and tended to speak for several minutes, which was then written in one or two sentences by the translator. Despite her professionalism, this might have been caused by her limitations in English language.

Before the fieldwork I had made contact with Save the Children and Plan, both long active in carrying out development projects in Ethiopia. This gave me the opportunity to meet with them and discuss issues related to education when I was in Addis Abeba. I also met three other NGOs in Mekelle. However, I regret not having discussed issues like health and nutrition with organisations present in Ethiopia, which would have provided me with a better understanding of this. The reason for this was that these issues were not the focus of the research at that time.

It was not possible for me to carry out interviews with a large enough number of individuals to constitute a statistically representative sample, both because of time and resource constraints. However, I believe that some qualitative data is of great value in order to examine such questions as I have risen, in addition to the quantitative data already collected in the area.

5.5 Econometric challenges

Establishing relations of health and nutrition on schooling achievements is difficult (Behrman, 1996). Many studies have found that poor child health and nutrition are associated with educational outcomes such as lower test scores, late enrollment, higher repetition and dropout rates, and consequently fewer years in school. Others have found that this translates into lower productivity and income in the future and that it further has consequences for overall economic achievement for a country (Hoddinott et al., 2008; Mankiw et al., 1992). In fact, half of the economic growth in western Europe in the past two centuries has been argued to come from the marked improvement in health and nutrition and the subsequent gains in height (Fogel, 1994). However, and as I explicitly pointed out in the literature review; an association does not necessarily indicate causality.

There are many obstacles in obtaining credible estimates on this issue, such as the limited data available, omitted variables and measurement errors (Behrman, 1996; Glewwe and Miguel, 2008). Many decisions regarding child health and schooling are made by individuals who base their choices on characteristics that are unobserved (to the researcher) such as innate ability, preferences and motivation (Behrman, 1996). Estimating relations with endogenous variables, meaning variables that are influenced by household behavior and thus being correlated with the error term in the equation (Glewwe and Miguel, 2008), and failing to control for these, may have caused many of the associations previously found in the literature to be substantially biased, either upward or downward, and the true causal relation may therefore be very different (Alderman et al., 2001; Behrman, 1996; Glewwe and Jacoby, 1996). Trying to control for these problems, Alderman et al. (2001) found that child health is actually three times as important for enrollment as found by studies that fail to control for this endogeneity, which they characterize as “naïve estimates”.

Similar problems may also arise in non-health variables, for example measurement error with respect to income, failing to account for important factors leading to omitted variable bias or unobserved household or individual characteristics such as parental taste or preferences.

In the absence of a randomized evaluation, which is regarded as the best way of solving many of the above mentioned difficulties (Behrman, 1996) instrumental variables become a likely method of controlling for endogeneity in the explanatory variables. In the matter of child health and schooling, such variables should be correlated with the endogenous variable (child health) but it should not directly influence schooling behavior after controlling for health (Glewwe and Miguel, 2008). That is, it should not suffer from the same problem as the endogenous variable. One limitation of this approach is that finding good instruments is often difficult (ibid). However, some variables have been used, such as food prices (Alderman et al., 2001; Zhao and Glewwe, 2009), distance to health facilities (Grira, 2004; Glewwe and Jacoby, 1995), parental height (Glewwe and Jacoby, 1995), weight at birth (Zhao and Glewwe, 2009), and older siblings’ height-for-age in the first two years of life (Glewwe et al., 2001). Most of them find a significant and positive effect of child health and nutrition on schooling, and the results also show that OLS often produce a downward bias when estimating the effect of child health on schooling.

5.6 Methods

The dependent variable, school participation, is a binary variable taking the value 1 if the child is attending school and 0 otherwise. Several models are available for this analysis, they all have advantages and disadvantages, and it is not always obvious which model is the best for each effect of interest. I will therefore apply some of them and compare the results. The methods that will be used are the instrumental variable linear probability model (LPM), the instrumental variable probit model, a recursive bivariate probit model and a semiparametric recursive bivariate probit model. For the first two, instrumental variables (IV) are employed to identify the endogenous regressor child height-for-age z-score. The first three will be implemented using STATA, with the commands “ivregress 2sls” for LPM, and “ivprobit” and “biprobit” for the IV probit and recursive bivariate probit model, respectively. In all three of them the option “cluster” (by household id) will be used in order to account for unobserved inter-household differences. The last model, semiparametric recursive binary probit model, will be implemented using the software package R.

IV linear probability model (LPM)

It has generally been said that linear models should not be used when the dependent variable is binary. Others, e.g., Angrist and Pischke (2009), argue that using a linear probability model (LPM) in such a case has many advantages and may as well be the preferred method. The LPM is linear in the parameters and is estimated by OLS. The estimates are interpreted as probability of success (i.e. y = 1), given a one unit increase in one of the independent variables (Wooldridge, 2009):

$$\Delta P(y = 1|\mathbf{x}) = \beta_j \Delta x_j \tag{4}$$

LPM is easy to estimate and interpret, and it is a useful and widely applied method. However, it also has some drawbacks. The most important are that it can produce predicted probabilities less than or greater than zero, it contains heteroskedasticity, and it assumes constant marginal effects (ibid). The limitation of constant marginal effects is however not substantial, since I am interested in the marginal effects at the mean.

Probit model

A probit model has been advocated as the preferred method when the dependent variable is dichotomous (Schaffner, 2004), as it avoids some of the mentioned limitations of the LPM. Instead of estimating a linear model, the probit estimates the probability of a function:

$$P(y = 1|\mathbf{x}) = G(\beta_0 + \mathbf{x}\,\boldsymbol{\beta}) \tag{5}$$

where G(z) is the standard normal cumulative distribution function (cdf). As opposed to the LPM, the fitted probabilities of school participation are now between zero and one: $0 < G(z) < 1$, and the partial effects are diminishing rather than constant (Wooldridge, 2009). Estimation is done using maximum likelihood estimation (MLE), and the model can be specified as follows:

$$PARTICIPATION^*_i = x_i\beta + \varepsilon_i\ ,\ i = 1. \ldots,n \tag{6}$$
$$PARTICIPATION_i = 1 \text{ if } PARTICIPATION^*_I > 0$$
$$PARTICIPATION_i = 0 \text{ if otherwise}$$
$$E \sim N(0, 1)$$

where $PARTICIPATION_i$ is the binary indicator of school participation, which is determined by $PARTICIPATION^*_i$. X are containing the independent variables such as child personal characteristics, household characteristics, and community characteristics; β is the coefficients to be estimated; and ε_i is the error term.

One of the disadvantages of the probit model is that it is more difficult to interpret. The coefficients only serve as indicators for the direction of the effect of each of the independent variables. However, the marginal effects are easy to calculate and will thus be provided in order to easily compare and interpret the results. The marginal effects show the impact of increasing one of the independent variables by one unit on the probability that the child is currently attending school (Schaffner, 2004).

Instrumental variables and identification strategy

The variable of most interest, the child's height-for-age z-score, is endogenous, so instrumental variables will be applied for the two above mentioned methods in order to control for this. One variable is used as instrument, namely the height of the head of household, while household size is added as an additional instrument to perform a test of validity. Height of the parents has been used by others to instrument child health, for example by Glewwe and Jacoby (1995). The argument is that parental height is a strong predictor for child height and that genetic endowments captured by parental height has a strong influence on the child's health as disease susceptibility is genetically transferred (ibid).

The effect of household size has been a matter of discussion for economists for a long time. The quantity quality trade-off model developed by Becker (1960) and Becker and Lewis (1973) has been used to analyse the effect of family size (quantity) on child outcomes (quality), such as child health. One theory which assumes a positive effect is the hygiene hypothesis, which says that children in smaller families are less exposed to disease due to the smaller degree of interaction with other children (Strachan, 1989). Children in larger families have thus developed a better immune system and are less susceptible to disease. Studies have confirmed this positive effect, e.g., Peters et al. (2012).

However, the validity of these instruments is a concern, and according to Berkowitz et al. (2008), "nearly exogenous instruments" are likely to give unreliable inference. Height of the head of household might affect the labor productivity (Schultz, 2002), thereby affecting household income and the ability to invest in schooling, thus potentially violating the exclusion restriction (i.e., making the instrument invalid). In the case of family size, this might as well be an invalid instrument. Assume that the household chooses between child labor and schooling. The number of children in the household will then affect the consumption needs in the family (demand for child labor), while the number of adults will affect the labor supply and thus would lower the need for child labor (if adult and child labor would be supplementary) or increase it (if complements) (Basu and Van, 1998). Tests of the strength and validity of the instruments will be performed.

In the light of the identification problems given the concerns about instrument validity possibly leading to misleading inferences, the bivariate probit model (see e.g. Maddala, 1983) is also estimated. Since the bivariate probit model is identified from functional form without the need for instrumental variables, this will help to assess the robustness of the estimates of the effect of child nutritional status, as measured by height-for-age z-score, on school participation.

(Semiparametric) recursive bivariate probit model

The recursive bivariate probit model is an increasingly adopted method and is appropriate with an endogenous binary variable that is simultaneously determined with the dependent binary variable (Monfardini and Radice, 2008). This method therefore requires the endogenous regressor to be binary; to that end the child's height-for-age z-score (HAZ) is converted into a binary variable taking the value 1 if the child is stunted (i.e., HAZ<–2) and 0 if otherwise. This is a drawback in that potentially important information will be lost when binarizing a continuous variable: mostly the effects near the cutoff will be captured, so it will be less informative about what happens at the tails of the HAZ distribution. Even though we will lose some information by doing this, estimating the recursive bivariate probit models in addition to the IV models is likely to increase the robustness of the findings due to the previous mentioned validity concerns of the IV models. It is better to lose some information and have an identified model rather than use a model that is not identified. In addition, the height-for-age cutoff at –2 as a measure of stunting is the most common cutoff in the public health literature and recommended by the World Health Organisation (WHO, 2006).

Exclusion restrictions are not needed to obtain identification in the recursive bivariate probit model (Wilde, 2000): "Wilde (2000) shows that identification [in a bivariate probit model] is achieved as soon as both equations of the model contains a varying exogenous regressor" (as cited in Monfardini and Radice, 2008).

The model consists of one equation where the binary endogenous regressor is the dependent variable, Y_2, and one equation where this endogenous regressor is included as an explanatory variable to explain the outcome of interest, Y_1. In its simplest form, the model can be specified as follows:

$$
\begin{aligned}
Y_1 &= \beta_0 + \delta Y_2 + \sum_{k=1}^{K} \beta_k X_k + u_1 \\
Y_2 &= \gamma_0 + \alpha_l X_1 + \sum_{l=1}^{L} \gamma_l X_l + u_2
\end{aligned}
\tag{7}
$$

where Y_1 is the binary variable "school participation", and Y_2 is the binary variable "stunting"; X_k are the exogenous regressors in the outcome equation; X_l are the exogenous regressors in the selection equation; u_1 and u_2 are the bivariate normally distributed error terms.

Similarly, the semiparametric recursive bivariate probit model will be applied. The semiparametric recursive bivariate probit model is the bivariate recursive probit model with the beta's for the continuous variables replaced by functions; $f(X_k)$ instead of $\beta_k X_k$, and where X_1 and X_2 (see below) are vectors of parametric model components, i.e. categorical and dummy variables (Marra and Radice, 2011):

$$\begin{aligned} Y_1 &= \beta_0 + \delta Y_2 + \alpha_k X_1 + \sum_{k=1}^{K} f(X_k) + u_1 \\ Y_2 &= \gamma_0 + \alpha_l X_2 + \sum_{l=1}^{L} f(X_l) + u_2 \end{aligned} \tag{8}$$

Hence, this method does not impose linearity on the continuous covariates, as opposed to the recursive bivariate probit model, but estimates the continuous covariates as smooth functions (ibid). Imposing linearity when in fact effects are nonlinear can result in large biases and even cause the estimates to have the wrong sign (Achen, 2005). The assumptions are less restrictive than in the classic recursive bivariate probit model, and this model might add some trust and robustness to the results. The model will be implemented using SemiParBIVProbit (Marra and Radice, 2012) in the software package R.

6. RESULTS AND DISCUSSION

6.1 Results

The results are reported for all children using four different models. The two IV models and the two recursive bivariate probit models are presented in table 6.1 and 6.2, respectively, using height of head of household as an instrument in the IV models. The results from all four models are presented together in table 6.3. Marginal effects from the first three models are provided, while average treatment effect is provided for the semiparametric recursive bivariate probit model.

It should be noted that some assumptions about the instruments have to be met for the results to be consistent. They should not be weak, meaning that the correlation between the instrument and the endogenous regressor should not be below a certain limit. As a rule of thumb, the F-test of joint significance should exceed 10 to be called a strong instrument. In this case the F-value exceeds 22, so the hypothesis of weak instrument is rejected. A test of whether there was a problem of endogeneity in the first place can also be performed. The hypothesis is exogeneity, which is rejected in this case with a p-value of 0.07, meaning that the child's height-for-age z-score is indeed endogenous.

The most important test, however, relates to instrumental validity, telling us if the results from IV LPM and IV probit can be trusted. For the instrument to be valid, it should not be correlated with the error term in the outcome equation. In order to perform the test of instrument validity, however, one needs to have more instruments than endogenous regressors, in which case the model is overidentified (Wooldridge, 2009). Therefore, household size is added as an instrument in addition to height of head of household in order to perform this test. With a p-value above 0.9, the test fails to reject the hypothesis of overidentifying restriction, hence the instruments are valid. The result from using this additional instrument is more or less identical compared to that where only height of head of household is used (see Appendix A). The fact that the estimates coincide when using one or two instruments indicates that they are robust and their reliability therefore increases.

Table 6-1: Factors affecting school participation, IV-LPM and IV-PROBIT*

Variables	IV-LPM	IV-PROBIT
Height-for-age z-score (HAZ)	**-0.098***	**-0.095****
	(0.052)	(0.043)
Child's age	0.004	0.004
	(0.008)	(0.007)
Child's gender (1=male)	-0.033	-0.036
	(0.042)	(0.039)
Education of household head	**0.066*****	**0.071*****
	(0.016)	(0.018)
Distance to primary school	0.001	0.001
	(0.001)	(0.001)
Distance to secondary school	**-0.001****	**-0.001****
	(0.000)	(0.000)
Farm size (tsimdi^)	0.005	0.005
	(0.006)	(0.006)
Own irrigated land (dummy)	**-0.077***	-0.074
	(0.046)	(0.046)
Tropical livestock units	-0.013	-0.014
	(0.009)	(0.009)
Off-farm income (dummy)	0.055	0.056
	(0.043)	(0.042)
Children below 6 years	-0.013	-0.014
	(0.028)	(0.027)
Boys between 13–18 years	0.026	0.024
	(0.028)	(0.028)
Girls between 13–18 years	-0.007	-0.005
	(0.033)	(0.032)
Youth 19–24 years	-0.024	-0.024
	(0.031)	(0.030)
Adults 25–60 years	0.018	0.017
	(0.031)	(0.031)
Observations	662	662

Standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01 ^1 tsimdi=0,25 hectares, * Variable used as instrument for HAZ is height of head of household

Even though the instruments turn out to be strong predictors for HAZ, and valid in that they do not belong in the initial model, some concerns may still be raised regarding the IV approach: The fact that the instruments pass the Sargan overidentifying restrictions test does not imply that the instruments are valid. The Sargan test has zero power against certain alternatives and low power against many alternatives. For instance, the test has zero power when the errors of the two equations are bivariate normally distributed, as is assumed in ivregress and ivprobit (Small, 2007). Furthermore, Dahlberg et al. (2008:1) concluded in the context of dynamic panel data models that "in the very likely case of measurement errors in either the dependent or any of the independent variables, we will, if we rely on the Sargan test quite likely accept a misspecified model and end up with biased results."

Due to this concern, I seek to increase the robustness of the results by relying on different identification strategies: Firstly by instrumentation: instrumental variables linear probability model and instrumental variables probit model, and secondly by functional form: recursive bivariate probit model and semiparametric recursive bivariate probit model. None of the models used in this paper are without limitations. I have therefore used different identification strategies to see how the results change when changing the identification assumptions.

The results from the two recursive bivariate probit models can be seen in table 6.2. Since the recursive bivariate probit model is just a probit model with an extra equation for the endogenous binary variable, the model imposes linearity on the continuous covariates. The semiparametric recursive bivariate probit model, on the other hand, does not impose linearity on the continuous covariates. The 95% confidence interval for the continuous covariates can be plotted in R, see figures 6.1–6.3. By looking at these graphs, we might suspect that some of the covariates, such as age, distance to secondary school, and farm size are indeed non-linear. It is therefore reasonable that the semiparametric recursive probit model might be closer to the truth than the simple recursive bivariate probit model.

Table 6-2: Factors affecting school participation, BIPROBIT and SP-BIPROBIT[2]

Variables	**BIPROBIT**	**SP-BIPROBIT**
Stunting (dummy)	**0.369***	**0.478***
	(0.120)	(0.091)
Child's age	0.008	n.a
	(0.006)	n.a.
Child's gender (1=male)	**-0.070**	**-0.068**
	(0.041)	(0.101)
Education of household head	**0.066***	n.a
	(0.017)	n.a.
Distance to primary school	0.001	n.a
	(0.001)	n.a.
Distance to secondary school	**-0.001**	n.a.
	(0.000)	n.a.
Farm size (tsimdi^)	0.003	n.a.
	(0.005)	n.a.
Own irrigated land (dummy)	-0.066	-0.050
	(0.045)	(0.109)
Tropical livestock units	-0.013	n.a
	(0.009)	n.a.
Off-farm income (dummy)	0.031	0.022
	(0.038)	(0.065)
Children below 6 years	-0.023	n.a
	(0.024)	n.a.
Boys between 13–18 years	0.012	n.a.
	(0.025)	n.a.
Girls between 13–18 years	-0.036	n.a.
	(0.027)	n.a.
Youth 19–24 years	-0.028	n.a
	(0.026)	n.a.
Adults 25–60 years	0.038	n.a
	(0.026)	n.a.
Observations	662	662

Standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01, ^1 tsimdi=0,25 hectares..

[2] Regressors used for childstunting in both biprobit and sp-biprobit: age, gender, height of household head, household size, TLUcurrent, own irrigated land (dummy) and landarea

Figure 6-1: Plot of child's age on school participation

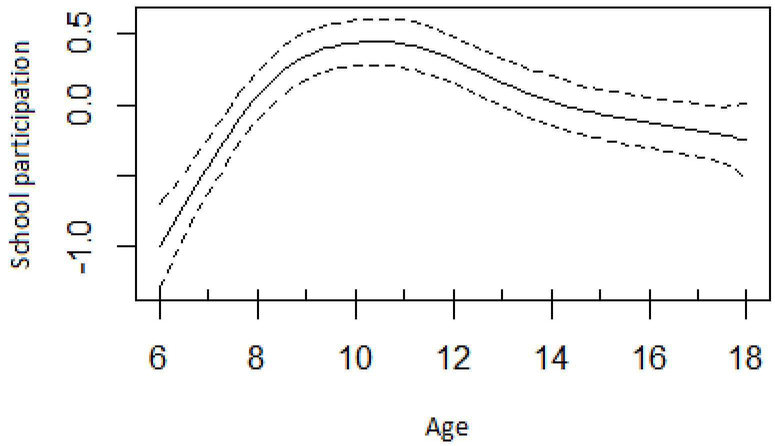


Figure 6-2: Plot of distance to secondary school on school participation

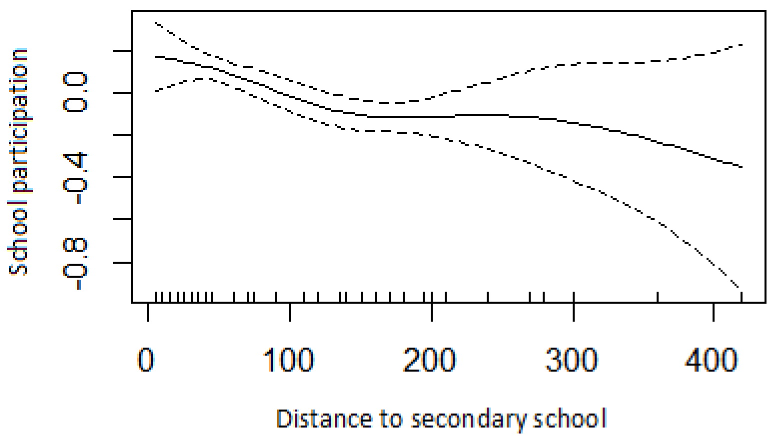


Figure 6-3: Plot of farm size on school participation

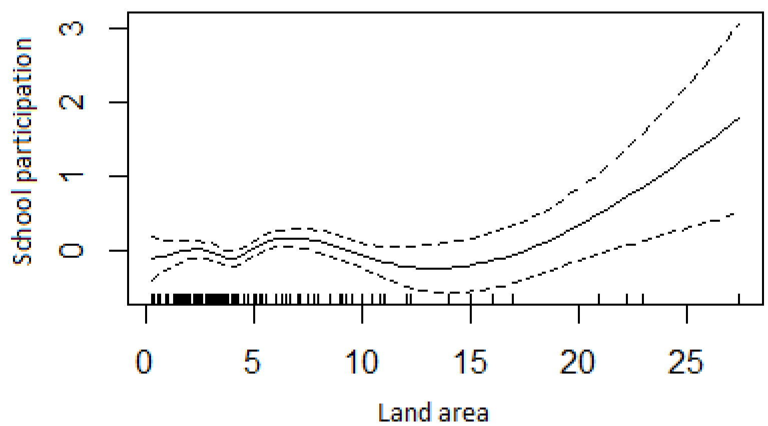


Table 6-3: Factors affecting school participation – all four models

Variables	IV-LPM	IV-PROBIT	BIPROBIT	SP-BIPROBIT
Stunting (dummy)	n.a	n.a	**0.369*****	**0.478*****
	n.a.	n.a.	(0.120)	(0.091)
Height-for-age z-score (HAZ)	**-0.098***	**-0.095****	n.a.	n.a
	(0.052)	(0.043)	n.a.	n.a.
Child's age	0.004	0.004	0.008	n.a
	(0.008)	(0.007)	(0.006)	n.a.
Child's gender (1=male)	-0.033	-0.036	**-0.070***	**-0.068****
	(0.042)	(0.039)	(0.041)	(0.101)
Education of household head	**0.066*****	**0.071*****	**0.066*****	n.a
	(0.016)	(0.018)	(0.017)	n.a.
Distance to primary school	0.001	0.001	0.001	n.a
	(0.001)	(0.001)	(0.001)	n.a.
Distance to secondary school	**-0.001****	**-0.001****	**-0.001****	n.a.
	(0.000)	(0.000)	(0.000)	n.a.
Farm size (tsimdi^)	0.005	0.005	0.003	n.a.
	(0.006)	(0.006)	(0.005)	n.a.
Own irrigated land (dummy)	**-0.077***	-0.074	-0.066	-0.050
	(0.046)	(0.046)	(0.045)	(0.109)
Tropical livestock units	-0.013	-0.014	-0.013	n.a
	(0.009)	(0.009)	(0.009)	n.a.
Off-farm income (dummy)	0.055	0.056	0.031	0.022
	(0.043)	(0.042)	(0.038)	(0.065)
Children below 6 years	-0.013	-0.014	-0.023	n.a
	(0.028)	(0.027)	(0.024)	n.a.
Boys between 13–18 years	0.026	0.024	0.012	n.a.
	(0.028)	(0.028)	(0.025)	n.a.
Girls between 13–18 years	-0.007	-0.005	-0.036	n.a.
	(0.033)	(0.032)	(0.027)	n.a.
Youth 19–24 years	-0.024	-0.024	-0.028	n.a
	(0.031)	(0.030)	(0.026)	n.a.
Adults 25–60 years	0.018	0.017	0.038	n.a
	(0.031)	(0.031)	(0.026)	n.a.
Observations	662	662	662	662

Standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01, ^1 tsimdi=0,25 hectares

As we see from tables 6.2, 6.3 and 6.4 above, coefficients and standard errors from the semiparametric recursive bivariate probit model are only presented for the binary regressors. However, some of the continuous covariates are significant as well. These can be seen in table 6.4 below with reported p-values.

Table 6-4: Significant continuous covariates in SP-BIPROBIT

Variables	p–value
Age	0.000***
Education of household head	0.000***
Youth 19–24 years	0.007***
Siblings below 6 years	0.010**
Distance to secondary school	0.013**
Farm size	0.033**
Tropical livestock units	0.070*
Nonsignificant continuous covariates in SP-BIPROBIT	
Adults 25–60 years	0.141
Distance to primary school	0.143
Boys between 13–18 years	0.207
Girls between 13–18 years	0.494

6.2 Discussion

In **H1** I hypothesized that children who are characterized as stunted, i.e. with a height-for-age z-score below –2, are less likely to attend school. Surprisingly, this is rejected in all four models. The regression coefficient is significant and negative in the two instrumental variable models, meaning that a lower HAZ positively affects the probability of attending school. In the two recursive bivariate models the binary variable stunting is positive and the function estimate is significant, meaning that a stunted child has a higher probability of participating than a non-stunted child. The regression coefficient is significant at 10% and 5% in the IV LPM and IV probit models, respectively, and the function estimate is significant at 1% in the two recursive bivariate probit models.

One explanation for this might be that in terms of labor productivity, a stunted child, who is most likely weaker than a non-stunted child, is less worth at the farm: the opportunity cost of schooling decreases with worse nutritional status, since malnutrition adversely affects child labor productivity. Parents therefore choose to send them to school and prefer to keep the healthy children engaged in farm activities, such as herding animals. The finding might also indicate that parents compensate unhealthy children by investing in their education

When teachers were asked if they thought they had a high dropout rate in their classes, 61 per cent of them said yes. When asked why they thought so many children were leaving school, the most reported reasons were that parents did not see the benefits of education (30%) and that there was a need for child labor (27%). This indicates that many parents are still not fully aware of the benefits of education and if they have to choose which child to withdraw from school, they most likely choose the child with highest labor productivity. When conducting interviews with development organisations in Tigray, the lack of awareness among parents regarding the benefits of education, and the expectation that their children should contribute at home, was highlighted. As one of the respondents said: “Farming is their life and will continue to be – so why go to school?”

This finding may also be seen in relation to the hypotheses postulated in **H2a** and **H2b**, which stated that the ownership of irrigated land and the size of livestock holding negatively affect the probability of attending school due to the increase in child responsibilities and thereby a higher opportunity cost of schooling. Both of them have negative coefficients throughout the four models, but they are not, however, significant in all of them. The regression coefficient of ownership of irrigated land is significant at 10% in the IV LPM model, whereas the function estimate for amount of livestock units is significant at 10% in the semiparametric recursive bivariate probit model. This indicates, at least to some degree, that ownership of irrigated land and a higher amount of livestock holding leads to an increase in child responsibilities which is deterrent for their schooling, assuming that households chooses between schooling and child labor. This negative relation suggests that ownership of irrigated land and the amount of livestock holding are complementary with child labor, rather than substitutes, lending support to the previous mentioned “wealth paradox”.

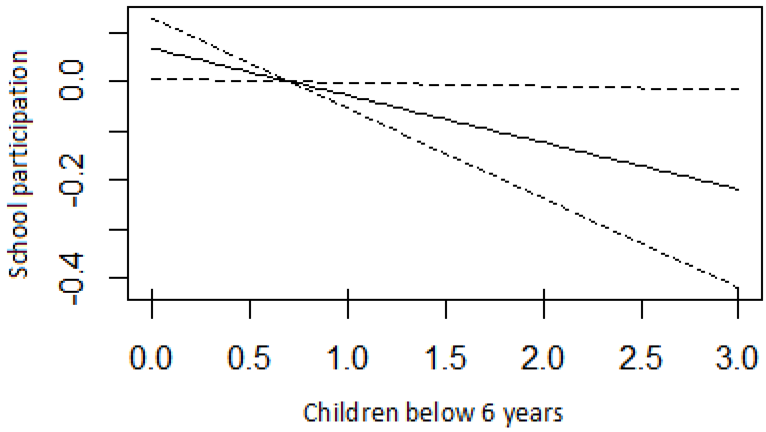
This can be further supported by information from the interviews conducted during the personal fieldwork where all of the children in the sample were doing some sort of work, such as herding animals, collecting firewood and water, or any kind of domestic work. When asked whether they thought working was bad for their education, 15 per cent said yes as they felt they did not have enough time for their studies. Among the nearly 30 per cents that did not enroll school on time, almost all of them reported labor as the main reason for this.

Similarly, one would expect that farm size would have the same effect as the two previous variables, but its coefficient is not significant in any of the three first models. In the last model, however, its function estimate becomes significant at 5 %. By looking at the graph in figure 6.3 we can see that it is non-linear and the effect is positive over some range of the covariate and negative elsewhere, and seems to be significant (and positive) only above a certain range, that is above approximately 5.5 tsimdi which equals 5.5 hectares. This indicates that only for very large land holdings is the wealth effect greater than the substitution effect, and child labor and land holdings thus become substitutes rather than complements.

In **H3** I postulated that school participation is positively affected by parents’ education level, measured here as the education of the head of household. This hypothesis cannot by rejected as the variable is positive and its regression coefficient is significant at 1% in all four models. Educated parents value education more than less educated parents and choose to invest in their children’s schooling at a higher rate than parents with no education. This became evident from interviews with teachers and development organisations which stated that lack of awareness, most likely due to low levels of education, were one reason for not sending their children to school.

The number of siblings below the age of six years was postulated to negatively affect the child's probability of attending school in **H4a**. The variable is negative but its coefficient is not significant in either of the IV models or in the recursive bivariate probit model. In the semiparametric recursive bivariate probit model, however, the function estimate becomes significant at 5%. As mentioned earlier, we do not get the coefficient estimate from the continuous covariates in this model. The variable can, however, be plotted and we see from figure 6.4 below that there is a negative relation as already indicated by the coefficients from the other models. As it is not significant throughout the four models, an absolute conclusion cannot be stated regarding the effect of siblings below 6 years. However, it may seem like the presence of younger children is negative for a child's school participation as they are required to take care of them.

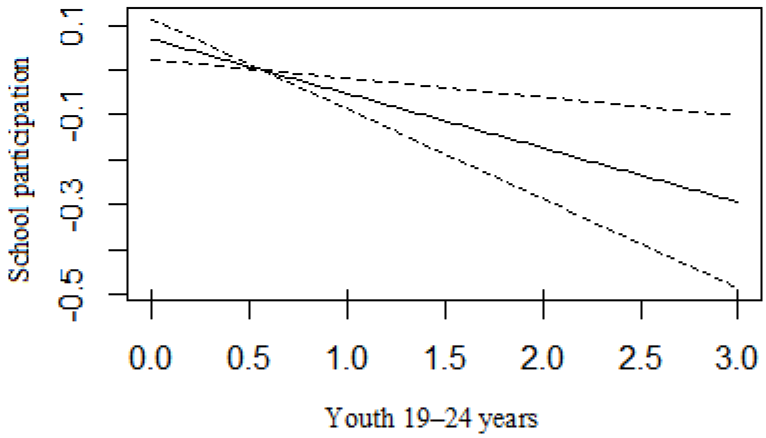
Figure 6-4: Plot of children below 6 years on school participation



Hypothesis **H4b** stated that the number of siblings aged 13–18 years positively affects the child's probability of attending school. However, neither the coefficient for boys or for girls aged 13–18 years was significant in any of the models. We can see that the coefficient for boys aged 13–18 years is positive while that for girls aged 13–18 years is negative, which is true also for the semiparametric recursive model. We cannot draw any conclusions, but it seems like the presence of boys is positive for a child's school participation, perhaps because older boys can perform more of the farming responsibilities, while the presence of girls is negative for a child's school participation.

The regression coefficient for the presence of youth aged 19–24 years is negative but not significant in any of the three first models. In the last model, however, its function estimate becomes significant at 1%, and we can see from the graph in figure 6.5 below that it is significant over most of the covariate, indicating that the presence of youth negatively affects school participation.

Figure 6-5: Plot of youth between 19–24 years on school participation



Distance to school is negative and its coefficient is significant at 5% in all four models, in line with the literature. However, the effect is only found for secondary school. The same effect would be expected for distance to primary school as well, but surprisingly a positive, albeit non-significant, relation occurs. The coefficient on distance to primary school is very small, it is measured in walking minutes and the result could therefore be due to noise in the measurement, i.e. people do not necessarily know exactly how far they live from school. Alternatively, access to primary schools has improved significantly in Tigray, so distance to them may therefore be less important.

As the child becomes older, the child's labor productivity increases and so does the opportunity cost of schooling. Parents may therefore prefer the secondary school aged child to work at home instead of participating in school. Some of the development organisations being interviewed during the fieldwork emphasized that there is still a shortage of secondary schools in Tigray, particularly in the most rural parts. In addition, the road to school is often physically very demanding, and may include risks of sexual violence against girls, giving further support for this result.

Age has a positive regression coefficient in the first three models, but is not significant. In the last model, however, its function estimate becomes significant at 1%. Looking at the plot in figure 6.1 we can see that the effect of age is increasing from the child is 6 years until approximately the age of 11 years, after which it decreases. However, it is only significant until the age of approximately 13 years. This highlights one of the benefits of the semiparametric recursive bivariate probit model, in that it gives more information than the linear, parametric approaches: one can see if the effect is positive over some range of the covariate and negative elsewhere, significant only over a certain range etc.

Gender is negative in all four models and its coefficient becomes significant in the two recursive bivariate probit models, meaning that girls are significantly more likely to participate than boys. This is a surprising result due to the fact that boys historically have been favoured with respect to education in developing countries. However, trends are now shifting, and Tigray is one of the regions in Ethiopia that has succeeded regarding gender equality in education. Information from fieldwork further supports this: When parents were asked if education is most important for girls or boys, 82.4 per cent answered that it is of equal importance, 5.9 per cent preferred to send boys to school while 11.7 per cent said that education was most important for girls.

The possibility to investigate indicators of school quality was not possible since these data were not available in the dataset. Because of this, some information of this kind was collected during the fieldwork. What emerged as the most important challenge in the education sector when talking to teachers and development organisations in Tigray was the observed drop in quality due to the big surge in enrollment. Repeated concerns were factors such as lack of classrooms (average student-teacher ratio was 54 among the schools being visited), unqualified and unmotivated teachers, shortage of learning materials, and poor learning facilities (buildings were often very basic and at some places the students were sitting on stones and had lessons in temporary shelters).

When teachers were asked what the most negative aspect of the education sector in Tigray was, the most common answer was the poor quality and the very basic facilities. And when asked what the most challenging part of being a teacher in Tigray was, most of them replied the low salary, that the work burden is too heavy and the fact that being a teacher in Tigray has a low status in the society. What was needed to make improvements, the teachers stated, was to have a better relation with the society in order to improve people's awareness, to improve the quality, and to have more qualified teachers. When asked what the most positive part of being a teacher in Tigray was, the most common answer was that schools have been made available for almost all and that enrollment is approaching 100 per cent. However, as one of the respondents from a development organisation said: "Even if enrollment rates have been a success, the completion rate in primary school is still below 50 per cent." And further pinpointed by another: "It is not enough to have many schools and high enrollment rates if the children are not learning anything."

Teachers and parents were asked to grade the quality of their school on a scale from 1–5 where 5 was the best. While only 3 per cent of the teachers gave full score on quality, 58 per cent of the parents did the same. This might tell a story of parents not being informed about the quality of their child's school, or, alternatively, that parents do not have the knowledge and thus the possibility to rate the quality of the school on a well-founded basis.

7. CONCLUSION

There are many reasons to be optimistic about the future in Ethiopia. More children than ever are attending school and the gender gap is decreasing. However, there are still some major challenges ahead. One of them is the low completion rate at primary school. Another is the low quality of education. A third is the high prevalence of malnutrition among children, previously found in other studies as detrimental to educational outcomes such as late entry, repetition of grades, dropouts and poor learning achievements.

This paper has analysed determinants of school participation among children aged 6–18 years in the region of Tigray in Ethiopia, using cross-sectional data from 2010 and data collected during an individual fieldwork in 2011. Given the past findings that malnutrition is an important impediment for different schooling outcomes particular focus was given to child health, as measured by the child's height-for-age z-score (HAZ).

The findings do not, however, fall in line with previous research: The lower the child's HAZ, the greater is the probability of the child attending school. Or similarly; a stunted child has a higher probability of attending school than a non-stunted or healthy child. This finding should be seen together with the fact that Ethiopia has one of the highest rates of child labor in the world. A child is expected to contribute either working on the farm or in the household, and this seems to be one of the main reasons why children are not attending school or why they enrol school late: the opportunity cost of schooling decreases with worse nutritional status, since malnutrition adversely affects child labor productivity.

Related to this, I find that the ownership of irrigated land and the amount of livestock holding is negative for school participation, meaning that the same factors leading to high production on the farm makes school participation less likely due to child labor. This suggests that child labor and these input factors are complementary, indicating that the effect of more input factors demanding more labor, combined with widespread child labor, is greater than the wealth effect of having irrigated land and more livestock holding.

Access to primary schools has improved and is no longer a barrier for school participation in Tigray. Distance to secondary school, however, is found to negatively affect school participation. There is often a shortage of secondary schools, especially in the very rural areas, and it became evident as an important factor for non-participation also after interviewing development organisations during the personal fieldwork. .

In the future, increased parental education and thereby better awareness regarding the benefits of education, better availability of secondary schools, higher income leading to less pressure to keep the children working on the farm as labor, and finally better quality of schools will increase school participation in Tigray. The latter became apparent after interviewing 30 teachers in seven different tabias, where almost all of them emphasized the need for better quality education, such as more and better qualified teachers, better access to materials, and better learning facilities.

Due to the continued increase in enrollment, particularly in primary schools, the demand for more teachers is big and increasing. In order to ensure improved quality education, qualified and highly motivated teachers are needed. A continued effort to raise the awareness is therefore much recommended in Tigray, as teachers continually expressed that they did not feel valued or heard.

In conclusion, I will emphasize the novelty of the findings related to the effect of child health on school participation. The finding that children characterised as stunted have a higher probability of attending school is surprising compared to previous assumptions. Unhealthy children's school participation seems to be at the expense of the healthy children. Besides, one has to question whether these children actually learn anything in school and if they will complete their education, or dropping out. This question will be for later research to investigate.

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Appendix A: Comparison of IV LPM and IV Probit with one and two instruments

Table A.1: Factors affecting school participation, IV-LPM and IV-PROBIT

Variables	**IV-LPM**[3]	**IV-LPM**[4]	**IVPROBIT**[5]	**IV-PROBIT**[6]
Height-for-age z-score (HAZ)	**-0.097****	**-0.098***	**-0.093****	**-0.095****
	(0.048)	(0.052)	(0.040)	(0.043)
Child's age	0.004	0.004	0.004	0.004
	(0.007)	(0.008)	(0.007)	(0.007)
Child's gender (1=male)	-0.033	-0.033	-0.036	-0.036
	(0.041)	(0.042)	(0.039)	(0.039)
Education of household head	**0.066*****	**0.066*****	**0.070*****	**0.071*****
	(0.016)	(0.016)	(0.018)	(0.018)
Distance to primary school	0.001	0.001	0.001	0.001
	(0.000)	(0.001)	(0.000)	(0.001)
Distance to secondary school	**-0.001****	**-0.001****	**-0.001****	**-0.001****
	(0.000)	(0.000)	(0.000)	(0.000)
Farm size (tsimdi^)	0.005	0.005	0.005	0.005
	(0.006)	(0.006)	(0.005)	(0.006)
Own irrigated land (dummy)	**-0.077***	**-0.077***	-0.073	-0.074
	(0.045)	(0.046)	(0.045)	(0.046)
Tropical livestock units	-0.013	-0.013	-0.014	-0.014
	(0.009)	(0.009)	(0.009)	(0.009)
Off-farm income (dummy)	0.055	0.055	0.055	0.056
	(0.043)	(0.043)	(0.041)	(0.042)
Children below 6 years	-0.013	-0.013	-0.014	-0.014
	(0.028)	(0.028)	(0.027)	(0.027)
Boys between 13–18 years	0.026	0.026	0.023	0.024
	(0.028)	(0.028)	(0.028)	(0.028)
Girls between 13–18 years	-0.007	-0.007	-0.006	-0.005
	(0.033)	(0.033)	(0.032)	(0.032)
Youth 19–24 years	-0.024	-0.024	-0.024	-0.024
	(0.031)	(0.031)	(0.030)	(0.030)
Adults 25–60 years	0.018	0.018	0.019	0.017

[3] IV-LPM with height of head of household and household size as instruments
[4] IV-LPM with height of head of household as instrument
[5] IV-PROBIT with height of head household and household size as instruments
[6] IV-PROBIT with height of head of household as instrument

	(0.031)	(0.031)	(0.031)	(0.031)
Observations	662	662	662	662

Standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01 ^1 tsimdi=0,25 hectares

Testing for weak instruments:

Using height of head of household as an instrument gives a F-value of 22.4, while adding household size as an instrument gives a F-value of 16.6. Both of them exceed the critical value of 10, meaning that the hypothesis of weak instruments is rejected.

Testing for endogeneity:

Using height of head of household as an instrument gives a p-value of 0.07, while adding household size as an instrument gives a p-value of 0.04. The hypothesis of exogeneity is thus rejected.

Testing for overidentifying restrictions in the case of two instruments:

A p-value of 0.97 indicates that the hypothesis of over-identifying restrictions cannot be rejected.

Appendix B: Research Permission

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ናብ ወረዳ፡ ______________________

ዋኒኑ፡- ትሕብብር ምጥያቕ ይምልከት

ኢኮኖሚክስ ዲፓርትመንት (መቐለ ዩኒቨርሲቲ) ኣብ ዘካይዶ መፅናዕቲ ዘድሊ መረዳእታ ኣብ ጣቢያኹም/ወረዳኹም ንኽእክብ፣ ብዶ/ር ሆስእና ገብሩ ዝምራሕ ቡድን ኣድላይ ዘበለ ሓበሬታ ክትህብዎምን ክእክቡን ዝተለመደ ትሕብብርኩም ክትገብርሉ ንላቦ፡፡

ምስ ሰላምታ

የሱፍ መሐመድኑር
የኢኮኖሚክስ ትምህርት ክፍል
Yesuf Mohammednur
Head. Department of Economics

Appendix C: Questions for individual fieldwork 2011

Questions to teachers

1) Name of your school: ______________________________________
2) Your age: ____
3) Sex: A – Male ( ) B – Female ( )
4) Qualification: ____
5) Grade level you are teaching: _________________________________
6) For how many years have you been a teacher: ___________________
7) How many students do you have in your class on average: _________
8) Do you have high dropout-rates in your classes: A – Yes ( ) B – No ( )
9) If yes, please indicate three major reasons for students to drop out of school:

____

____

____

10) What do you think are the main reasons some children are not attending school in Tigray? Please rank order (1-9) the following reasons for not sending children to school by assigning number 1 to the most important reason, 2 to the next important, 3 to the third etc:

A – School distance____
B – Poor quality of education ___________________________________
C – School payments____
D – Grade repeating by child____________________________________
E – Need for child labor_______________________________________
F – Costs related to school materials, clothes etc____________________
G – Not enough places in classrooms_____________________________
H – Parents don't see the benefits from education___________________
I – Early marriage for girls______________________________________
If other reasons, please explain:__________________________________

11) Is enrollment higher or lower today than when you first started as a teacher?

A – Higher ( ) B – Lower ( ) C – The same ( )

12) What do you think is the main reason for this?
13) Are dropout-rates higher or lower today than when you first started as a teacher?

A – Higher ( ) B – Lower ( ) C – The same ( )

14) What do you think is the main reason for this?
15) Are you satisfied with the following facilities at this school?

School buildings: A – Yes B – OK C – No
Textbooks: A – Yes B – OK C – No
Drinking water: A – Yes B – OK C – No
Toilet: A – Yes B – OK C – No

If other, please explain:____

16) On a scale from 1 – 5 (5 is best), how satisfied are you with the quality of this school?

1 – 2 – 3 – 4 – 5

17) What do you see as the main challenges as being a teacher in Tigray?
18) What are the most positive things regarding education in Tigray today?
19) What are the the most negative things regarding education in Tigray today?
20) If politicians asked you what they could do to improve primary (secondary) education in Tigray, what would you have answered?

Questions to households

1) Sex: A – Male ( ) B – Female ( )
2) Age: ______ years
3) Educational background for parents: Mother ( ) Father ( )
4) Occupation: ______________________________________
5) Number of children: _______________________________
6) How old are they: _________________________________
7) Number of children above age 6 attending school: A – Male ( ) B – Female ( )
8) If your children are attending school, what is your reason for sending them to school?
9) If you have school age children not attending school, please explain your reasons for not sending them to school.
10) Have any of your children dropped out of school: _________________
11) If yes, please explain the reason for this
12) Do you think that all of your children will attend secondary school (university)? (Why/why not)
13) How far is it to school by walking distance: _______________________
14) Does most of your friends send their children to school: A – Yes ( ) B – No ( )
15) Are your children doing any housework? A – Yes ( ) B – No ( )
16) If they are working, what kind of work are they doing?
17) How many hours per week are they working: __________________
18) Is education most important for girls or for boys? Please explain:
19) What kind of job do you want your children to have when they grow up?
20) On a scale from 1 – 5 (5 is the best), how satisfied are you with the quality of the school your children are attending?

1 – 2 – 3 – 4 – 5

Questions for students

1) How old are you____
2) Sex: A – Male ( ) B – Female ( )
3) How many brothers and sisters do you have: A – Brothers ( ) B – Sisters ( )
4) Which of the following are you:

Youngest child ( ) Oldest child ( ) In between ( ) Only child ( )

5) Are you attending school: A – Yes B – No (**If no, start from question 22**)
6) In what grade level are you a student________________________
7) How old were you when you first started school______________
8) If you started school late, what is the reason for this?
9) How far is it to school by walking distance__________________
10) Do you like going to school? A – Yes B – No
11) Please explain why:
12) Are you satisfied with the following facilities at your school:
    Quality of teachers: A – Yes B – OK C – No
    Availability of textbooks: A – Yes B – OK C – No
    Quality of desks and chairs: A – Yes B – OK C – No
    Toilets: A – Yes B – OK C – No
    Drinking water: A – Yes B – OK C – No
13) On a scale from 1 – 5 (5 is best), how satisfied are you with the quality of your school?
    1 – 2 – 3 – 4 – 5
14) Are you doing any housework at home: A – Yes B – No
15) If yes, what kind of work are you doing?
16) How many hours per week are you working______________________
17) Do you feel that working is bad for your education? A – Yes B – No
18) If yes, please explain why:
19) Do you want to go to secondary school (university) after completed primary school (secondary school)? A – Yes B – No
20) Please explain why?
21) What kind of job would you like to have when you are finished with your education?
22) If you are not attending school, why did you quit?
23) Would you like to start education again: A – Yes B – No
24) Please explain:
25) How far is it to school by walking distance_________________________
26) Are you doing any housework A – Yes B – No
27) If yes, what kind of work are you doing:
28) How many hours per week are you working_______________________
29) Did you feel that working was bad for your education? A – Yes B - No
30) If yes, please explain

THANK YOU!

Appendix D: Questionnaire for fieldwork 2010

Farm household survey: Household characteristics									**Page 1**
Woreda:		Interviewer:			Household number:				
Tabia		Date of interview:							
Kushet		Household head name:							
Household composition in 2002 (E.C.)									
Household members		Religion:							
MNo:	Name	relationship	Sex	Age	Education	Skills		Occupation	Presence
1		Head							
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									

Codes: Relation to household head: 1=wife, 2=child, 3=grand child, 4=brother, 5=sister, 6=hired labour
7=other, specify:
Sex: 1=female, 2=male. Age: Years. Skills: specify
Education: 0=illeterate, 1=read and write, 2= elementary, 3= church education, 4= secondary, 5=other, specify.