ATTENDING SCHOOL, TWO "RS" AND CHILD WORK IN RURAL ETHIOPIA

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Abstract

Rural Ethiopia has amongst the highest rates of children's labor force activity in the world. Children start assuming household and farm responsibilities as early as four years of age and on average contribute 29-30 hours of labor per week. This paper examines the consequences of working on the formal human capital development of children. In particular, we investigate whether the number of hours worked by children has an effect on school attendance and on their reading and writing ability (RWA). An intermediate step in our analysis, before assessing consequences, is identification of the factors that determine the allocation of children's time to school and work. A noteworthy aspect here is our assessment of the link between the spread of modern agricultural technologies and child work.

In our study we detect a non-linear relationship between hours of work and school attendance/RWA of children. Initially there is a positive link between working and schooling/RWA. However, at between 16-22 hours of weekly work, we find that the ability of a child to read and write begins to suffer while school attendance is not affected. Beyond this threshold RWA and school attendance suffer. In terms of determinants we find that agricultural modernization has a mixed effect. While the availability of agricultural machinery reduces the demand for child labor other technologies such as the spread of improved seeds, at least in the short run, increases the burden of work.

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1. INTRODUCTION

Two major conventions, ILO convention 138 and the UN Convention on the Rights of the Child (CRC) are often used as benchmarks for providing a working definition of child labor. The main criteria for determining whether an activity constitutes child labor are the age of the child and the nature of the work. The former convention deals with the definition of a child and the minimum age of employment. Although there are exceptions, it is generally accepted that the minimum age of employment should be 15 and an individual below 15 years should be treated as a child. Turning to a definition of labor, according to the CRC the main criterion for deciding whether a particular activity should be termed as "labor" is the nature of the work. The convention states that children should be protected from work that is hazardous, interferes with their education and is harmful to their health, physical, mental, spiritual, moral or social development. The convention has received world-wide ratification (Fyfe, 2001) and national documents that deal with the definition of child labor echo this language.

The idea that work should be considered as labor if it is harmful for a child does not provide a definition of child labor. In fact, it throws up questions that need to be answered before a particular activity may be deemed as child labor. Apart from the most egregious types of work which no doubt harm a child, there may be a wide range of activities carried out by children, especially in rural areas, which may not harm the overall development of a child. Before labeling all types of work as child labor it may be important to identify the potentially different effects of the different types of work activities carried out by children. Furthermore, it is not just the incidence of work that needs to be considered but whether there is a threshold beyond which the number of hours of work provided by children begins to harm any dimension of their development.

In this paper we use information on the work activities of children in rural Ethiopia to investigate some of the issues highlighted in the previous paragraph. We do not pretend to investigate the many different ways in which the labor force activities of children may harm all dimensions of their development. We concentrate on the formal human capital development of children. In particular, we examine whether the number of hours worked by children has an effect on school attendance and on their ability to read and write. We also go beyond the aggregate effect of the number of

hours worked and investigate the effect of different types of work activities on school attendance and reading and writing ability.[3]

An intermediate step in our analysis before we turn to a study of the consequences of child labor is identification of the factors that determine the allocation of children's time to work. A factor that we pay special attention to in this section of the paper is an assessment of the link between access to modern agricultural technologies and child labor. Information about the potential link between the adoption of improved agricultural practices and child work is particularly relevant as Ethiopia is currently engaged in an aggressive extension program aimed at introducing farmers to new and modern methods of agricultural production. [4]

The paper is organised along the following lines. In the succeeding section we review the relevant literature and highlight the potential contributions of this paper. Section III outlines an analytical framework. Section IV discusses the data. Section V provides a descriptive and diagrammatic analysis of the links between child work, schooling and reading and writing ability. Section VI presents empirical results and section VII concludes.

2. A REVIEW OF THE LITERATURE

2.1 Agricultural technology and child labor

There is a substantial literature on the determinants of child labor.[5] However, papers that deal with the link between technological change and child labor are limited. Even the few existing studies focus mainly on the manufacturing sector and on mechanical power. For instance, Galbi (1997) points out that one of the most powerful reasons for the decline in the incidence of child labor in industrialized societies was the gradual sophistication of technology. Similarly, a study in Colombia

[3] Our aim is to detect whether the number of hours worked by children has an impact on their formal human capital development. In the rest of the paper we use the terms child work and child labor to refer to the total number of hours worked by children. Our concept of work includes the time spent by children on five activities, that is, farming, domestic chores, child care, herding and fetching water/wood.

[4] The Government of Ethiopia's agricultural led growth strategy calls for the liberalization of (agricultural) output and input (especially fertilizer) prices. In addition, a crucial aspect of the growth strategy was the launch of a new extension program called the Participatory Demonstration and Training Extension System (PADETES) in 1994/95. This new program merges the extension and management principles of the T & V system with the technology diffusion experiences of the SG2000 program and emphasizes the provision of fertilizers, improved seeds, pesticides, herbicides and modern farming methods.

[5] For an extensive set of references see Ray (2000).

shows that the introduction of wheelbarrows displaced children who had previously carried rocks piece by piece (Salazar, 1988). Turning to studies dealing with the agricultural sector, Rosenzweig and Evenson (1977) argue that the green revolution in India led to a reduction in child labor and promoted school attendance. Similarly, Levy (1985) shows that the mechanization of Egyptian agriculture (the use of tractors and irrigation pumps) reduces the demand for child labor in tasks such as picking cotton, hauling freight and driving animals to power water wells. Apart from these few examples it is hard to find empirical studies that examine the link between the spread of modern agricultural technology and child labor.

2.2 Child labor and schooling

There is a growing body of literature that studies the substitutability between children's schooling and labor and the effectiveness of education related policy measures in reducing child labor. This literature may be divided into two broad categories. One approach, which may be termed the indirect or reduced form approach studies the links between child work and schooling by examining the effects of education related measures such as concentration of schools, distance to schools, school fees (subsidies) and school quality on the incidence of child labor. If schooling and child work are substitutes then a reduction in school fees or a reduction in the time required to reach school, should lead to an increase in school attendance and at the same time lead to a reduction in the incidence and duration of work. Papers that have adopted this approach report mixed results.

For instance, Grootaert (1999) reports that child labor force participation in rural Cote d'Ivoire is responsive to distance from school. According to his estimates, a $3 reduction in annual schooling costs (induced by increased school proximity) may lead to a 1 percentage point reduction in the probability of child labor force participation. However, schooling costs are not found to be statistically significant correlates of child labor in urban Cote d'Ivoire. Cartwright and Patrinos (1999) find a strong positive relationship between schooling costs and child labor force participation in urban Bolivia. In contrast, Cartwright's (1999) work on Colombia shows that higher school costs are associated with a lower probability of working. Using data from the Tanga region of mainland Tanzania, Akabayashi and Psacharopoulos (1999) report that children work longer hours per day in localities with a lower school concentration. Their measure of school quality has no influence on child work.

Grootaert and Patrinos (1999) argue that the empirical ambiguities in the effects of schooling related policy measures on child labor force participation are largely due to data limitations. While this argument has its merits, it is possible that households

adjust to changes in school prices (quality) along dimensions other than children's work. For instance, Ravallion and Wodon (2000) show that a school enrolment subsidy in the form of monthly food rations to households in rural Bangladesh reduces the incidence of child labor. However, they emphasise that the decline in the incidence of child labor that may be ascribed to the subsidy accounts for a small proportion of the increase in school enrolment, implying higher school attendance comes mainly at the expense of children's leisure. Thus, they conclude that child labor force participation may not be very responsive to reductions in school fees. Hazarika and Bedi (2003) report a similar finding for Pakistan. They find that a reduction in the price of schooling increases school enrolment but the corresponding reduction in labor force participation is not as large, suggesting that the increase in the probability of attending school comes from a reduction in time allocated to leisure.

A second approach that may be termed the direct or structural approach gauges the links between schooling and child labor by comparing children's educational outcomes across work status. Psacharopoulos (1997) uses data from Bolivia and Venezuela to show that children who work are more likely to fail at school and that child work reduces educational attainment by almost two years. In contrast, Patrinos and Psacharopoulos's (1997) work on Peru shows that child labor is *not* detrimental to schooling. While these papers represent some of the first attempts at directly gauging the effect of child work on schooling, their inclusion of work status, a choice variable, as an exogenous regressor may not be appropriate. Ignoring the endogeneity between school participation and working status may exaggerate the negative effects of work on school attendance if children who work may be less likely to go to school even if work was not an option. In contrast to these studies, Akabayashi and Psacharopoulos´s (1999) paper accounts for endogeneity and examines the trade-off between hours of work, school participation and the reading and mathematical skills of children. The authors report that for boys an additional hour of work reduces their ability to tackle mathematical problems by 8 percent. For girls there is no negative effect on mathematical skills, however, working does reduce their ability to attend school. Along similar lines as Akabayashi and Psacharopoulos (1999), Heady (2003) examines the effect of work on the learning achievement of children in Ghana. The paper does not control for endogeneity but includes a variable designed that captures the ability of children. A notable aspect of Heady's work is that he draws a distinction between work outside the household and domestic work and finds that only work done outside the household has a negative impact on achievement.

Our work in this paper is a combination and extension of the direct and indirect approaches. Our primary aim is to examine the effect of the numbers of hours

worked by children on school attendance and their ability to read and write. While the indirect approach is well suited to examining the effect of changes in school prices/quality on child work it does not allow a clear assessment of whether child work harms attendance (or reading and writing ability). Given the main aim of our work it is natural to adopt the direct approach. A credible implementation of the direct approach requires that we account for the potential endogeneity between school participation and hours of work. In this paper we adopt a two-stage method to tackle endogeneity. The first-stage in this method requires reduced form estimates of the school attendance and hours of work relationships. Thus, our implementation of the direct approach nests the indirect approach.

Although our paper shares some of the features of the papers outlined above it differs in several ways. First, in addition to the usual determinants of child labor we include a set of variables that allows us to explore the (immediate or short-run) links between the availability of modern agricultural technology and child work. Second, the bulk of the literature uses a discrete indicator (set of discrete indicators) to measure child work. This measure of work is clearly not very informative and it is likely that the ambiguities in the existing direct approach literature arise due to the use of this limited variable. Our paper relies on a more informative measure, that is, the total number of hours worked by a child in a week. This measure allows us to identify whether there is a certain threshold (of hours worked) beyond which work begins to harm the development of a child. Third, in addition to the total number of hours we have detailed information on the type of work and hours of work devoted to each type of activity. This information allows us to identify whether certain types of work may be particularly harmful.

3. ANALYTICAL FRAMEWORK AND EMPIRICAL SPECIFICATION

In this section we present a framework that explores the interaction between schooling (whether a child can read and write) and hours of work under two regimes.[6] We first consider a situation where there is a functioning market for child labor, and families can freely hire in or hire out child labor at a market wage rate w. In the second regime we relax this assumption and consider situations where households are not able to hire in or hire out child labor. The framework also highlights the key econometric issues that need to be considered and tackled.

[6] The discussion here refers to school attendance and work. However, in the empirical work we consider the interaction between school attendance and work and the interaction between RWA and work.

3.1 A complete market for child labor

Consider a household consisting of a child and its adult guardians. Assume the adults maximize a twice-differentiable quasi-concave utility function,

$$U = U(C, l, S; E) \tag{1}$$

where C is a composite consumable representing the household's standard of living, l is the child's leisure, S is the child's school attendance, and E is a vector of exogenous child, household and demographic characteristics that parameterise the utility function. The second component of the model is a household production function, $q = f(L, I; K)$, where L signifies total child labor input in household production. L may consist of both household child labor, L^H, and hired child labor. There is no restriction on the composition of the total child labor input as households are free to hire in or hire out child labor at a market determined wage rate. I is a vector of intermediate inputs. K is a vector of exogenous variables that includes the elements in E but may also include other exogenous variables such as land quantity, land fertility, and other agro-climatic factors that may influence production.[7]

The adults allocate the child's total endowment of time, T, between school attendance, leisure, work in the labor market (extra-household child labor), L^M, and work in household production (intra-household child labor), L^H. Utility maximization is subject to the time constraint

$$T = l + S + L^M + L^H = l + S + L^S, \tag{2}$$

where L^S, the total labor supplied by the child, is the sum of extra-household labor, L^M, and intra-household labor, L^H. Let Y denote adult contribution to household income (assumed to be exogenous). Since Y and the output of child labor in household production must together suffice to meet the costs of hiring child labor, household consumption, and schooling, the household's budget constraint may be written as,

$$Y + f(L, I; K) = C + pS + w(L - L^S), \tag{3}$$

where p represents the price of schooling.

[7] Land available for cultivation is assumed to be exogenous. This is appropriate because in Ethiopia agricultural land is state property. Households are granted rights to cultivate land on a long-term basis and the market for leasing land is thin.

The household adults may be assumed to maximize the utility function (1) subject to (2) and (3).

Before dealing with the utility maximization decision, consider the household's demand for child labor input in household production. Optimal labor demand, that which maximizes 'profit', may be obtained by maximizing $f(L, I; K) - wL - rI$, where *r* represents the prices of the intermediate inputs. The maximization yields that a household's demand for child labor is a function only of *w*, *r*, and *K*, and may, thus, be represented as,

$$L^{D*} = L^{D}(w, r, K). \quad \textbf{(4)}$$

Having determined the optimal demand for child labor and the maximized value of child output, the consumption choices of the household may be obtained by maximizing the Lagrangian function of the optimization problem,

$$Z = U(C, l, S; E) + \lambda[Y + wT + \left\{f(L^{*}, I^{*}; K) - wL^{*} - rI^{*}\right\} - C - (w + p)S - wl\,] \quad \textbf{(5)}$$

where λ denotes the Lagrange multiplier. The first order conditions (FOC) for an interior utility maximum may be solved for optimal C, S, and l. From the time constraint, (2), household child labor supply, L^{S}, equals T less the sum of S and l. Since optimal *S* and l are each functions of w, p, E, and Y,[8] optimal *S* and L^{S} may be represented as,

$$S^{*} = S(w, p, E) \quad (6)$$

$$L^{S*} = L^{S}(w, p, E) \quad (7)$$

The labor supply (7) and labor demand (5) equations show that changes in the price of schooling affects the supply of labor but does not influence the demand for labor.[9]

[8] We assume that *Y*, the exogenous adult contribution to household income, is a function of a subset of the variables *E*.

[9] The separation of the household's production decision (optimal child labor input in household production, L^{D*}) from its consumption decisions is a well-known feature of agricultural household models. As long as it is possible to hire in and hire out child labor without hindrance,

It is possible to draw sharper implications. Consider first, the case of optimal household child labor supply exceeding optimal demand, i.e., $L^{S*} > L^{D*}$. Child labor input in household production will then consist entirely of household child labor, so that optimal intra-household child labor supply is given by

$$L^{H*} = L^{D*} = L(w, r, K). \tag{8}$$

Since household child labor unused in household production will be supplied to the labor market, optimal extra-household child labor supply may be denoted as

$$L^{M*} = L^{S*} - L^{D*} = L^{S}(w, p, E) - L^{D}(w, r, K). \tag{9}$$

According to (8), changes in the price of schooling, p, will not influence the optimal intra-household labor supply of children engaged in extra-household (market) work. On the other hand, (9) indicates that optimal extra-household child labor supply may respond to changes in the price of schooling.

Next, consider the case where $L^{S*} < L^{D*}$. Now, $L^{M*} = 0$ and intra-household labor supply will be given by

$$L^{H*} = L^{S*} = L^{S}\left(w, p, E\right), \tag{10}$$

with the difference drawn from the labor market. Equation (10) implies that the price of schooling, p, may influence the intra-household labor supply of children unengaged in market work. Thus, the model predicts that while extra-household labor supply may respond to changes in schooling costs, the effect of these costs on a child's intra-household labor supply may depend on whether the child is also engaged in market work.

There are three implications of the model: (i) the extra-household labor supply of children may be (positively) associated with schooling costs; (ii) the intra-household labor supply of children providing extra-household labor should not respond to changes in schooling costs; (iii) the intra-household labor supply of children unengaged in market work may be (positively) associated with schooling costs.

it is predicted that household demand for child labor will be independent of household child labor supply.

These implications may be tested via estimation of child labor-supply functions. For further details on the testing procedure see Hazarika and Bedi (2003).

3.2 A constrained market for child labor

So far we have assumed that it is possible for families to hire in or hire out labor without any hindrance. However, there are several factors that may inhibit the functioning of a market for child labor. For instance, there may be limited wok opportunities for a child outside the confines of a household. Alternatively, during certain periods of the agricultural cycle there may be a shortage of child labor supply. Consider a situation where a farming household is constrained on the supply side, that is, at the prevailing market wage rate optimal labor supply exceeds optimal labor demand,

$$L^{S*} = L^S(w, p, E) > L^{D*} = L^D(w, r, K), \tag{11}$$

and there are no off-farm employment opportunities. A household rationed in this way can turn to its own farm for further employment until it achieves household equilibrium. In such situations the amount of labor used does depend on household preferences. Instead of the market wage, the equilibrium intra-household hours of work provided by children will now depend on household valuation of child time, or on a shadow child wage denoted by w^*. Equilibrium hours of work provided by children may be represented by,

$$L^{H*} = L^S(w^*, p, E) = L^D(w^*, r, K). \tag{12}$$

Now consider the opposite case, i.e., at the prevailing market wage household demand for labor outstrips household supply of child labor and it is not possible to hire in any additional workers.

$$L^{S*} = L^S(w, p, E) < L^{D*} = L^D(w, r, K) \tag{13}$$

Faced by this constraint household equilibrium will depend on a shadow child wage. Once again, it will be optimal for a child to apply labor to its own farm until the shadow wage equilibrium is achieved, i.e.,

$$L^{H*} = L^S(w^*, p, E) = L^D(w^*, r, K). \tag{14}$$

Thus, in situations where there are limited possibilities of hiring in or hiring out labor the distinction between labor demand and supply cannot be maintained. The observed hours of work provided by a child depends on variables that influence the demand and supply of child labor. Unlike the case of complete markets where the effect of schooling related variables depends on whether a child works outside the household or within the household, such distinctions are not relevant in the case of a constrained market. Accordingly, school attendance and hours of work may be expressed in terms of the following functions,

$$S^* = S(w^*, p, E), \tag{15}$$

$$L^{H^*} = L^S(w^*, p, r, E, K). \tag{16}$$

The preceding sections considered the link between schooling (prices) and work in the context of a complete and incomplete market for child labor, respectively. As displayed, the links between schooling (costs of schooling) and child work may depend on whether labor is performed within or without the household. Our assessment of the relevant information on Ethiopia shows that while child labor is widespread there does not seem to be a well-developed market for child labor with a market determined wage rate. Almost all children work within the context of the household and distinctions between intra-household and extra-household work and labor demand and labor supply do not appear to be meaningful in the Ethiopian context.[10] Thus, our empirical work is based on the assumption of an incomplete market for child labor.

3.3 Empirical Approach

The direct approach that we adopt in this paper requires the estimation of a structural schooling equation. For the time being consider a linear specification of schooling,

$$S^* = \beta_{Sw^*} w^* + \beta_{Sp} p + \beta_{SE} E + \beta_{L^{H^*}} L^{H^*} + \varepsilon_S, \tag{17}$$

[10] The lack of a well-developed market for child labor may be attributed to the patterns of land-use in Ethiopia. Almost all households in rural Ethiopia have access to some agricultural land and there do not appear to be sharp inequalities in land-use rights. Less than half a percent of households in our sample have no access to land. The mean holding is about 1.32 hectares with a standard deviation of 1.08.

where the $\beta's$ are coefficients to be estimated and ε_S captures the effect of unobservables. Our schooling variable is dichotomous. If we assume that the error term is normally distributed we may employ a probit model to estimate (17). However, since hours of work is a choice variable, it is quite likely that single-equation estimation of (17) will lead to inconsistent estimates. There are several methods that may be used to obtain consistent estimates of the schooling equation. In this paper we use Rivers and Vuong´s (1988) two-stage conditional maximum likelihood (2CML) procedure. Reduced form expressions for the schooling and hours of work may be written as,

$$S^* = \beta_{Sw^*} w^* + \beta_{Sp} p + \beta_{SE} E + \varepsilon_S \qquad (18)$$

$$L^{H^*} = \beta_{Lw^*} w^* + \beta_{Lp} p + \beta_{Lr} r + \beta_{LE} E + \beta_{LK} K + \varepsilon_L. \qquad (19)$$

In the first stage we estimate the hours of work equation (19) using OLS. [11] In the second stage we include estimates of the residual ($\hat{\varepsilon}_L$) from this first step-regression in (17).

This procedure yields,

$$S^* = \beta_{Sw^*} w^* + \beta_{Sp} p + \beta_{SE} E + \beta_{L^{H^*}} L^{H^*} + \lambda \hat{\varepsilon}_L + \varepsilon_S. \qquad (20)$$

As shown by Rivers and Vuong (1988), this augmented probit equation yields consistent estimates. An advantage of this procedure is that estimates of λ may be used to perform an exogeneity test.

If working reduces school attendance and harms the ability of a child to attend school then the coefficient on hours of work in equation (20) should be negative. On the other hand if working and schooling are not incompatible then this coefficient may be positive or may not be different from zero.

While the estimation procedure has been discussed, a key issue that still needs to be confronted is the identification of these two-stage models. There are several possibilities that may be explored. First, since our hours of work equation is estimated using OLS and our schooling equation is a probit equation, we may

[11] In the indirect approach the idea is to estimate these two equations and examine the effects of the price of schooling on schooling and hours of work. Schooling and hours of work will be substitutes if β_{Lp} is positive.

achieve identification on the basis of differences in functional form. While this approach is feasible, differences in functional form are a weak basis for identification. A look at the framework sketched above shows that there may be variables that influence child labor but do not have a direct influence on schooling. These include variables such as the prices of intermediate inputs, denoted by *r*, and the vector of exogenous variables, denoted by *K*. It is possible that these variables influence the hours of work provided by a child but do not have a direct effect on schooling. Their effect on schooling may be mediated via their influence on the hours of work decision. Thus, a second identification strategy is to exclude the variables denoted by *r* and *K* from the schooling equation. While we rely on this identification strategy we are aware that it is questionable. In our empirical work we conduct a sensitivity analysis to examine variations in the estimates in response to changes in the identification strategy.

4. THE DATA

The Department of Economics of Addis Ababa University, in collaboration with other organisations, has carried out five rounds of a rural household survey.[12] The data used for this paper are drawn from the fifth round of the rural survey which was conducted during the 1999-2000 crop season in 18 peasant associations. The 18 survey sites are located in four major regional national states, i.e., the Amhara National Regional State, the Tigray National Regional State, the Oromiya National Regional State and the Southern Nations, Nationalities and Peoples Regional State. These four regions include more than 90 percent of the country's population and account for a similar proportion of economic output. Pre-tested survey questionnaires designed to assess the living standards of individuals and households were used to gather information. Data were collected from 1,680 households consisting of 9,844 individuals. A special feature of the fifth edition of the survey was its focus on the work activities of children. Detailed information on the time-use patterns of all children in the age group 4 to 15 in the seven days preceding the survey was collected. Household heads were asked to provide information on the hours spent by children on farming, child care, carrying out domestic chores, fetching wood/water and herding.

In this paper we restrict our attention to children between 4 and 15 years of age on whom we have complete information. This yields a sample of 3,043 children. A

[12] The surveys have been conducted in collaboration with Oxford University, the International Food Policy Research Institute, and the United States Agency for International Development. In addition, the University of Bonn´s, Center for Development Research participated in the fifth round of the survey.

detailed discussion of the dependent variables in our analysis, that is, patterns of work, school attendance and the ability of children to read and write is provided in the next section and in Tables 1, 2 and 3. The specification of the equations to be estimated and a description of the dependent variables is provided in Section V and in Table 4.

5. PATTERNS OF WORK AND SCHOOL ATTENDANCE – A DESCRIPTION

Ethiopia is the second largest country in Sub-saharan Africa with an estimated population of over 60 million. It is one of the world´s least developed nations with a per capita GDP of about $110. Agriculture is the mainstay of the economy and accounts for about 45 percent of GDP, 90 percent of foreign exchange earnings and employs about 85 percent of the population. The substantial contribution made by children to Ethiopia´s subsistence agricultural economy has been well documented in previous work (Walta Information Center, 1999).

In terms of labor laws, a reading of the Ethiopian constitution and current legislative measures on child labor shows that the Ethiopian constitution follows international standards and gives consideration to the rights and the welfare of the child as embodied in the UN CRC. Labor laws concerning the minimum age of employment are also laid down. The law stipulates a minimum age of 14 years for admission to any employment and allows employment between the age of 14-18 only as apprentices and under a number of restrictions. These labor laws focus mainly on the manufacturing sector and disregard the rural economy. Ethiopian labor law does not make any reference to the problem of child labor in the agricultural sector and agricultural and household employment are exempt from laws. Thus, an estimated 85 percent of national economic activity falls outside the protection of the labor code as it consists of small scale and subsistence farming.

5.1 Patterns of work

Previous work on Ethiopia reports a very high incidence of child labor. Based on a 1994 rural household survey, Admassie (2000) provides a picture of the work activities of children. As compared to Admassie (2000) the data set that we use contains far more detailed information on the primary and secondary occupations of every member of the household including children above the age of 4 years. This allows us to construct a detailed portrait of the work activities of children.

Table 1 summarizes work participation rates and the time children spend on different types of work activities. Column 1 provides this information for all children in the age group 4-15 while columns 2 and 3 present gender specific information. The final column tests for any statistically significant differences in participation rates and hours of work across gender. There are several points to be noted. About 75 percent of all children participate in work activities. On average a child spends around 4 hours a day or approximately 30 hours a week on work activities. There are no differences in participation rates or the mean number of hours (total) worked across genders. Rather than focusing on a single measure of central tendency, gender specific kernel density estimates of hours of work are provided in Figure 1[13]. These density estimates show that the mode of the distribution occurs between 20-30 hour of work and that gender differences in the distribution of hours worked are minor. Formal statistical tests are unable to reject the null hypothesis of equality of the distributions.[14]

While total time spent on work activities does not differ by gender, a breakdown of work activities by five different types of work reveals considerable differences. Our data allows us to decompose the total number of hours worked by children into five different types of work. Table 1 presents this breakdown. Boys spend more than 50 percent of their total hours of work on herding and 10-15 percent of their time on activities such as farm work, fetching water/wood and other domestic tasks. Girls, as may be expected, spend considerable time on domestic tasks (about 33 percent of their total work time) followed by around 23-24 percent of their time on fetching wood/water and herding, respectively.

To examine the dynamics of work participation and hours of work, Figures 2 and 3 present graphs that depict the relation between age and hours of work and age and work participation. These relationships are also presented separately for males and females.[15] The graphs display that children as young as 4 have a 21 percent participation rate and spend about 5 hours a week on work activities. Work activities increase with age and show a concave pattern. By the age of 11 work participation rates reach a peak of 91 percent and weekly hours of work reach a peak of about 41 at the age of 14.

[13] The kernel density estimates are based on the Epanechnikov kernel and a width calculated using the Silverman (1986) optimal bandwidth formula. Deaton (1997) contains further details on kernel density estimation and a discussion on appropriate bandwidth and choice of kernels.
[14] The null hypothesis of equal distribution of hours of work for males and females could not be rejected (p-value 0.591) on the basis of a Kolmogorov-Smirnov test.
[15] These graphs are based on estimating locally weighted sum of squares (lowess) regressions of hours of work on age (Figure 2) and participation on age (Figure 3). A bandwidth of 0.8 was used for obtaining the locally weighted regression smoother. Further details on lowess estimation are available in Deaton (1997).

A more disaggregated picture of the link between hours of work and age is provided by the graphs presented in Figure 4. These graphs present the relationship between hours of work and age for each of the five different work activities. They show that gender-specific work patterns may already be discerned at the age of 4 with boys spending more time on herding as compared to girls, while the patterns are reversed for child-care. For the other types of work activities (fetching water/domestic/farm-work) differences appear when children are aged between 6 and 7, with girls spending more time on domestic tasks and fetching water/wood and boys sending more time on farm work.

5.2 Schooling and 2 "Rs"

Table 2 presents school enrolment rates and information on the proportion of children who are able to read and write in Ethiopia. This information pertains to children above the age of 7, the age at which children are expected to enroll in primary school. As Table 2 shows, the school participation rate is quite low at about 44 percent.[16] There are clear differences across gender with 47 percent of boys attending while the corresponding figure is 41 percent for girls. To obtain an idea of the dynamic patterns in school participation, Figure 5 presents estimates of the probability of attending school as a function of age for the full sample and by gender. The probability of attending school increases with age and reaches a peak of about 60 percent for boys and about 50 percent for girls. Gender differences in the probability of attending school emerge between the age of 9 and 10 and remain steady at about 7-10 percentage points until children reach the age of 15.

Patterns in the reading and writing ability of children are very similar to the patterns of school participation.[17] About 40 percent of children are able to read and write. While 43 percent of boys are able to read and write the corresponding figure for girls is about 36 percent. Age and gender specific patterns are displayed in Figure 5. The ability to read and write increases with age and reaches a peak (at age 13) of about 58 percent for boys and 43-44 percent for girls. Figure 5 also plots the school participation rates and the ability to read and write versus age on the same graph.

[16] In 1996 the primary school Gross Enrolment Rate (GER) in Ethiopia was 42.9 percent. This enrolment rate is quite low as compared to other countries in Eastern Africa and is amongst the lowest in the entire continent. For example, in 1996 the GER in Sudan was 50.9 percent, it was 66.1 percent in Tanzania and 74.3 percent in Uganda. Admassie (2000) provides educational statistics for other African countries.

[17] Reading and writing pertains to the ability of a child to read and write in Amharic. The questionnaire asks respondents, usually the head of the household, to indicate whether a child can read, can write, can read and write or is illiterate. Respondents decide the category in which to place a child on the basis of their personal judgement and not on the basis of objective standards.

There is a gap (4 percent gap) between school participation and the ability to read and write which implies that not all those who attend school acquire the ability to read and write. Apart from this gap, the age-specific patterns in the two variables are similar and suggests that school attendance and the ability to read and write may be treated synonymously.

Work Participation, schooling and human capital

The main aim of this paper is to examine whether the work activities of children hinders their ability to go to school and interferes with the development of their reading and writing abilities. To obtain a preliminary idea of the relationship between these variables, we examined successively, the bivariate relationships between work participation and school participation, and the relationship between hours of work and school participation. Table 3 presents our estimates. We find that children who attend school are in fact more likely to work. About 92 percent of the children who go to school, work, while the figure is about 87 percent for those who do not attend school. If we had no additional information we may have concluded that work participation *does not* hinder school participation. However, our information on duration of work allows us to go beyond participation rates. Children who attend school contribute about 38 hours of work in a week while those who do not attend school contribute 34 hours a week. Despite the lower number of hours worked by children who do attend school, their work burden at about 5 hours a day is substantial. A look at the differences in the type of work activities carried out by the two groups reveals a clear pattern. For 4 of the 5 work activities there are no differences in patterns of work by school status. The only difference lies in the time spent on herding. Children who attend school spend far less time on herding (8 hours) as compared to those who do not attend school (14 hours).

Gender-specific patterns are presented in Tables 3b and 3c. The pattern for boys matches the overall patterns. Work participation rates for school-attending boys is higher than for boys who do not attend school, while average hours of work is higher for those who do not attend school (34 versus 40). The differences in the duration of work stem mainly from the far greater time spent on herding by boys who do not attend school. Similar to the overall pattern, girls who attend school have a higher participation rate but unlike boys average hours of work do not differ across schooling states for girls. Regardless of their schooling status girls provide about 35-36 hours of work effort in a week. There are differences across school states in terms of the individual work activities. Girls who attend school spend less time on herding (4.4 versus 8 hours) but spend more time on domestic tasks.

To obtain an idea of the distribution of hours of work by school status, Figure 6, presents kernel density estimates of the total hours of work conditional on school participation. A comparison of the densities suggests that differences in the mean hours of work across schooling status arises due to differences in the right tail of the distribution. The distribution of hours of work for those who do not attend school is stretched to the right, i.e., some children who do not attend school spend a lot of time on work and this leads to the differences in the means of this variable across school participation.

The numbers presented in Table 3 and the discussion so far suggests that there may be a negative relationship between the probability of school attendance and the number of hours worked. To explicitly explore the bivariate relationship between school attendance (reading and writing ability) and hours of work, Figure 7a presents estimates from a lowest regression of the probability of attending school on the total number of hours of work. Figure 7b presents lowest estimates of the probability that a child can read and write versus the total number of hours of work. Figure 7a shows that there is a non-linear relationship between the probability of attending school and hours of work. Until about 30 hours of work, school participation and working are positively related but beyond that peak there is a negative relationship between the two variables. The same pattern prevails for the probability that a child can read and write. These patterns suggest that it is only beyond a certain number of hours of work that the labor contribution of children begins to hinder school attendance and their ability to read and write.

6. SCHOOLING, RW, AND HOURS OF WORK - REDUCED FORM AND STRUCTURAL RELATIONSHIPS

6.1 Specification

The reduced form schooling and RWA equations are specified as functions of the shadow wage of a child, the price and quality of schooling and a vector of exogenous attributes. We treat the shadow wage as a function of the gender, age, ethnicity, and religion of a child and several variables that reflect the demographic composition of the household (family size, number of infants, number of females, female headed household).

The cost of attending school is measured by the time taken to reach school. Regardless of school attendance parents were asked whether they were satisfied with the available educational quality. This variable is used as a crude measure of the quality of educational inputs.

The exogenous variables corresponding to *E* (*K*) in equation (19) include a set of two indicators that indicate whether the household head has completed primary or secondary education. Variables which capture household wealth and assets are the materials used to construct the roof and the wall of a household's dwelling, the livestock owned by a household, and variables that indicate the quantity and quality of the land available to the household. Two additional variables that reflect institutional arrangements and may have a bearing on school attendance/hours of work are whether a household has a share-cropping contract and whether a household is involved in a traditional labor-sharing arrangement.[18]

Both the schooling and the hours of work equations include the set of variables discussed above. In addition, the hours of work equation contains an additional set of variables that corresponds to *r* in equation (19). Ideally, this set of variables should be the prices of relevant agricultural inputs. Since we don't have this information we use peasant association (PA) level averages of the use of four inputs as proxies for household accessibility to modern agricultural technologies. In our work we consider the effects of the availability of land-saving technologies such as inorganic fertilisers and high-yielding seed varieties and the effect of labor-saving technologies such as access to tractors, agricultural machinery and agricultural chemicals (pesticides and herbicides) on hours of work. We expect that access to agricultural machinery and agricultural chemicals will be associated with a reduction in child labor. On the other hand the application of fertilizers and improved seeds may call for additional effort from children and in the short run may increase the demand for child labor.

6.2 Schooling and RW - reduced form

Tables 5a and 5b present reduced form estimates of the probability that a child attends school and the probability that a child can read and write. The estimates are presented for the combined sample of children and then for boys and girls separately. For the most part, the probit estimates of school attendance and RWA do not differ and we confine our discussion to the estimates of school attendance.

Consistent with the gender differences discussed earlier, males are more likely to attend school. Being male is associated with an 8 percentage point increase in the probability of attending school. The probability of attending school increases with age (a marginal effect of close to 10 percentage points) and reaches a peak at about twelve and a half years of age.

[18] A traditional labor arrangement is a labor-exchange practice where households share the available household labor resources for farm work in a rotating manner. This practice allows households to fulfil their demand for labor, especially during the peak season.

The effect of the set of demographic variables is markedly different across genders. The size of the household, the number of infants and the number of female members have no bearing on the school attendance decision for boys. For girls, a larger family size and particularly the number of infants in a household sharply reduces the probability of school attendance while a larger number of female members in a household encourages school attendance. This suggests that adult and child female labor are substitutes.

The cost of attending school as captured by the distance to the closest school has the expected sign configuration but is not statistically significant. Although crude, our measure of the quality of school inputs has a positive sign and shows that school attendance decisions are motivated by the perceived quality of school inputs. The marginal effect is about 14 percentage points. The effect differs across genders with a much larger effect for boys. Thus, any marginal improvement in the quality of schooling is likely to lead to a far greater increase in school attendance for boys and exacerbate existing gender differences.

Parental education has a strong impact on the school attendance decisions. The effect is stronger for those parents with secondary education. Children from families where the household head has secondary education are 15-28 percentage points more likely to send their child to school. There are several variables that capture the wealth and asset position of the household. Of these variables, only the number of cattle owned by the household appears to have an impact on the attendance decisions. The number of cattle owned by a household may increase the need for child labor and reduce school attendance. On the other hand this variable reflects household wealth and the ability to access credit and it may be positively associated with school attendance. A priori, it is difficult to sign the effect of this variable. In our case, there is a clear positive effect. An additional unit of cattle owned by a household increases the probability of attending school by about 1.6 percentage points. The amount of land cultivated by a household may also have ambiguous effects on the schooling decisions. A larger land endowment may reflect household income and wealth but also increases labor demand. In the absence of a market for child labor, a larger land endowment may reduce the ability of children to attend school. In our case we are unable to detect any direct link between land endowment and school attendance. In the Ethiopian context, all land belongs to the state and households may not consider the amount of land that they cultivate as a part of their asset portfolio. It is possible that the lack of a link between land endowment and school attendance is a reflection of the insecurity of land tenure.

Variation in the type of institutional arrangements (share-cropping and labor-sharing) across households does not appear to have a strong bearing on school attendance.

6.3 Hours of Work – reduced form

Table 6 presents OLS estimates of the total hours of work equation. The tables present estimates for the full sample and separately for males and females.[19] Consistent with the discussion in the earlier sections there are no differences in the hours of work across genders. As children age they are more likely to work. Based on our estimates, a one-year increase in age is associated with an additional weekly contribution of about three hours of work.

The demographic composition of the household and patterns of work are quite interesting. An increase in the number of infants (age 0-3) in a family calls forth extra work effort from older children. As may be expected the marginal effect is much larger for girls (2.6) than for boys (1.4). Less work effort is required from children living in families with a larger number of adult female household members. The effect is large and statistically significant suggesting that the work effort provided by girls and that provided by adult female members are strong substitutes.

The variables that reflect the cost and quality of education have no impact on the number of hours worked by children. The coefficients on the two schooling related variables are the key coefficients in the indirect approach and combining these results with those obtained from the schooling equation suggests that school attendance and hours of work are *not* substitutes. The pattern of results across the two equations indicates that while improvements in school quality will increase the probability of attending school, the additional time spent in school will not come at the cost of reduced hours of work. Thus, a reduction in leisure and not a reduction in the number of hours of work may accompany an increase in time spent in school.

Education of the household head has strong effects on hours of work. The marginal impact of a household head with secondary education work is a reduction in work effort by about 4 hours. There are sharp differences across gender. While education is associated with a 5 hour reduction in the work week for boys there is no statistically significant impact on girls. These differences across gender are in sharp contrast to the effect of the education of the household head on schooling decisions. The story

[19] In addition to OLS, we used a Tobit model and Powell´s Censored Least Absolute Deviations (CLAD) Estimator to estimate the hours of work equation. Since labor force participation is very high, differences between the OLS and Tobit estimates were not pronounced. These estimates are available on request.

that emerges is that while both boys and girls from better educated households are more likely to attend school, it is only boys who are expected to work less. Regardless of school status girls are expected to complete their quota of work.

Since the wealth variables capture household assets and also, in some cases, the demand for child work, they need to be interpreted carefully. Similar to the schooling estimates we are unable to detect a relationship between hours of work and the amount of land that a household cultivates. On the other hand the relationship between an important household asset - cattle - and hours of work is weakly non-linear. As the cattle holdings of a family increase there is an increase in the number of hours of work provided by children. However, beyond a certain point the work effort declines. While the relationship between assets and hours of work is non-linear, it is weak and operates only beyond a substantial cattle holding. For cattle, the peak is reached at about 17 livestock units. This figure is about 3.5 standard deviations to the right of the mean holdings. Thus, for most households one may consider that increased asset ownership is associated with increased work effort. Given the absence of a well-functioning labor markets the positive relationship between asset ownership and hours of work is not surprising. Overall, the pattern of results suggests that additional asset ownership (cattle) leads to an increase in the number of hours of work and an increase in the probability of attending school.

The final set of variables included in the specification are those that capture the use of modern agricultural technologies. As mentioned earlier, the Government of Ethiopia is currently pushing an extensive and aggressive extension program aimed at introducing farmers to new and modern methods of agricultural production. To examine the links between the availability of these technologies and child work we include a set of four variables. These variables are defined as the percentage of households in a peasant association that use fertilisers, improved seeds, agricultural machinery and agricultural chemicals.[20] Of these four measures, the first two may be termed land-saving technologies. The impact of these innovations on the use of child labor is not clear. While increased application of fertiliser and improved seeds may increase the productivity of land, they may also lead to an increase in demand for harvest labor, including child labor at least in the short run.[21] On the other hand the introduction of labor-saving technologies such as tractors and other agricultural machinery may reduce labor demand for cultivation and planting. Similarly the use of

[20] An alternative specification would have been to use dummy variables to indicate whether a household uses a particular technology. However, we avoided this approach as the adoption and use of modern technologies may be endogenously determined with the number of hours of work.

[21] In future work we plan to carry out an analysis of the long-run impact of fertilizers and improved seeds on child labor.

agricultural chemicals such as herbicides may have a labor-displacing effect. The use of herbicides should reduce labor needs for weeding, which is an important activity for women and children in rural Ethiopia.

Estimates of the effect of the technology variables on hours of work are presented in Table 6. Two of the four measures are statistically significant. The availability of machinery has a large negative impact on hours of work. A percentage point increase in the availability of machinery is associated with almost a one hour reduction in child labor. At the moment the availability and use of agricultural machinery such as tractors, harvesters, threshers and shellers is extremely low in Ethiopia. The extent to which the adoption of such technologies is possible and/or relevant given the typical features (e.g. small landholdings) of Ethiopian farming needs to be examined. However it is quite clear from our estimates that the availability of agricultural machinery has an immediate impact on reducing the demand for male and female child labor.

Of the two land-saving technologies only the availability of improved seeds is associated with an increase in the use of child labor. The estimates indicate that a one standard deviation increase in the availability of improved seeds increases a child's workload by about 4 hours. While the long run impact of the adoption of improved seeds and the consequent increases in productivity ought to be a decline in child labor, in the short run the spread of this technology may be expected to increase the burden of work for children.

6.4 Structural Relationships (Direct links)

We begin our examination of the effect of hours of work on schooling and the RWA of children by including total hours of work as an additional regressor in the schooling/RWA equations. This first set of estimates does not treat hours of work endogenously and is similar to some of the early work in this area (for e.g., Patrinos and Psacharopouos, 1997). The estimates (Probit-1 in Table 7) show that there is a negative and statistically significant relationship between hours of work and schooling/RWA. The magnitude of the variable indicates that 10 hour increase in work effort is associated with a 2-4 percentage point decline in school attendance and reading and writing ability.

As displayed in Figures 7a and 7b we detect a non-linear relationship between hours of work and school attendance/RWA. Taking a cue from these estimates we re-estimate a probit model with a quadratic specification of the hours of work variable. The results are consistent with the patterns displayed in the figures. There is a clear

non-linear relationship between hours of work and school attendance. According to the probit estimates (Probit-2), initially, there is a positive relationship between hours of work and school attendance/RWA. Gradually, this positive effect declines and beyond a certain threshold additional work effort is associated with declining school participation/RWA. According to our estimates the inflexion point occurs between 16-22 hours of work for reading and writing ability and between 24-31 hours of work for school attendance. The non-linear relationship and different thresholds suggests that a work effort of about two hours a day does not interfere with the formal human capital development of a child. Beyond this threshold and between a daily workload of two to three hours a day the school performance of a child may be expected to suffer. A workload of more than three hours a day may be expected to hinder school performance and school attendance. An alternative way of interpreting the threshold effect is to consider the position of the 16-hour threshold in the distribution of the hours of work variable. We find that 60 percent of the children in our sample provide more than 16 hours of work, thus, working may be expected to have a negative impact on the school performance and attendance of about 60 percent of children in rural Ethiopia.

As discussed earlier, if work and schooling are endogenous then single-equation probit estimates will be misleading. For instance, if unobserved variables that influence schooling are negatively correlated with hours of work then the probit estimates presented in Table 7 will be overestimates of the negative effect of work on schooling. To account for the potential endogeneity we use the two-stage conditional maximum likelihood (2CML) approach sketched in section II.

Table 7 presents three sets of estimates based on the 2CML approach. These estimates rely on different identification strategies.[22] For all three sets of estimates the coefficient λ on the endogeneity correction term is usually negative and statistically insignificant. This pattern of results suggests that schooling and hours of work are not simultaneously determined. Of course, the lack of precision and the inability to detect an endogenous relationship may lie in the poor quality of the instruments. Notwithstanding the statistical insignificance, the negative sign on the coefficient supports the idea that probit estimates that do not correct for endogeneity exaggerate the negative effect of work on schooling. Accordingly, the estimates that

[22] Identification of 2cml-1 is based on functional form differences. The specification of the schooling and work equations are exactly the same. 2cml-2 is based on including the intermediate input variables in the hours of work equation but excluding them from the schooling/RWA equations. 2cml-3 is based on excluding the intermediate input variables and the institutional variables (share cropping and labor sharing arrangements), and variables that reflect the quantity and quality of land (landholding, fertility of land, number of plots) from the schooling equation.

we present in columns Probit-1 and Probit-2 err on the side of caution and may be thought of as providing estimates of the lowest threshold at which work may begin to interfere with school performance and school attendance.

So far we have been concerned with the effect of the total number of hours of work on school attendance and RWA. It is possible that amongst the five broad types of work activities that we have information on, some are more harmful than others. To examine this possibility one approach is to re-estimate the schooling models with the inclusion of a dis-aggregated set of five hours of work variables. A comprehensive assessment of the differential effect of work-type requires us to examine the endogeneity between each type of work and schooling. While data requirements preclude such a comprehensive approach we can still provide an idea of the effects of the different types of work. Figure 8 presents lowest estimates of the bivariate relationship between school attendance and each type of work activity.

The various components of Figure 8 reveal some clear-cut patterns. The clearest effect is that for both males and females herding activities and school attendance are unequivocally incompatible. There is a negative and approximately linear relationship between hours of work spent on herding and schooling. Consistent with the overall effect of hours of work, the effect of farm work is non-linear. Up to a certain threshold there is a positive relationship which gradually becomes negative. The effect is far clearer for boys than for girls. For the total sample the effect of child care on school attendance is negative. Once again the effect is pronounced for boys and not very clear for girls. For the other types of work activities the effects on schooling are not very distinct. Domestic work and schooling appear to be uncorrelated while there appears to be a positive link between schooling and fetching wood/water.[23]

7. DISCUSSION AND CONCLUDING REMARKS

Child labor is a sensitive and controversial issue. What constitutes child labor, what is the best way to address it and what are the consequences of child labor are topics that are hotly debated. Although the highest incidence of child labor is found in sub-Saharan Africa, studies on child labor in the continent are limited and sketchy. To fill some of the gaps in the existing literature this paper takes advantage of a recently collected data set that contained a module specially designed to gather information

[23] Exploratory regression analysis confirms these patterns. Herding, child care and farm work hinder the ability of boys to attend school while it is only time spent on herding that appears to have a negative impact on girls. Domestic work and collecting water and wood do not seem to have a detrimental effect on school attendance.

on the work activities of children in the age group 4-15. This information collected in rural Ethiopia during the crop season 1999-2000 allowed us to address several issues of topical concern. First, we used the detailed data on time-use patterns of children to provide an idea of the incidence and intensity of child labor in rural Ethiopia. Second, we assessed the factors that were responsible for determining the allocation of child time to schooling and work. Third, we examined the consequences of child labor on the school attendance and the reading and writing ability of children.

Our main findings are highlighted in the following paragraphs. We began our analysis by establishing the patterns of child labor force and schooling participation amongst Ethiopia children. Although not entirely unexpected the extent of labor force participation prevailing in rural Ethiopia is very high. We found that as early as four years of age about 21 percent of children are involved in work activities and by the age of ten almost all children are involved in some form of work. On average children contribute 29-30 hours of work per week. While there are gender differences in the allocation of time to different types of work activities, with boys spending more time on herding and farm work and girls allocating more time to domestic chores, there are no differences in the total time allocated to work.

While the high intensity of work effort is striking the low levels of school participation may be of greater concern. We found that only about 44 percent of children in the age group seven to fifteen attend school and about 40 percent of the same age cohort are able to read and write. While both boys and girls shoulder the same workload, boys are far more likely to attend school than girls (47 vs 40 percent).

Our assessment of the factors responsible for school and work participation showed that school related measures such as school quality and school price have a strong effect on schooling but have no impact on the allocation of time to work. Policies that lead to improvements in the quality of education are likely to encourage school attendance but should not be expected to lead to a reduction in child work. Our analysis supports the idea that the household schooling and work decisions should be viewed separately. It is quite likely that any increases in school participation induced by quality increases in education are likely to come from a reduction in leisure and not from a reduction in work.

The impact of demand side characteristics such as the prevailing production technology on child work is relatively unexplored in the African context. The ongoing extension program in Ethiopia focuses on the spread of modern agricultural technology amongst Ethiopian farmers and may be expected to have an impact on agricultural productivity as well as on the allocation of child time to work. In this

paper we examined the impact of the increasing availability of agricultural machinery, chemicals (pesticides and herbicides), fertilizers and improved seeds on child work. We found that the increased availability of agricultural machinery sharply reduces the demand for child labor. The impact of land-saving technologies such as fertilizers and improved seeds is ambiguous. In the short run that we studied their presence was associated with an increase in the work burden. Whether the spread of labor-displacing technologies such as machinery and chemicals is the best way to increase agricultural productivity is debatable. However, if the aim is to have an immediate and direct impact on child labor then policies designed to spread the use of labor-saving technologies are most likely to achieve this goal.

The third issue that we examined in this paper was whether schooling and work are substitutes. We used an indirect and a direct approach to tackle this issue. Since variables that reflect the price/quality of schooling have no impact on child work, the indirect approach supported the idea that schooling and work are *not* substitutes. In contrast the direct approach led to a far more nuanced picture. We detected a non-linear relationship between duration of work and school attendance. Initially, there is a positive relationship between school attendance/RWA. Between 16-22 hours of weekly work, the ability of a child to read and write begins to suffer while school attendance is not affected. Beyond this threshold RWA and school attendance suffer. Although limited, we were able to examine the links between five different types of work activities and school attendance. We found that herding, farm work and child care activities were incompatible with school attendance. On the other hand time spent on domestic work and fetching wood/water did not appear to have a detrimental effect on schooling. While this aspect of our paper is still tentative, what is clear is that with 60 percent of children working more than 16 hours the formal human capital development of a majority of Ethiopian children is hindered.

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Table 1: Work Participation Rates and Hours of Work of Children age 4-15

	Total (N=3677)	Male (N=1785)	Female (N=1892)	T-statistic [a] (p-value)
Work Participation (%)	74.4	74.4	74.5	0.868
	(43.6)	(43.6)	(43.5)	(0.385)
Total Hours of Work in a week	29.61	29.99	29.21	0.410
	(27.23)	(27.54)	(26.9)	(0.681)
Hours worked on week days	25.10	25.25	24.93	0.063
	(24.02)	(24.01)	(24.03)	(0.946)
Fetching Wood/Water	4.72	3.70	5.80	8.58
	(7.44)	(6.65)	(8.05)	(0.000)
Domestic Tasks	5.80	3.47	8.27	14.49
	(10.21)	(8.17)	(11.51)	(0.000)
Child Care	2.57	1.55	3.63	8.35
	(7.54)	(6.27)	(8.56)	(0.000)
Farm Work	2.16	2.91	1.36	6.97
	(6.84)	(7.98)	(5.27)	(0.000)
Herding	9.85	13.61	5.86	13.71
	(17.72)	(20.09)	(13.73)	(0.000)

Notes: Figures are based on an Ethiopian Rural Household Survey conducted in 1999. [a] Two-tail t-statistic, absolute value. The null hypothesis is equality of means for males and females.

Table 2: School Participation and Writing and Reading Ability of Children age 7-15

	Total (N=2657)	Male (N=1365)	Female (N=1292)	T-statistic [a] (p-value)
School Participation (%)	43.9	47.0	40.7	3.245
	(49.6)	(49.9)	(49.1)	(0.0012)
Writing and Reading Ability (%)	39.4	43.0	35.6	3.918
	(48.8)	(49.5)	(47.9)	(0.0001)

Notes: Figures are based on an Ethiopian Rural Household Survey conducted in 1999. [a] Two-tail t-statistic,
absolute value. The null hypothesis is equality of means for males and females.

Table 3a: Schooling and Work - Children age 7-15

	School = 0 (1488)	**School = 1 (1169)**	**T-statistic [a] (p-value)**
Work Participation (%)	86.6	91.6	4.06
	(34)	(27.7)	(0.000)
Total Hours of Work in a week	38.44	34.36	4.00
	(28.06)	(23.13)	(0.000)
Hours worked on week days	33.03	28.39	5.12
	(24.93)	(20.7)	(0.000)
Fetching Wood/Water	5.68	6.26	1.875
	(7.98)	(7.97)	(0.061)
Domestic Tasks	7.21	7.94	1.685
	(11.07)	(11.32)	(0.092)
Child Care	3.27	2.69	1.5803
	(8.76)	(7.16)	(0.114)
Farm Work	2.63	3.11	1.828
	(7.78)	(7.76)	(0.0676)
Herding	14.24	8.38	8.1556
	(21.59)	(13.17)	(0.000)

Table 3b: Schooling and Work – Boys age 7-15

	School = 0 (723)	School = 1 (642)	T-statistic [a] (p-value)
Work Participation (%)	86.0	91.2	3.05
	(35)	(28.2)	(0.002)
Total Hours of Work in a week	40.07	33.68	4.48
	(28.87)	(23.09)	(0.000)
Hours worked on week days	34.28	27.63	5.31
	(25.36)	(20.2)	(0.000)
Fetching Wood/Water	3.85	5.45	4.081
	(6.59)	(7.87)	(0.000)
Domestic Tasks	3.95	4.91	1.942
	(9.01)	(9.23)	(0.052)
Child Care	2.23	1.38	2.263
	(8.36)	(4.70)	(0.024)
Farm Work	3.53	4.27	1.519
	(9.25)	(8.77)	(0.128)
Herding	20.71	11.63	8.20
	(24.17)	(14.97)	(0.000)

Table 3c: Schooling and Work – Girls age 7-15

	School = 0 (765)	School = 1 (527)	T-statistic [a] (p-value)
Work Participation	0.872	0.920	2.75
	(0.33)	(0.271)	(0.003)
Total Hours of Work in a week	36.90	35.20	1.165
	(27.21)	(23.18)	(0.244)
Hours worked on week days	31.86	29.31	1.923
	(24.48)	(21.2)	(0.053)
Fetching Wood/Water	7.41	7.26	0.319
	(8.76)	(7.99)	(0.754)
Domestic Tasks	10.28	11.64	1.967
	(11.93)	(12.47)	(0.049)
Child Care	4.25	4.28	0.060
	(9.02)	(9.07)	(0.952)
Farm Work	1.78	1.70	0.253
	(5.96)	(6.04)	(0.800
Herding	8.12	4.43	4.629
	(16.67)	(9.16)	(0.000)

Notes: Figures are based on an Ethiopian Rural Household Survey conducted in 1999.

[a] Two-tail t-statistic, absolute value. The null hypothesis is equality of means conditional on school enrolment status.

Table 4: Descriptive Statistics

Variable	Full Sample	
	Mean	Std. Dev.
Child characteristics		
Male = 1	0.514	0.499
Age	9.505	3.433
Ethnicity and Religion		
Amhara = 1	0.248	0.431
Oromo = 1	0.353	0.478
Tigrawi = 1	0.099	0.298
Orthodox Christian = 1	0.546	0.497
Muslim = 1	0.254	0.436
Educational characteristics		
Distance to the closest school (minutes)	40.09	34.38
Satisfied with the quality of education = 1	0.636	0.480
Household demographic and human capital characteristics		
Family size	9.304	3.527
Female headed household = 1	0.200	0.400
Number of infants (0-4 age group)	1.586	1.243
Number of female members in family	3.780	1.833
Head of household has 1-6 years of education = 1	0.210	0.407
Head of household has 7-12 years of education = 1	0.075	0.263
Household Wealth and Assets		
Roof of dwelling made of galvanized iron = 1	0.288	0.453
Wall of dwelling made of concrete, brick or cement = 1	0.186	0.389
Number of cattle (in livestock units)	4.279	4.052
Small ruminants (in livestock units)	2.936	5.319
Number of equines (in livestock units)	0.855	1.302
Size of cultivable land in hectares	1.324	1.087
Number of plots	3.376	2.246
Weighted fertility of land (index ranging from 1-good to 3-poor)	1.591	0.638
Institutional and regional controls		
Sharecropping = 1	0.295	0.456
Participation in traditional labor-sharing arrangement = 1	0.618	0.485
Family resides in region1 = 1	0.079	0.269
Family resides in region 2 = 1	0.289	0.453
Family resides in region 3 = 1	0.368	0.482
Family resides in region 4 = 1	0.090	0.286
Family resides in region 5 = 1	0.172	0.377
Intermediate Inputs		
Percentage of fertilizer users in PA	59.4	34.4
Percentage of machinery users in PA	2.78	5.68
Percentage of improved seed users in PA	21.6	24.9
Percentage of agricultural chemical users in PA	11.7	17.5
Number of Observations	***3677***	

Table 5a: Probability of Attending School, Children age 7-15 (Standard Errors)

Variable	Marginal Effects Full Sample	Marginal Effects Males	Marginal Effects Female
Male	0.082	.	.
	(0.024)		
Age	0.413	0.474	0.389
	(0.045)	(0.063)	(0.064)
Age squared	-0.016	-0.018	-0.015
	(0.002)	(0.003)	(0.003)
Distance to closest school	-0.0006	-0.0003	-0.0008
	(0.0035)	(0.0005)	(0.0005)
Quality of Education	0.137	0.197	0.092
	(0.024)	(0.036)	(0.034)
Family Size	-0.010	-0.008	-0.015
	(0.004)	(0.007)	(0.006)
Number of infants	-0.020	-0.003	-0.037
	(0.011)	(0.015)	(0.016)
Number of female members	0.017	0.011	0.032
	(0.009)	(0.012)	(0.012)
Household head has 1-6 years of education	0.079	0.065	0.093
	(0.029)	(0.042)	(0.043)
Household head has 7-12 years of education	0.220	0.148	0.285
	(0.043)	(0.062)	(0.062)
Roof	0.032	0.072	-0.008
	(0.026)	(0.037)	(0.037)
Wall	0.023	0.099	-0.060
	(0.040)	(0.056)	(0.056)
Cattle	0.016	0.015	0.016
	(0.008)	(0.011)	(0.011)
Cattle Squared	-0.0003	-0.0001	-0.0004
	(0.0004)	(0.0006)	(0.0006)
Small ruminants	-0.011	-0.007	-0.014
	(0.003)	(0.004)	(0.004)
Landholding in hectares	-0.023	-0.077	0.029
	(0.041)	(0.059)	(0.059)
Landholding in hectares squared	0.0038	0.012	-0.005
	(0.009)	(0.012)	(0.012)
Share cropping = 1	0.021	0.015	0.029
	(0.029)	(0.041)	(0.041)
Labour sharing arrangements = 1	-0.035	-0.012	-0.065
	(0.027)	(0.039)	(0.039)
Log Likelihood	-1311	-665	-614
Number of Observations	2227	1159	1068

Notes: Other regressors include indicator variables for ethnicity, religion, presence of biological parents in the household, female-headed household and region. Additional continuous variables in the model control for the fertility of the land, number of plots owned by the family, the number of equines and small ruminants.

Table 5b: Probability that Children age 7-15 can Read and Write (Standard Errors)

Variable	Marginal Effects Full Sample	Marginal Effects Males	Marginal Effects Female
Male	0.088	.	.
	(0.024)		
Age	0.394	0.447	0.375
	(0.046)	(0.068)	(0.063)
Age squared	-0.015	-0.017	-0.014
	(0.002)	(0.003)	(0.003)
Distance to closest school	-0.0004	0.0001	-0.0002
	(0.0036)	(0.0005)	(0.0005)
Quality of Education	0.128	0.184	0.091
	(0.024)	(0.034)	(0.033)
Family Size	-0.009	-0.008	-0.014
	(0.004)	(0.006)	(0.006)
Number of infants	-0.020	-0.005	-0.033
	(0.011)	(0.016)	(0.016)
Number of female members	0.020	0.026	0.023
	(0.008)	(0.012)	(0.012)
Household head has 1-6 years of education	0.080	0.059	0.094
	(0.029)	(0.042)	(0.043)
Household head has 7-12 years of education	0.224	0.130	0.313
	(0.046)	(0.065)	(0.065)
Roof	0.043	0.066	0.022
	(0.026)	(0.037)	(0.037)
Wall	0.068	0.135	0.011
	(0.041)	(0.056)	(0.057)
Cattle	0.005	-0.004	0.015
	(0.008)	(0.011)	(0.011)
Cattle Squared	-0.0006	0.0007	-0.0005
	(0.0004)	(0.0006)	(0.0006)
Small ruminants	-0.009	-0.008	-0.009
	(0.003)	(0.003)	(0.004)
Landholding in hectares	0.009	-0.032	0.042
	(0.041)	(0.060)	(0.058)
Landholding in hectares squared	-0.006	-0.003	-0.008
	(0.009)	(0.012)	(0.012)
Share cropping = 1	-0.007	-0.015	-0.002
	(0.028)	(0.041)	(0.039)
Labour sharing arrangements = 1	-0.035	-0.008	-0.068
	(0.026)	(0.039)	(0.038)
Log Likelihood	-1280	-650	-598
Number of Observations	2227	1159	1068

Notes: Other regressors include indicator variables for ethnicity, religion, presence of biological parents in the household, female-headed household and region. Additional continuous variables in the model control for the fertility of the land, number of plots owned by the family, the number of equines and small ruminants.

Table 6: Hours Worked Per Week by Children age 4-15, OLS Estimates (Standard Errors)

Variable	Full Sample	Males	Female
Male	-0.187	.	.
	(0.916)		
Age	11.89	11.53	12.25
	(0.728)	(1.038)	(1.02)
Age squared	-0.456	-0.454	-0.455
	(0.039)	(0.056)	(0.056)
Distance to closest school	-0.002	-0.017	0.020
	(0.014)	(0.019)	(0.020)
Quality of Education	0.934	0.523	1.524
	(0.978)	(1.454)	(1.311)
Family Size	-0.501	-0.444	-0.625
	(0.171)	(0.251)	(0.238)
Number of infants	1.921	1.358	2.616
	(0.427)	(0.611)	(0.601)
Number of female members	-0.846	-0.354	-1.258
	(0.327)	(0.463)	(0.475)
Household head has 1-6 years of education	-1.136	-2.399	0.439
	(1.084)	(1.541)	(1.526)
Household head has 7-12 years of education	-4.303	-4.808	-2.990
	(1.647)	(2.182)	(2.526)
Roof	1.309	0.557	1.960
	(1.033)	(1.504)	(1.426)
Wall	-5.584	-5.181	-6.866
	(1.527)	(2.173)	(2.105)
Cattle	0.676	0.481	0.894
	(0.294)	(0.415)	(0.410)
Cattle squared	-0.019	-0.012	-0.029
	(0.014)	(0.021)	(0.019)
Small ruminants	0.037	0.044	-0.041
	(0.120)	(0.169)	(0.163)
Landholding in hectares	1.695	2.572	0.822
	(1.896)	(2.339)	(2.596)
Landholding in hectares squared	-0.273	-0.473	-0.058
	(0.387)	(0.446)	(0.528)
Share cropping = 1	-0.031	2.390	-2.591
	(1.061)	(1.554)	(1.445)
Labour sharing arrangements = 1	0.876	1.182	1.012
	(1.105)	(1.624)	(1.510)
Percentage of fertiliser users in PA	-0.030	-0.002	-0.058
	(0.028)	(0.039)	(0.041)
Percentage of machinery users in PA	-0.934	-0.909	-0.926
	(0.146)	(0.214)	(0.198)
Percentage of improved seed users in PA	0.159	0.068	0.254
	(0.046)	(0.065)	(0.066)
Percentage of agricultural chemical users in PA	0.030	0.044	0.026
	(0.047)	(0.070)	(0.064)
R^2	0.249	0.235	0.295
Number of Observations	3043	1577	1466

Notes: Other regressors include indicator variables for ethnicity, religion, presence of biological parents in the household, female-headed household and region. Additional continuous variables in the model control for the fertility of the land, number of plots owned by the family, the number of equines and small ruminants.

Table 7a: Probability of Attending School, Children age 7-15 Marginal Effects from Probit and Two-stage Conditional Maximum Likelihood (2CML) Specifications (Standard Errors)

	Full Sample					Males					Females				
	Probit 1	**Probit 2**	**2cml 1**	**2cml 2**	**2cml 3**	**Probit 1**	**Probit 2**	**2cml 1**	**2cml 2**	**2cml 3**	**Probit 1**	**Probit 2**	**2cml 1**	**2cml 2**	**2cml 3**
Hours worked per week	-0.0030	0.004	0.006	0.008	0.008	-0.004	0.005	-0.0004	0.008	0.006	-0.002	0.005	0.004	0.009	0.005
	(0.0005)	(0.002)	(0.013)	(0.004)	(0.004)	(0.001)	(0.002)	(0.013)	(0.006)	(0.005)	(0.001)	(0.002)	(0.022)	(0.006)	(0.005)
Hours worked per week - squared *100	.	-0.009	-0.009	-0.009	-0.009	.	-0.011	-0.010	-0.010	-0.010	.	-0.008	-0.008	-0.008	-0.007
		(0.002)	(0.002)	(0.002)	(0.002)		(0.003)	(0.003)	(0.003)	(0.003)		(0.003)	(0.003)	(0.002)	(0.002)
Lambda	.	.	-0.002	-0.004	-0.004	.	.	0.005	-0.003	-0.001	.	.	0.001	-0.004	-0.0002
			(0.013)	(0.004)	(0.004)			(0.014)	(0.005)	(0.004)			(0.022)	(0.005)	(0.005)
Peak	.	*23.9*	*31.7*	*47.9*	*47.9*	.	*22.6*	*0*	36.2	26.9	.	*30.9*	*23.1*	*56.6*	*31*
N	2227	2227	2227	2227	2227	1159	1159	1159	1159	1159	1068	1068	1068	1068	1068
Log Likelihood	-1290	-1277	-1270	-1276	-1279	-648	-639	-636	-639	-641	-611	-605	-601	-605	-613

Table 7b: Probability that Children age 7-15 can Read and Write Marginal Effects from Probit and Two-stage Conditional Maximum Likelihood (2CML) Specifications (Standard Errors)

	Full Sample					Males					Females				
	Probit 1	**Probit 2**	**2cml 1**	**2cml 2**	**2cml 3**	**Probit 1**	**Probit 2**	**2cml 1**	**2cml 2**	**2cml 3**	**Probit 1**	**Probit 2**	**2cml 1**	**2cml 2**	**2cml 3**
Hours worked per week	-0.0029	0.002	0.007	0.004	0.005	-0.004	0.003	-0.005	0.005	0.005	-0.002	0.002	0.018	0.006	0.002
	(0.0005)	(0.0015)	(0.012)	(0.004)	(0.004)	(0.001)	(0.002)	(0.014)	(0.006)	(0.005)	(0.001)	(0.002)	(0.021)	(0.006)	(0.004)
Hours worked per week - squared *100	.	-0.006	-0.006	-0.006	-0.006	.	-0.008	-0.008	-0.008	-0.008		-0.004	-0.004	-0.004	-0.004
		(0.002)	(0.002)	(0.002)	(0.002)		(0.003)	(0.003)	(0.003)	(0.003)		(0.002)	(0.002)	(0.002)	(0.002)
Lambda	.	.	-0.005	-0.003	-0.003	.	.	-0.008	-0.003	-0.002	.	.	-0.016	-0.004	-0.001
			(0.012)	(0.004)	(0.004)			(0.013)	(0.005)	(0.005)			(0.021)	(0.005)	(0.005)
Peak	.	*15.8*	*62.5*	*40*	*45*	.	*17.7*	*0*	*33*	*31*	.	*22.1*	*193*	*73*	*29.5*
N	2227	2227	2227	2227	2227	1159	1159	1159	1159	1159	1068	1068	1068	1068	1068
Log Likelihood	-1261	-1256	-1252	-1255	-1262	-635	-630	-628	-630	-633	-595	-593	-590	-593	-602

Figure 1: Kernel Density Estimates-Hours of Work

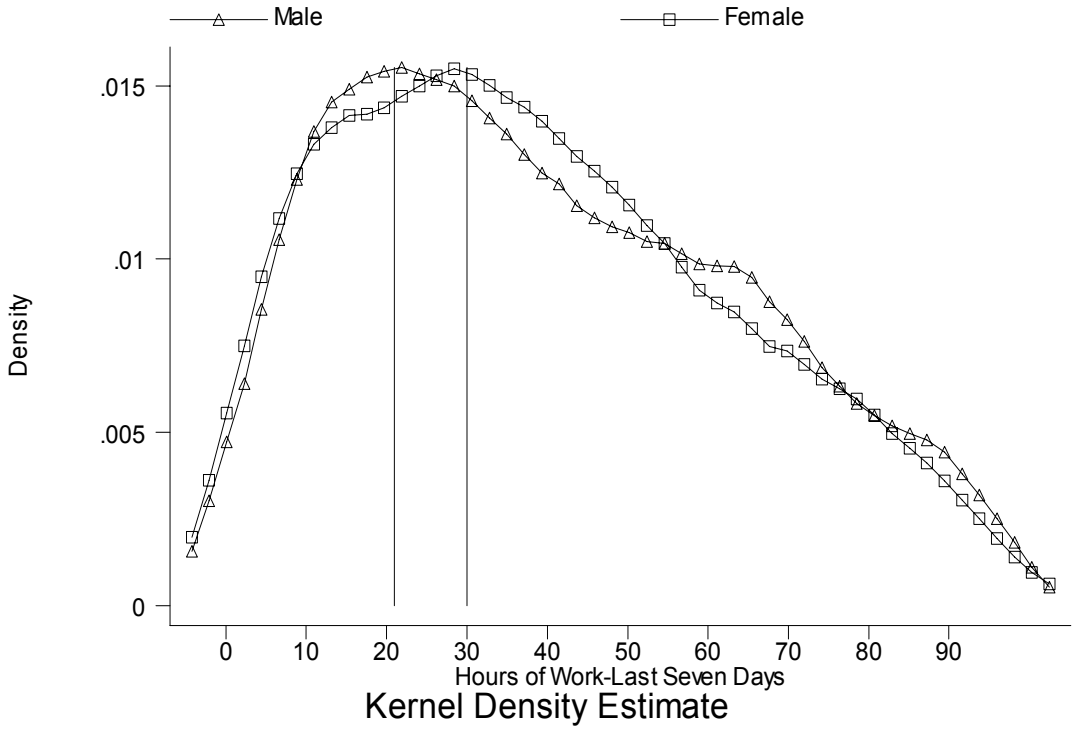


Figure 2: Hours of Work by Age and Gender

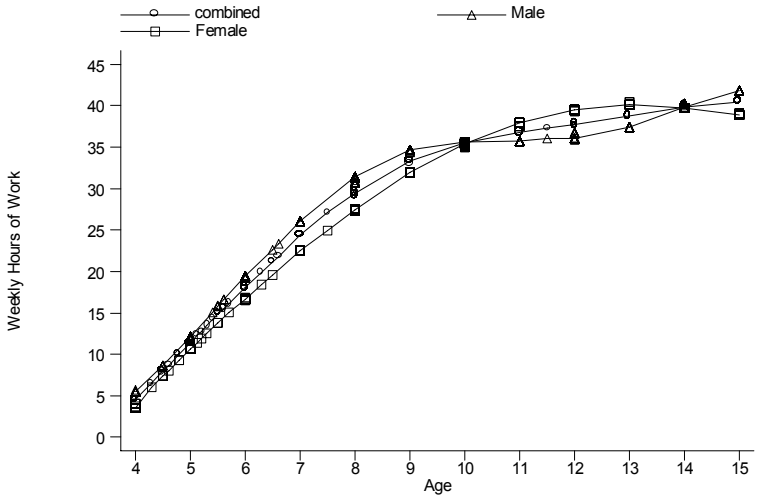


Figure 3: Participation by Age and Gender

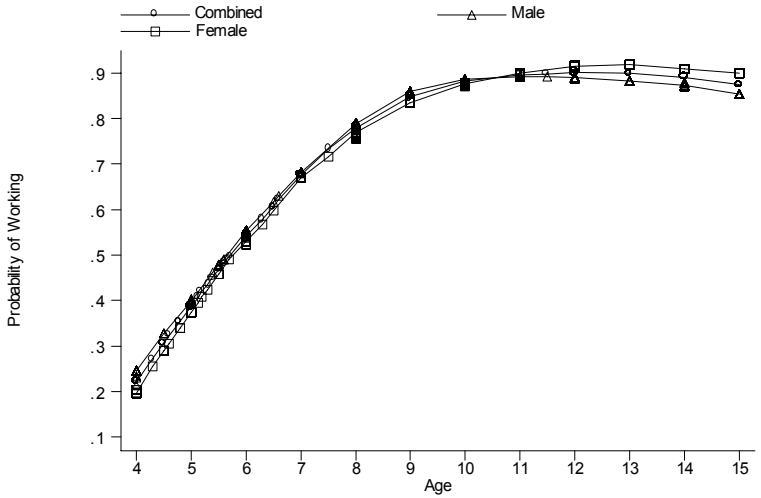
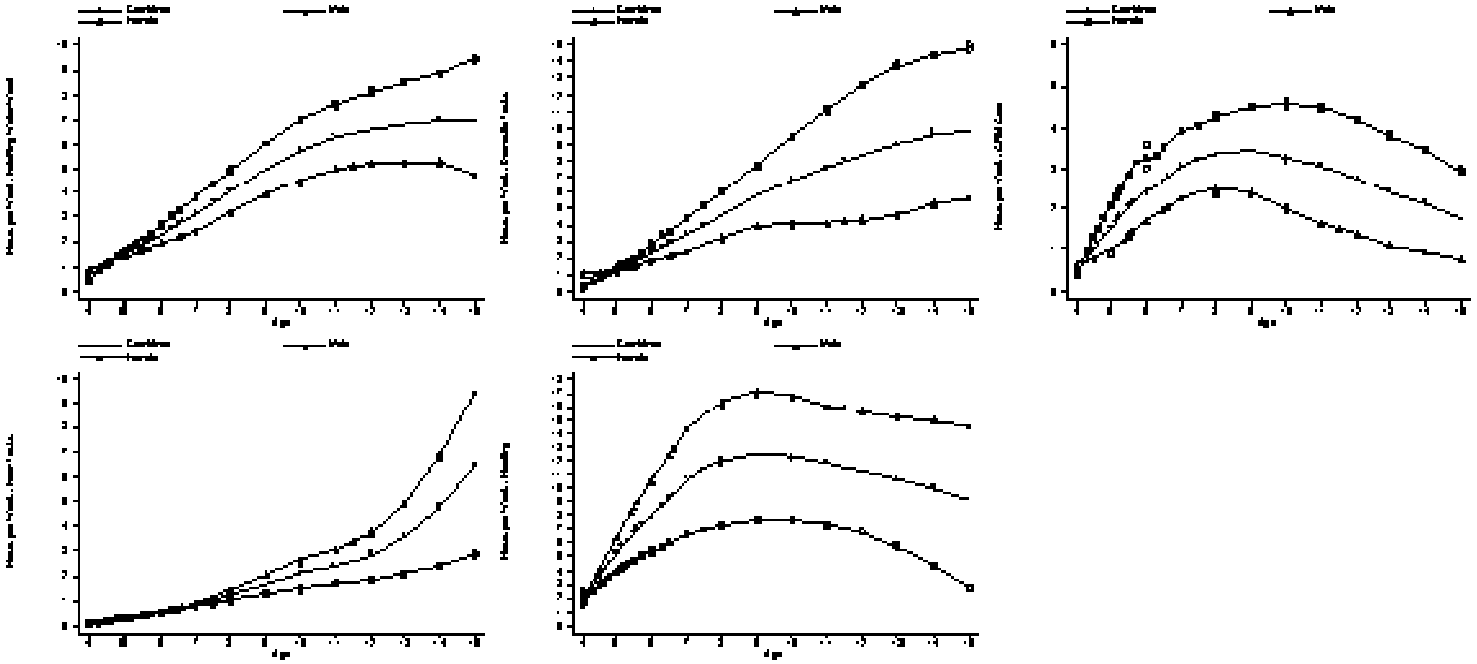
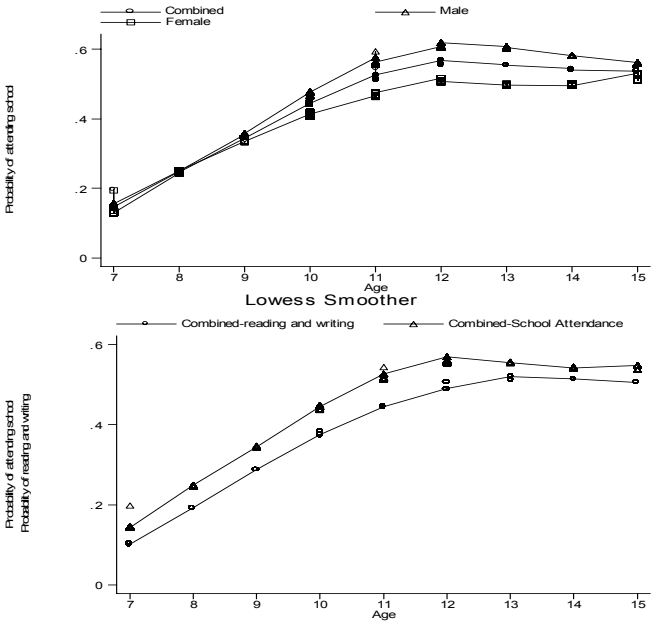
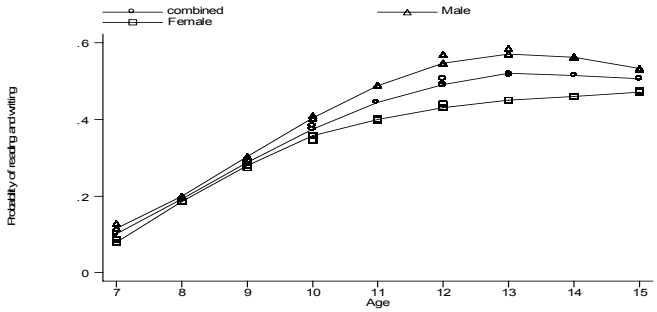


Figure 4: Hours of Work by Activity, Age and Gender







Lowess Smoother

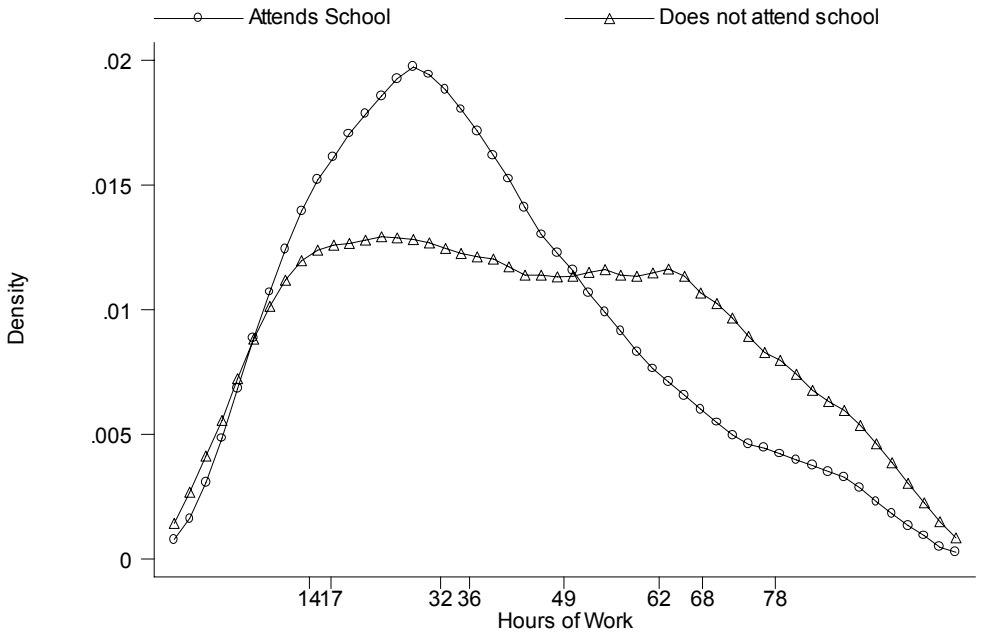

Attends School
Does not attend school
.02
.015
.01
.005
0
Density
14
17
32
36
49
62
68
78
Hours of Work

Figure 7a: Probability of Attending School

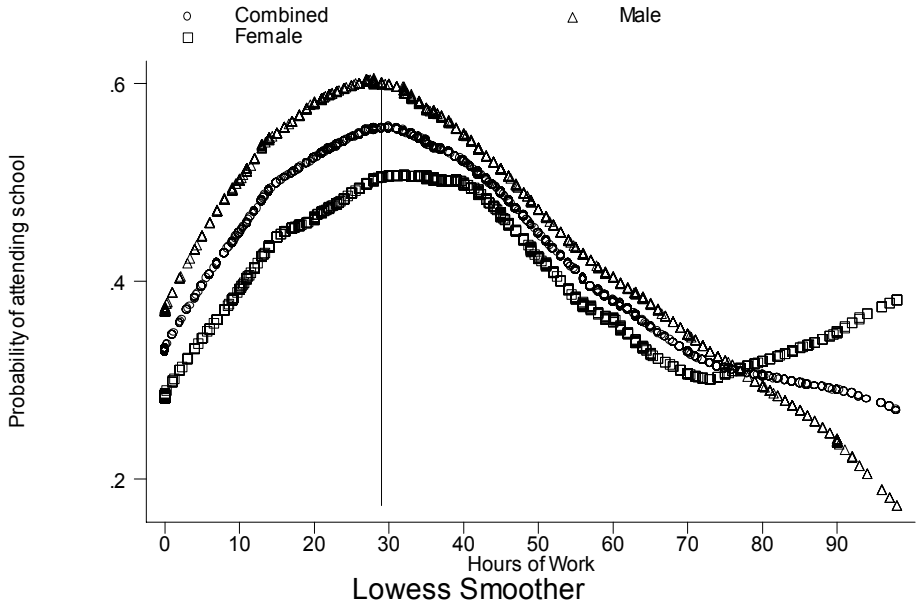


Figure 7b: Probability of Reading and Writing

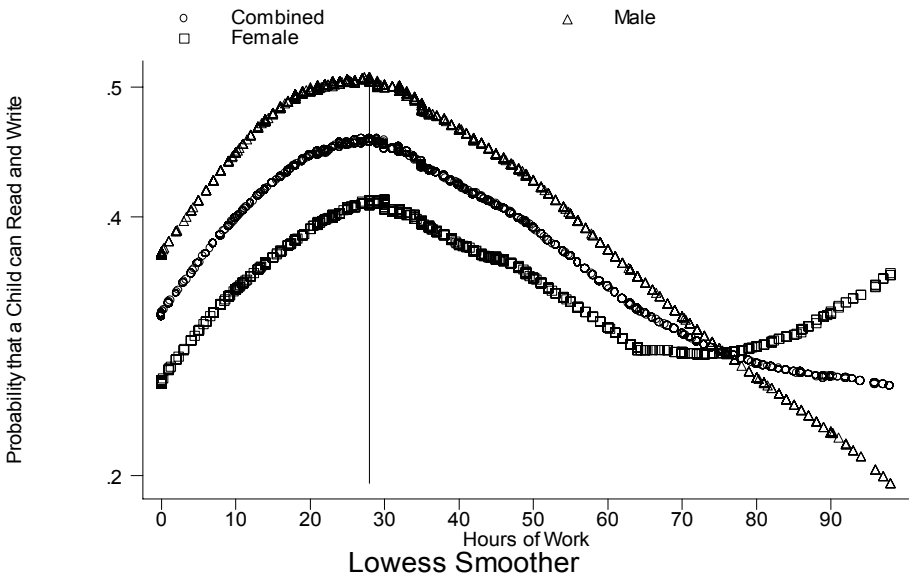


Figure 8: Probability of Attending School versus Hours of Work