Abstract: This paper formally analyzes the incidence of child labor by employing an overlapping-generations general-equilibrium model of a small open economy. An individual’s ability determines whether or not he/she becomes a skilled worker. The supply side of the economy is composed of two sectors: a modern sector that produces a homogeneous good using skilled labor and physical capital; and an agrarian sector that produces a traditional good using unskilled adult labor, child labor, and land. An increase in foreign direct investment and improvements in education reduce the incidence of child labor. Emigration of skilled (unskilled) workers reduces (raises) the supply of child labor, while trade sanctions reduce the demand for child labor. Child wage subsidies have an ambiguous effect on the incidence of child labor while education subsidies are effective in reducing the incidence of child labor. Simulation analysis is used to investigate the welfare effects of the aforementioned policies.

JEL Classification: J24; D60

Keywords: Child Labor; Economic Development; Efficiency Wages; Skill Acquisition; Trade

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1 Introduction

This paper builds a theoretical model that examines both the supply and demand sides of child labor in order to test the various policy options available to combat the problem. Over the last decade, the incidence of child labor has been in steady decline around the world. However, the number of children classified as economically active (over 191 million as of 2006)\(^1\) is still too high and highly concentrated in the poorest regions, namely in sub-Saharan African and Asia where the percentage of economically active children are 25% and 17%, respectively (ILO 2006b).

Economists have mostly examined the issue of child labor through the use of theoretical models due to the difficulty of acquiring data for empirical studies. The few published empirical papers have focused on household surveys in small regions in developing countries, but the results have shown contradictory evidence. For instance, Edmonds and Pavcnik (2005) found that globalization led to an increase in the price of rice in Vietnam, which decreased the incidence of child labor even though child labor is used heavily its production. On the other hand, Kruger (2007) found that globalization had the opposite effect, increasing the incidence of child labor in the coffee sector in Brazil when globalization led to an increase in the price of coffee beans.

Basu and Van (1998) began the theoretical investigation into the incidence of child labor. In their model, they examined the existence of multiple equilibriums: an equilibrium with low wages where children worked and another with high wages and no child labor. They found that a ban on child labor might be used effectively to jolt the economy to the favorable equilibrium with no child labor, but only if the ban increased

\(^1\) See International Labor Organization (ILO) 2006a. For a comprehensive survey of the child labor literature, see Basu (1999), Rogers and Swinnerton (2001), and Brown, Deardorff, and Stern (2003).
adult wages above a sustainability level. Ranjan (2001) and Jafarey and Lahiri (2002) focused on the parental decision of either sending their children to school or to work. These papers closely examined the factors that affect the supply of child labor, but they ignore or simplify the factors that determine the demand for child labor.

Gupta (2001) and Dinopoulou and Zhao (2007) put forth papers that focus predominately on the demand for child labor. Both studies use child nutritional efficiency wages, a practice continued in this paper, which allows for the child wage to be fixed. In Dinopoulou and Zhao, the supply of child labor is assumed to be perfectly elastic, and the income that guardians receive from sending their child to work is exogenous. Unfortunately, this assumption appears to be unrealistic, given that one of the main results, the effect of subsidies, has been shown to have an impact on the supply of child labor. This paper, in contrast to Dinopoulou and Zhao, makes endogenous the decision that parents have about whether to educate or employ their children, and thus allows for the supply of child labor to depend on the returns that parents receive from sending their children to work. This endogenizes the parental premium and allows the model to analyze the effect that policies have on both the supply and demand of child labor.

This paper aims to build on the theoretical literature by taking into account the parental decision as well as the production sector demands for child labor. This paper shows that policies enacted to reduce the incidence of child labor must carefully explore both the supply and demand components of child labor. A policy like child wage subsidies, while meant to reduce the supply of child labor, will also increase the demand for child labor by reducing the cost of hiring one unit of child labor. This can result in an
increase in the overall incidence of child labor. Education subsidies given to unskilled households are a better policy that will reduce the supply of child labor without affecting demand\(^2\). By endogenizing the premium paid to parents through the use of nutritional efficiency wages, this paper creates a market for child labor which can be used to test domestic and foreign policies.

The paper is organized as follows. Section 2 describes the dynamic general equilibrium model, starting with the characterization of the child schooling decision made by parents and concluding with a description of the two production sectors in the economy. Section 3 solves for the steady-state equilibrium and section 4 analyzes the effect of domestic and international policies on the incidence of child labor. Simulations are also included to examine welfare and distributional effects of the various policies. Section 5 concludes with some final remarks.

### 2 The Model

The model is a dynamic, overlapping-generations model that endogenizes the incidence of child labor. The model has two homogeneous goods: an agrarian good that is produced using land and unskilled adult and child labor, and a modern good that uses skilled labor and capital in its production. The productivity of skilled workers depends on their innate ability, which is assumed to differ among households but is constant across generations as in Ranjan (2001). Perfect competition in the production sector guarantees that adult workers are paid their marginal revenue product of labor. The cost of one unit of child labor is split between the amount given to children in the form of

\(^2\text{This result is supported in studies by Schultz (2004) and Ravallion and Wodon (2000).}\)
meals, which determines their productivity, and the parental premium given to parents for the employment of their child.

2.1 Household Decision

Household income is the primary reason that parents resort to sending their child to work. This is referred to as the “luxury” axiom in Basu and Van (1998) since educating a child is considered an unaffordable luxury for poor families. In this model, households are differentiated by their innate ability level, which subsequently determines their adult wage if they attended school as children. For notational convenience, the population of each generation is normalized to 1. A family consists of one adult and one child, so the overall population in the economy is 2. The ability of each family follows a uniform distribution, where the range of abilities is $\lambda \in [0,1]$. Parents are assumed to know their child’s ability because it is the same as their own. The assumption that parents and children have the same ability is for notational simplification, while the assumption that parents are aware of their child’s ability is a plausible one. Children sent to work receive some form of education before they become old enough to work, whether in primary schooling or home schooling, and parents are able to gauge their child’s aptitude in these early stages.

It is assumed that parents care about the future well-being of their children as well as the family’s current consumption of a modern and agrarian good. This assumption is a standard one used in the child-labor literature\(^3\). Let $V_t$ be the parent’s utility function at time $t$:

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\(^3\) See Basu (1998), Ranjan (2001), and Jafarey and Lahiri (2001).
\[ V_t = U(C_{xt}, C_{yt}) + \delta V_{t+1} \]  

(1)

where \( \delta \) is the level of altruism that the parent has toward his child’s future utility, and \( U(C_{xt}, C_{yt}) \) represents the family’s current consumption of the agrarian and modern good, respectively. For simplicity, it is assumed that all families have identical preferences. Writing Equation 1 in terms of prices and income gives the following indirect utility function:

\[ V_t = Z(p_{xt}, p_{yt}, I_t) + \delta V_{t+1} \]  

(2)

Income is dependent on the child schooling decision and the household’s ability level, where income at time \( t \) for any family is equal to:

\[
I_t = \begin{cases} 
  b + \theta w_{ct} & \text{if parent sends child to work} \\
  b & \text{if parent sends child to school} 
\end{cases}
\]  

(3)

where \( b \) is the parent’s income, \( w_{ct} \) is the child wage paid in kind to child workers at time \( t \), and \( \theta w_{ct} \) is the parental income from sending his/her child to work at time \( t \), where \( \theta \) will be referred to as the parental premium. It is assumed that children are fed at school if parents choose not to send them to work, and if children are sent to work, the firm will pay children in-kind by providing them food. The amount of food that they provide will determine the productivity of the child.

To simplify the model and to allow for the supply of child labor to be determined explicitly, a Cobb-Douglas specification is used to represent the parent’s utility from current consumption\(^4\):

\(^4\) The results of the model hold generally for any homothetic utility function where income enters linearly. A possible extension of the model would be to incorporate a utility function in which the marginal utility of income decreases as income increases, which would allow for income effects in the determination of the supply of child labor.
\[ U(x, y) = x^\gamma y^{1-\gamma} \]  

This leads to the following indirect utility function from Equation 2:

\[ Z(p, I) = \frac{rI}{P} \]  

where \( r = \gamma'(1-\gamma)^{1-\gamma} \) and \( P = p_x^\gamma p_y^{1-\gamma} \) is the price index. Since the income enters the indirect utility function linearly, the condition that determines the child labor decision of high-skilled households and low-skilled households is identical (see Appendix A for the derivations of the value functions and conditions for both types of households).

In the steady-state equilibrium, values of the endogenous variables must remain constant. To solve for the critical ability of the household that is indifferent between sending their child to work or school, \( \lambda^* \), in the steady-state equilibrium, we can use the corresponding value function for skilled and unskilled households:

\[
V_H(\lambda) = \max \left\{ Z((1+\lambda)w_H) + \delta V_H(\lambda), \ Z(((1+\lambda)w_H + \theta w_c) + \delta V_L(\lambda) \right\} 
\]

\[
V_L(\lambda) = \max \left\{ Z(w_L) + \delta V_H(\lambda), \ Z(w_L + \theta w_c) + \delta V_L(\lambda) \right\} 
\]

In the steady-state, it must be true that the first term in Equation 6 solves an educated parent’s maximization problem since skilled workers choose to educate their child. Likewise, the second term in Equation 7 must solve an unskilled parent’s maximization problem. The following must therefore be true in the steady-state equilibrium:

\[
V_H(\lambda) = \frac{1}{1-\delta} Z((1+\lambda)w_H) = \frac{1}{1-\delta} \frac{r}{P} [(1+\lambda)w_H] 
\]

\[
V_L(\lambda) = \frac{1}{1-\delta} Z(w_L + \theta w_c) = \frac{1}{1-\delta} \frac{r}{P} (w_L + \theta w_c) 
\]
Substituting Equations 8 and 9 into Equation 5, we can solve for the critical ability level \( \lambda^* \) that determines the supply of child labor:

\[
\frac{r(\theta w_c)}{P} = \frac{\delta}{1-\delta} \frac{r}{P} \left[ (1+\lambda)w_H - (w_L + \theta w_c) \right]
\]

\[
\Rightarrow \lambda^* = \text{Max} \left\{ 0, \frac{w_L + \theta w_c}{w_H} - 1 \right\}
\]  

(10)

Families with ability level \( \lambda \geq \lambda^* \) educate their children, while families with ability level \( \lambda < \lambda^* \) send their children to work.

Since a uniform distribution of abilities is assumed, and the population of children is normalized to 1, the supply of child labor is equal to the critical ability level:

\[
C^s = \int_0^\infty f(\sigma) d\sigma = \lambda^* \Rightarrow C^s = \text{Max} \left\{ 0, \frac{w_L + \theta w_c}{w_H} - 1 \right\}
\]  

(11)

As the unskilled wage, \( w_L \), and the parent’s income from sending their child to work, \( \theta \), increases, the supply of child labor will increase. As the skilled wage, \( w_H \), or the level of altruism, \( \delta \), increases, the supply of child labor will decrease.

2.2 Production

The production sector is characterized by perfect competition, which ensures that factors are paid their marginal revenue product. Capital complements skilled labor in the production of a modern good, while land complements unskilled adult and child labor in the production of an agrarian good. The production functions in both sectors are represented by constant returns to scale technologies of Cobb-Douglas form.
Modern sector

Skilled labor and capital are used in the production of the modern good. The productivity of a skilled worker will depend on his ability level. Using specific sector capital which is fixed in the modern sector allows for the analysis of foreign direct investment and its effect on the returns to education and the parental schooling decision. The production of the modern good is described by the following Cobb-Douglas production function:

\[ Y = F(H, K) = H^\beta K^{1-\beta} \] (12)

where \( H = \int_{\lambda}^{1} (1 + \lambda) d\lambda \) is the total human capital stock of skilled workers and \( 1 + \lambda \) is the productivity of a skilled worker given his ability. The price of the modern good will act as the numeraire. The profit function for a firm producing the modern good is:

\[ \Pi_Y = \left[ H^\beta K^{1-\beta} \right] - w_H H - r_K K \] (13)

The first order conditions of the production sector are shown in Appendix B. The wage paid to a skilled worker is dependent on the ability of that worker, \( \lambda \), resulting in his productivity being equal to \( 1 + \lambda \) and his income equal to \( (1 + \lambda)w_H \).

Agrarian sector

Output in the agrarian sector is determined by the amount of unskilled labor, both adult and child, and the amount of land available. Studies by the International Labor Organization (2006a) have found that the majority of children who forgo schooling tend to work in rural settings, so the use of land as a complement to child labor is warranted. The use of nutritional efficiency wages, not unlike that used in Stiglitz (1976), describes

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5 For an evaluation of the integral, see Equation 20.
how the productivity of child laborers may be dependent on the amount of food given to them. The nutritional efficiency function, which determines the productivity of children, \( h(w_c) \), is an increasing and concave function with respect to the consumption of food (the in-kind child wage), and is bounded from above. (i.e., there is a limit to how productive children can be, and since it is assumed that child labor is always less productive than adult unskilled labor, \( 0 < h(w_c) < 1 \).

The production of the agrarian good is determined by the following production function:

\[
X = G(L, C) = \left[ L + \tau h(w_c)C \right]^\alpha T^{1-\alpha}
\] (14)

where \( h(w_c) \) is the nutritional efficiency function of a child worker; \( \tau \) is a child equivalent scaling constant that equates how one unit of adult unskilled labor corresponds with one unit of child labor; \( \alpha \) is a productivity parameter; and \( C, L, \) and \( T \) are the amount of child labor, adult unskilled labor, and land, respectively. Firms in the agrarian sector maximize their profit with respect to land, adult unskilled labor, child labor, and the child wage paid to children in the form of meals\(^6\):

\[
\Pi_x = p_x \left[ L + \tau h(w_c)C \right]^\alpha T^{1-\alpha} - w_c L - (1 + \theta)w_c C - r_T T
\] (15)

Although children are paid \( w_c \) in the form of food, firms have to pay the premium, \( \theta w_c \), to parents, which makes the total cost of one unit of child labor equal to \( (1 + \theta)w_c \).

The wage paid to children in-kind is determined by the following function which is standard in the nutritional efficiency wage literature:

\[\]  

\(^6\) See Appendix B for the first-order conditions and the rental of land in the steady-state equilibrium.
\[ h'(w_c^*) = \frac{h(w_c^*)}{w_c^*} \] (16)

For agrarian firms to maximize profits, they pay child workers a wage that equates their marginal productivity of labor to their average productivity. This leads to the child wage, \( w_c^* \), being fixed in the steady-state equilibrium for a given nutritional efficiency function.

The first-order conditions can then be used to solve for the adult unskilled wage in terms of the child wage, the parental premium, and the productivity of children:

\[ w_L^* = \frac{(1 + \theta)w_c^*}{\tau h(w_c^*)} \] (17)

The demand for child labor, \( C^D \), can then be calculated as a function of the wages of both types of unskilled workers, the quantity of land and adult unskilled labor available, the price of the agrarian good, and the parameters of the model:

\[ C^D = \alpha^{1-\alpha} p_x^{1-\alpha} \left[ \tau h(w_c^*) \right]^{\alpha} \left[ (1 + \theta)w_c^* \right]^{1-\alpha} T \frac{L}{\tau h(w_c^*)} \] (18)

The demand for child labor is increasing in the amount of land in the agrarian sector and the price of the agrarian good, and is decreasing in the amount of adult unskilled labor and the parental premium.

Substituting the wage of skilled and unskilled adult workers in the household schooling decision, Equation 11, the supply of child labor can be derived in terms of the parental premium and the parameters of the model:

\[ C^s = \left[ \frac{(1 + \theta)w_c^*}{\tau h(w_c^*)} + \frac{\partial w_c^*}{\partial h(w_c^*)} \right] \frac{H^{1-\beta}}{\beta K^{1-\beta}} - 1 \] (19)
The supply of child labor is increasing in the parental premium and in the supply of adult skilled workers and is decreasing in the amount of capital in the modern sector and in the price of the modern good.

2.3 Steady-State Equilibrium

In the steady-state equilibrium, \( C_t = C_{t-1} \) for all \( t > 0 \). The amount of child labor at any time \( t \) has to be in the range \( C \in [0,1] \). Children who work become unskilled laborers in the next period, while children who attend school become skilled laborers working in the modern sector. The supply of unskilled workers is equal to the quantity of child labor in the previous generation, \( L_t = C_{t-1} \), while the amount of skilled workers in efficiency units is:

\[
H_t = \int_{C_{t-1}}^{1} (1 + \lambda) d \lambda = \frac{3}{2} - \frac{C_{t-1}^2 + 2C_{t-1}}{2}
\]  

Substituting these values into Equations 18 and 19 and writing the equations in terms of the inverse supply and demand of child labor in the steady-state equilibrium yields:

\[
\theta^D = \left[ \alpha p_x \right] \left[ \tau h(w_c^*) \right]^\alpha \left( \frac{1 + \tau h(w_c^*)}{\tau h(w_c^*)} \right)^{a-1} T^{1-\alpha} C^{a-1} - 1
\]

\[
\theta^S = \frac{\beta K^{1-\beta} (C + 1)}{\left[ \frac{1}{2} (3 - C^2 - 2C) \right]^{1-\beta}} \left( \frac{\delta h(w_c^*)}{\delta + \tau h(w_c^*)} \right) w_c^* \left( \frac{\delta}{\delta + \tau h(w_c^*)} \right)
\]

These equations not only determine the incidence of child labor in the steady-state equilibrium, but they also ensure an interior equilibrium, \( C \in (0,1) \).
As $C \to 0$, the demand for child labor goes to infinity because the scarcity of unskilled labor drives the unskilled wage, and the parental premium, upward. The same holds as $C \to 1$. In this case, most of the population is employed in the agrarian sector, and the marginal productivity of a unit of skilled labor goes to infinity. As shown in Figure 1, the parental premium and the incidence of child labor in the steady-state are determined by the intersection of Equations 21 and 22.

3 Comparative Statics

In this section, the comparative statics are computed to show how globalization and domestic policies affect the incidence of child labor. The paper first examines how an increase in foreign direct investment can impact the incidence of child labor before exploring the effects of domestic policies. When applicable, simulations were conducted to analyze the effect of the different policies on welfare as measured by the household’s

Figure 1. Steady-state equilibrium
indirect utility. The parameters used in the simulations were $\alpha = .75$, $p_x = .3$, $\gamma = .5$, $w_c = .2$, $h(w_c) = .7$, $\beta = .6$, $K = 10$, $T = .9$, $\delta = .5$, and $\tau = 1$. Using these figures, the incidence of child labor is roughly 21% of the child population, and the parental premium, $\theta$, is 2, meaning that parents receive $\theta w_c = .4$ for sending their child to work, which is a little less than half of the adult unskilled wage.

3.1 Foreign Direct Investment

Globalization can impact an economy by allowing an additional influx of foreign capital and investment. In this model, foreign direct investment impacts the parent’s schooling decision by increasing the marginal product of skilled labor. The increase in the skilled wage, $w_H$, shifts the supply of child labor leftward, as shown in Figure 2. This results in a decrease in the incidence of child labor and an increase in the parental premium. An interesting observation is that the increase in the parental premium not only increases the family’s income from sending the child to work, but it also increases the adult unskilled wage through the relationship in Equation 17.

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7 Since the population is normalized to 1, the amount of land and capital can be thought of the land per capita and the capital per capita, respectively. The values of $K$ and $L$ were calculated using statistics from the Philippines, where $K$ is an approximation of the total capital divided by the population, and $T$ is the amount of usable land (in square miles) divided by the population. The other values were arbitrarily assigned, but changes in these values do not qualitatively impact results.

8 Davis and Voy (2007) and Edmonds and Pavcnik (2005) have studied the relationship between FDI and trade openness with the incidence of child labor while controlling for endogenous factors. They also find a negative relationship between child labor and foreign direct investment.
Consequently, an increase in foreign direct investment not only has the benefit of directly decreasing the incidence of child labor, it also increases the incomes of poor families\(^9\). This result can better be seen by comparing the indirect utility of households, Equation 2, before and after the increase in foreign direct investment in Figure 3. A 10% increase in capital reduces the incidence of child labor from 22% to 19% (since a uniform distribution of abilities is assumed, the critical ability level also measures the child labor rate), and all households are better off than previously. Skilled households with the highest abilities benefit the most from an increase in foreign direct investment since the higher-skilled wage benefits workers with the highest productivity. The results on the incidence of child labor depend on the fact that capital is used only to produce the

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\(^9\) See Appendix C for an empirical exercise examining the effect of FDI on child labor. The estimation results suggest that the incidence of child labor is negatively correlated with FDI inflow, but the results are not conclusive due to limitations in the data.
modern good. If capital were used in the production of both goods, then the results would be ambiguous.

![Welfare graph]

Figure 3. Welfare among households with an increase in FDI

3.2 Trade Sanctions

Internationally, trade sanctions have been recommended as a way of punishing countries that use child labor in the production of traded goods. By reducing the international demand for the good in question, trade sanctions attempt to lower the international price of the good. The fall in $p_x$ lowers the demand for child labor, Equation 21, and lowers the incidence of child labor in the steady-state equilibrium. However, families with low ability may be punished because sanctions reduce nominal incomes by decreasing the parental premium and the adult unskilled wage.
As shown in Figure 4, a reduction of the price of the agrarian good from .3 to .2 reduced the incidence of child labor from .22 to .15. The effect of trade sanctions on the utility of unskilled households is ambiguous due to the fact that the lower agrarian price reduces the price level and can increase real income. Whether the decrease in the price of the agrarian good negates the fall in unskilled households’ incomes depends on the relative demand for the agrarian good. Skilled nominal wages fall due to the increase in skilled workers, but real incomes may rise due to the decrease in the price of the agrarian good.

3.3 Education Improvements

One way governments can increase child enrollment in schools is to improve the efficiency of the education system, which makes skilled workers more productive. By increasing the marginal productivity of skilled workers, the incomes of skilled workers and the returns to education will decrease the supply of child labor. This can be modeled
by changing Equation 20, the amount of skilled adult labor in terms of efficiency units, to:

\[ H = \int_{1}^{\lambda} (1 + \lambda + \sigma) d\lambda \]  

(23)

where \( \sigma \) represents improvements in education that increase the productivity of skilled workers. The supply of child labor then becomes:

\[ C^s = \left[ \frac{(1 + \theta) w^*_c}{\tau h(w^*_c)} + \frac{1}{\delta} \theta w^*_c \right] H^{1-\beta} \beta K^{1-\beta} - 1 - \sigma \]  

(24)

which is unambiguously less than the supply of child labor in Equation 22. Similar to the case of foreign direct investment, an increase in the education efficiency parameter, \( \sigma \), will shift the supply of child labor leftward, leading to an increase in the parental premium and a decrease in the incidence of child labor. Welfare effects are also similar, but there are greater gains for adult skilled households due to the increase in productivity.

### 3.4 Migration

Emigration of skilled workers is common in developing countries as wages for skilled workers are higher in developed economies. Here, the paper examines how emigration affects the incidence of child labor. First, assume that the skilled workers who migrate are those with the highest abilities since they would benefit the most from moving. Let \( \bar{\lambda} \in (\bar{\lambda}, 1) \) represent the skilled worker with the lowest ability who decides to relocate. Therefore, the effective units of skilled labor in Equation 20 becomes:

\[ H_i = \int_{\bar{\lambda}}^{\lambda} (1 + \lambda) d\lambda = \frac{\bar{\lambda}^2}{2} + 2\bar{\lambda} + C_{t-1}^2 + 2C_{t-1} \]  

(25)
which is unambiguously smaller than Equation 20 since $\lambda < 1$. Replacing Equation 19 in the supply of child labor equation yields:

$$C^s = \left[ \frac{(1+\theta)w^*_c}{\tau h(w^*_c + s)} + \frac{1}{\delta} \theta w^*_c \right] \left[ \frac{\lambda^2 + 2\lambda C_{t-1}^{2^*} + 2C_{t-1}}{2} \right]^{1-\beta} \beta K^{1-\beta} - 1$$  \hspace{1cm} (26)

which is less than Equation 19 and represents a decrease in the supply of child labor in the steady-state equilibrium. Like the case of foreign direct investment, emigration of skilled labor causes the supply of child labor to shift leftward, reducing the incidence of child labor in the steady-state and increasing the incomes of unskilled households.

![Figure 5. Welfare of households with emigration of skilled workers](image)

When skilled labor migrates, a void of skilled labor is left in the modern sector while the amount of capital remains fixed. This increases the marginal productivity of skilled workers and thus the skilled wage. The increase in the returns to education reduces the number of parents who are willing to forgo sending their child to school. As
shown in Figure 5, where $\bar{\lambda} = .9$, the welfare of unskilled households remains unchanged, but the welfare of skilled households increases due to a higher skilled wage.

### 3.5 Subsidies

Last, this paper examines how two different types of subsidies affect the employment of children. The first type analyzes financial assistance given directly to child workers in the form of meals (Dinopoulos and Zhao, 2007). The second type, which has been empirically tested, deals with subsidies given directly to low-income families to encourage them to send their children to school.

**Child wage subsidies**

Child wage subsidies are assumed to come from an exogenous source, which might include foreign aid from developed countries and aid from non-governmental organizations. If the subsidy were financed by the government, we would then have to examine the scope of government and the way in which the subsidy is financed. When the agrarian firms maximize their profits with respect to the amount of child labor and the wage paid to child labor in terms of food, the standard nutritional efficiency wage equation becomes:

$$h'(w_{c}^* + s^w)w_c = 1$$

(27)

The child wage subsidy increases the average productivity while decreasing the marginal productivity in Equation 27. This causes firms to lower the child wage that they pay children in-kind. The demand for child labor, Equation 21, will increase, while the
supply of child labor, Equation 22, will decrease, as shown in Figure 6. The effect of the child wage subsidies on the incidence of child labor is ambiguous since the increase in the parental premium is countered by a decrease in the child wage.

This result differs from that found in Dinopoulos and Zhao (2007). In that paper, the supply of child workers is assumed to be perfectly elastic. The child wage subsidy would therefore only increase the demand for child labor, leading to an increase in child labor in the agrarian sector. In this model, the increase in the average productivity of child laborers and reduction in the child wage decreases the adult unskilled wage, which increases the relative returns to education and decreases the supply of child labor. This leads to an ambiguous change in the incidence of child workers.
Education subsidies

Some countries have used education subsidies to reduce the incidence of child labor. Schultz (2004) examined a Mexican program called Progressa, in which households in a randomly selected low-income locality were given income subsidies if they sent their children to school. This resulted in an increase in average schooling for children in the localities that received the subsidy compared with similar localities that did not. Likewise, Ravallion and Wodon (2000) examined a similar education subsidy in Bangladesh and found that although increases in school enrollments came mostly at the expense of child leisure, the education subsidy did have a significant effect in reducing the incidence of child labor.

To incorporate an education subsidy into the model, it is necessary to look back to the supply of child labor equation, Equation 10, and add the subsidy, $s^E$, that parents would receive if they send their child to school. The household maximization problem becomes:

$$
\lambda^* = \max \left\{ \frac{w_L + \frac{1}{\delta} \theta W_C - s^E}{w_H} - 1 \right\}
$$

(28)

The education subsidy becomes an opportunity cost to parents who send their child to work, increasing the incentive to send one’s child to school.

An education subsidy will cause a leftward shift of the child-labor supply curve and therefore will have an outcome similar to an increase in FDI. Unskilled family income will benefit twice: once through a direct increase in household income caused by the education subsidy, and then through an indirect increase in the unskilled wage caused by the decrease in child workers. Table 1 summarizes the comparative statics results and
the effects that policies have on the welfare of unskilled households. As shown, most policies that reduce the incidence of child labor will lead to an increase in the welfare of unskilled households, even though some of these policies reduce the wage of unskilled workers.

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Table 1. Summary of Comparative Statics Results

4 Conclusion

Child labor is a major problem in developing countries, but one that looks to be in decline around the world. Still, some forms of child labor might always exist as long as parents are unable to sustain their families with only their income, and as long as firms have access to this cheap form of labor. The only way to truly eradicate the problem is to ensure that families can sustain adequate incomes without child labor earnings and ensure that there are high rewards for schooling so that families can escape the cycle of poverty that plagues many parts of the developing world.

This paper develops a dynamic general-equilibrium model of child labor that incorporates the parental schooling decision, which determines the supply of child, labor
and the profit-maximizing conditions of private firms, which determine the demand for child labor. The use of child nutritional efficiency wages allows for the development of an active market for child labor that is dependent on the skilled and unskilled wages in both sectors, the amount of capital and land in the economy, and parental preferences toward educating their children. This allows us to study the impact of domestic and foreign policy and its effects on both the demand for and supply of child labor.

Increases in foreign direct investment increase the returns to education and lead to a decrease in the incidence of child labor. In the long run, this increases the human capital stock in future generations and leads to higher sustained economic growth. This finding is consistent with similar works by Dinopoulos and Zhao (2007). However, this paper differs from Dinopoulos and Zhao in regard to the impact of child wage subsidies. While Dinopoulos and Zhao find that child wage subsidies increase the incidence of child labor by increasing their complement of production in the agrarian sector, this paper finds that child wage subsidies increase the incomes of unskilled households but have an ambiguous effect on the incidence of child labor. Finally, this paper shows that education subsidies can unambiguously decrease the incidence of child labor by giving families a monetary incentive to send their children to school.
References


Appendix A

Value Functions

In the steady-state equilibrium it is necessary to examine both the child-schooling decision of parents who are skilled workers and those who are unskilled. A household is characterized by two factors: the parent’s skill level and the household’s ability level, \( \lambda \), which is constant across generations. This allows for a given household’s child-schooling decision to be written in the form \( V_i(\lambda) \), where \( i \in \{H, L\} \) corresponds to whether the parent is skilled \( (i = H) \) or unskilled \( (i = L) \).

A skilled parent’s child-schooling decision is summarized by the following equation:

\[
V_H(\lambda) = \max \left\{ Z((1 + \lambda)w_H) + \delta V_H(\lambda), \; Z((1 + \lambda)w_H + \theta w_C) + \delta V_L(\lambda) \right\} \tag{A1}
\]

where the first part represents the parent’s utility if he sends his child to school, and the second part represents the parent’s utility if he sends his child to work. To find the critical ability level that makes a skilled parent indifferent between sending the child to school versus work, we equalize Equation A1 using the Cobb-Douglas specification in Equation 4:

\[
Z((1 + \lambda)w_H + \theta w_C) - Z((1 + \lambda)w_H) = \delta [V_H(\lambda) - V_L(\lambda)] \tag{A2}
\]

\[
\frac{r(\theta w_C)}{P} = \delta [V(1, \lambda) - V(0, \lambda)] \tag{A3}
\]

Let \( \lambda_H \) represent the critical ability level that solves Equation A3. For all skilled households with \( \lambda \geq \lambda_H \), parents will choose to send their child to school. For all skilled households with \( \lambda < \lambda_H \), parents will opt to send their children to work.

Similarly, an unskilled parent’s child schooling decision is summarized by:
\[ V_L(\lambda) = \max \{ Z(w_L) + \delta V_H(\lambda), Z(w_L + \theta w_c) + \delta V_L(\lambda) \} \]  \hspace{1cm} (A4)

where the first part once again corresponds to the parent educating his/her child, and the second part to sending the child to work. Equalizing to find the critical ability level, \( \lambda_L \), yields:

\[ Z(w_L + \theta w_c) - Z(w_L) = \delta [V_H(\lambda) - V_L(\lambda)] \]  \hspace{1cm} (A5)

Using the Cobb-Douglas specification gives us the same equation as the one for skilled parents. Since Equation A3 represents the child schooling for both skilled and unskilled households, \( \lambda_H = \lambda_L \), and the parent’s decision over whether to educate his child or not is independent of whether the parent is educated himself.
Appendix B

B.1 First-Order Conditions in the Modern Sector

Firms in the modern sector maximize Equation 13 with respect to the employment of skilled workers and sector-specific capital, yielding the following first-order conditions:

\[
\frac{d\Pi_y}{dH} = \beta \left[ \frac{K}{H} \right]^{-\beta} w_H = 0 \tag{B1}
\]

\[
\frac{d\Pi_y}{dK} = (1 - \beta) \left[ \frac{K}{H} \right]^{-\beta} r_K = 0 \tag{B2}
\]

B.2 First-Order Conditions in the Agrarian Sector

Firms in the agrarian sector maximize Equation 14 yields the following first-order conditions:

\[
\frac{d\Pi_x}{dL} = \alpha p_x \left[ \frac{T}{L + \tau h(w_c)C} \right]^{-\alpha} - w_L = 0 \tag{B3}
\]

\[
\frac{d\Pi_x}{dC} = \alpha p_x \tau h(w_c) \left[ \frac{T}{L + \tau h(w_c)C} \right]^{-\alpha} - (1 + \theta)w_c = 0 \tag{B4}
\]

\[
\frac{d\Pi_x}{dw_c} = \alpha p_x \tau h'(w_c)C \left[ \frac{T}{L + \tau h(w_c)C} \right]^{-\alpha} - (1 + \theta)C = 0 \tag{B5}
\]

\[
\frac{d\Pi_x}{dT} = (1 - \alpha) p_x \left[ \frac{T}{L + \tau h(w_c)C} \right]^{-\alpha} - r_T = 0 \tag{B6}
\]

To determine the rental of land, we combine Equations B3 and B6 to determine the relative rental of land in proportion to the unskilled adult wage:

\[
\frac{\alpha}{(1 - \alpha)} \frac{r_T}{w_L} = \left[ \frac{L + \tau h(w_c)C}{T} \right] \tag{B7}
\]
Equations B3 and B7 lead to the zero-profit condition in terms of the unskilled adult wage, the productivity parameter, \( \alpha \), and the price of the agrarian good, \( p_X \):

\[
p_X = (1 - \alpha)^{a-1} \alpha^{-a} \left( w^*_L \right)^{\alpha} r_T^{1-\alpha}
\]

This zero-profit condition, along with Equation 17, determines the rental of land in the steady-state equilibrium:

\[
r_T^* = (1 - \alpha)^{\frac{a}{1-\alpha}} p_X \frac{1}{\left\{ (1 + \theta)w^*_c \right\}^{\frac{\alpha}{1-\alpha}}} \left[ \frac{1}{\tau h(w^*_c)} \right]
\]

(B8)

(B9)
Appendix C

The following empirical exercises follow closely the work of Neumayer and De Soysa (2005) using World Bank panel data from 1985-2007. The independent variable in Table C1 is the rate of economically active children, ages 7-14. The independent variable that is being examined is the inflow of FDI as a percentage of GDP. The other independent variables are the natural log of GDP per capita, trade volume as a percentage of GDP, value-added as a share of GDP, and lastly the pupil-teacher ratio in secondary education. Regional and time fixed effects are also employed.

As shown in Table C1, the data suggests that the rate of FDI inflow is negatively correlated with the incidence of child labor as predicted by the model, but the estimation results are not conclusive due to a limitation in the data. There are only 118 observations in the broadest estimation. A retrospective power analysis test shows that a sample size ten times as large is needed to attain the power necessary to reject a Type II error. Similar to Neumayer and De Soysa, secondary school enrollment rates were similarly regressed using the same independent variables. The model predicts that an increase in FDI will increase the incentives to education and increase secondary school enrollment rates.

The estimation results in Table C2 suggest that the rate of FDI inflow is positively correlated with secondary school enrollments although once again the results are not conclusive. Secondary school enrollment rates do not take into account children who are home schooled and, in some countries, do not take into account children that attend private school. Therefore, one needs to be careful about making inferences about these estimation results on the incidence of child labor.
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Table C1. Main estimation results where the rate of economically active children ages 7-14 is the independent variable. T-values reported in parentheses and standard errors are robust to heteroskedasticity.  
* Significant at .1 level  
** Significant at .05 level  
*** Significant at .01 level
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Table C2. Estimation results where the secondary school enrollment rate is the independent variable. T-values reported in parentheses and standard errors are robust to heteroskedasticity.

* Significant at .1 level
** Significant at .05 level
*** Significant at .01 level