Nutritional Efficiency Wages and Child Labor

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Abstract: This paper analyzes the demand and supply of child labor in a dynamic, overlapping generations general-equilibrium model of a small open economy. An individual’s ability determines their income if they become a skilled worker. The production sector is composed of two goods: a modern good produced by skilled labor and capital, and an agrarian good produced by unskilled adult labor, child labor, and land. The model predicts that an increase in foreign direct investment and improvements in education will decrease the incidence of child labor. Emigration of skilled (unskilled) workers will reduce (increase) the supply of child labor, while trade sanctions will 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 child labor. Simulations are conducted to analyze how the effects of these policies affect the welfare of all households.

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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 nations. The number of economically active children accounts for 14% of the children in the world, but in sub-Saharan Africa and Asia, the number is closer to 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 it is still in doubt whether the results of these studies are applicable elsewhere. 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 in the production of rice. 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 even though globalization led to an increase in the price of coffee beans and in the wages in that sector.

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

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$^1$ 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).
equilibrium with low wages where adults and their children competed for work and another with high wages and no child labor. They found that a temporary 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 adult wages sufficiently. 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 Dinopoulos 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 equilibrium. In Dinopoulos 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, these assumptions appears to be highly unrealistic, given that one of the main results, the effect of subsidies, has been shown to have a significant impact on the supply of child labor. This paper endogenizes 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. The parental premium that parents receive is endogenous 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. The model
shows that policies that are 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. This result is supported in studies by Schultz (2004) and Ravallion and Wodon 
(2000). 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. Child wage subsidies, which in Dinopoulos and Zhao 
(2007) cause an increase in the incidence of child labor, has an ambiguous effect when 
one accounts for the reduced supply of child labor.

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 Model

This paper develops a dynamic overlapping-generations model that endogenizes 
the incidence of child labor. In the model, there are two homogenous goods produced:
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 differs among households. Perfect competition in the production sector guarantees that adult workers are paid their marginal product of labor. The cost of one unit of child labor is split between the amount given to the child in the form of meals and the parental premium given to parents for the employment of their child.

This paper builds off two recent theoretical papers in the child labor literature. Ranjan (2001) used differing talent levels to differentiate households, assuming that talent remains constant across generations. This enables the analysis of how credit constraints and income inequality affect the child schooling decision of parents. While analyzing income inequality and credit constraints is not the aim of this paper, abilities, and the corresponding assumption that abilities remain constant through generations, is used to characterize the supply of child labor. Dinopoulos and Zhao (2007) utilize child nutritional efficiency wages to fix the child wage. This leads to the adult skilled wage being fixed and is used to derive the demand for child labor. A key difference between this paper and that of Dinopoulos and Zhao is that in this paper the parental premium is endogenously determined.

**Household Decision**

One of the major reasons why parents resort to sending their child to work is due to low household income. This is referred to as the “luxury” axiom in Basu and Van (1998) since educating a child is considered an unaffordable luxury to poor families. In
this model, households are differentiated by their innate ability level that subsequently determines their adult wage if they were to have 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 equal to 2. The ability for each family follows a uniform distribution, where the range of abilities is equal to \( \lambda \in [0,1] \). 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\(^2\), while the assumption that parents are aware of their child’s ability is a plausible one. Children that are sent to work receive some form of education before they become old enough to work, whether it is 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 \( t \):

\[
V_t = U(C_{X_t}, C_{Y_t}) + \delta V_{t+1}
\] (1)

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

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\(^2\) As long as parental income does not enter in the child schooling decision, which is the case in this model, the assumption that households have a given ability level is not critical one since the supply of child labor will depend only on the given wages in both production sectors and on the distribution of abilities.

\(^3\) See Basu (1998), Ranjan (2001), and Jafarey and Lahiri (2001)
\[ V_t = Z(p_x, p_y, I_t) + \delta V_{t+1} \] (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:

\[
I_t = \begin{cases} 
    b + \theta w_c & \text{if parent sends child to work} \\
    b & \text{if parent sends child to school}
\end{cases}
\] (3)

where \( b \) is the parent’s income, \( w_c \) is the child wage paid to the child worker in the form of meals at time \( t \), and \( \theta w_c \) 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 necessary to examine the child schooling decision of parents who are skilled workers and those who are unskilled in the steady-state equilibrium. A household is characterized by two factors: whether the parent is skilled or not and the household’s ability level, \( \lambda \), which is constant over time. This allows for a given household’s child schooling decision to be written in the form \( V(\lambda) \), 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:

\[
V_H(\lambda) = \text{Max}[Z(1+\lambda)w_H) + \delta V_H(\lambda), \ Z((1+\lambda)w_H + \theta w_c) + \delta V_L(\lambda)]
\] (4)

where the first term in the maximization problem represents the parent’s utility if they were to send their child to school and the second term is the parent’s utility if they were to send their child to work. Let \( \lambda_H \) represent the educated household with the lowest ability level such that the first term is the maximum in (4). In other words, for all \( \lambda \geq \lambda_H \), educated parents will chose to educate their children while for all \( \lambda < \lambda_H \), these
parents will opt to send their children to work. Similarly, an unskilled parent’s child schooling decision is summarized by:

$$V_L(\lambda) = \text{Max}\left[Z(w_L) + \delta V_H(\lambda), \ Z(w_L + \theta w_C) + \delta V_L(\lambda)\right]$$

where the first term in the maximization problem once again corresponds to the parent educating his/her child and the second term corresponds to sending the child to work. Let \(\lambda_L\) similarly denote the maximum ability level for an unskilled worker where the second term is the maximum in (5).

The critical ability levels \(\lambda_H\) and \(\lambda_L\) are determined by equating the terms in the maximization problem. More specifically, \(\lambda_H\) represents the educated worker that is indifferent between sending their child to school and can be found by solving the following for \(\lambda\):

$$Z((1+\lambda)w_H + \theta w_C) - Z((1+\lambda)w_H) = \delta [V_H(\lambda) - V_L(\lambda)]$$

Similarly, \(\lambda_L\) represents the unskilled worker that is indifferent between educating their child or sending them to work and is once again determined by solving the following for \(\lambda\):

$$Z(w_L + \theta w_C) - Z(w_L) = \delta [V_H(\lambda) - V_L(\lambda)]$$

To simplify the model 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 the household’s current consumption:

$$U(x, y) = x^\gamma y^{1-\gamma}$$
This leads to the following indirect utility function in (2):

\[ Z(p, I) = \frac{rI}{P} \quad (9) \]

where \( r = \gamma^\gamma (1-\gamma)^{1-\gamma} \) and \( P = p_\gamma^\gamma p_\gamma^{1-\gamma} \) is the price index.

The inclusion of (9) in the child schooling decision in (6) and (7) results in:

\[ \frac{r(\theta w_c)}{P} = \delta [V(1, \lambda) - V(0, \lambda)] \quad (10) \]

for both conditions. Therefore, \( \lambda_H = \lambda_L \) and parents will choose to educate their child depending on condition (10) regardless of whether they themselves are educated. The ability level that solves (10) is represented by \( \bar{\lambda} \).

To solve directly for \( \bar{\lambda} \) in the steady-state equilibrium, we can use the corresponding value functions. In the steady-state, it must be true that the first term in (4) solves an educated parent’s maximization problem since skilled workers are going to choose to educate their child. Likewise, the second term in (5) must solve an unskilled parent’s maximization problem. The following must therefore be true in the steady-state equilibrium:

\[ V_H(\lambda) = \frac{1}{1-\delta} Z((1+\lambda)w_H) = \frac{1}{1-\delta} \frac{r}{P} [(1+\lambda)w_H] \quad (11) \]

\[ V_L(\lambda) = \frac{1}{1-\delta} Z(w_L + \theta w_c) = \frac{1}{1-\delta} \frac{r}{P} (w_L + \theta w_c) \quad (12) \]

Substituting (11) and (12) into condition (10), we can solve for the critical ability level \( \bar{\lambda} \) that determines the supply of child labor:

\[ \frac{r(\theta w_c)}{P} = \delta \frac{r}{1-\delta} \frac{1}{P} \left[ (1+\lambda)w_H - (w_L + \theta w_c) \right] \]
\[ \Rightarrow \bar{\lambda} = \text{Max} \left\{ 0, \frac{w_L + \frac{1}{\delta} \theta w_c}{w_H} - 1 \right\} \]  

(13)

Families with ability level \( \lambda \geq \bar{\lambda} \) are going to educate their children while families with ability level \( \lambda < \bar{\lambda} \) are going to 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:

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

(14)

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

**Production Sector**

The production sector is characterized by perfect competition that ensures that factors are paid their marginal productivities. Capital complements skilled labor in the production of the modern good while land complements unskilled adult and child labor in the production of the 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 in the modern sector allows for the analysis of foreign direct investment and its affect 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:

\[ Y = F(H, K) = H^\beta K^{1-\beta} \]  \hspace{1cm} (15)

where \( H = \int \frac{1}{\beta} (1 + \lambda) d\lambda \) \(^5\) 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 is the numeraire and equal to 1. The profit function for a firm producing the modern good is equal to:

\[ \Pi_r = \left[ H^\beta K^{1-\beta} \right] - w_s H - r_K K \]  \hspace{1cm} (16)

Firms maximize (16) with respect to the employment of skilled workers and sector-specific capital giving rise to the following first order conditions:

\[ \frac{d\Pi_r}{dH} = \beta \left[ \frac{K}{H} \right]^{1-\beta} - w_s = 0 \]  \hspace{1cm} (17)

\[ \frac{d\Pi_r}{dK} = (1 - \beta) \left[ \frac{K}{H} \right]^{-\beta} - r_K = 0 \]  \hspace{1cm} (18)

\(^5\) For an evaluation of the integral, see equation (33).
The rental of capital is determined by (18), and (17) determines the wage paid to skilled workers per their productivity level. Since a skilled worker with ability \( \lambda \) has productivity equal to \( 1 + \lambda \), his income will be 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 labor, and the amount of land available. Studies by the International Labor Organization (2006a) have found that the majority of children that 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 how the productivity of child laborers is dependent on the amount of food given to them in the form of meals. Gupta (2001) developed a model where the productive efficiency of child labor depends on the amount of food that was given to them by their employer. He found that when employers maximize their profits, the wage paid to children is such that a child’s average productivity is equal to their marginal productivity. Dinopoulos and Zhao (2007) utilize nutritional efficiency wages for children along with efficiency wages for skilled adults to analyze the effects of globalization and domestic policies on the demand for child labor.

A different route one can take in regards to the structure of the model is for parents to be the decision makers on how much to give their children in the forms of meals which would then determine their productivity. Firms would then take this productivity as given and pay child laborers their marginal revenue product. This
method, while structurally different, is analogous to the one we will use with the firms determining the child nutritional efficiency wage. The results are robust to the use of either method.

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

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

where $h(w_c)$ is the nutritional efficiency function of a child worker, $\tau$ is a child equivalent scaling constant that equates the productivity of one unit of adult unskilled labor to one unit of child labor, 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:

$$\Pi_X = p_X \left[ L + \tau h(w_c) C \right]^\alpha T^{1-\alpha} - w_L L - (1 + \theta)w_c C - r_T T$$

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 $(1 + \theta)w_c$. Maximizing (20) leads to the following first order conditions:

$$\frac{d\Pi_X}{dL} = \alpha p_X \left[ \frac{T}{L + \tau h(w_c) C} \right]^{1-\alpha} - w_L = 0$$

$$\frac{d\Pi_X}{dC} = \alpha p_X \tau h(w_c) \left[ \frac{T}{L + \tau h(w_c) C} \right]^{1-\alpha} - (1 + \theta)w_c = 0$$

$$\frac{d\Pi_X}{dw_c} = \alpha p_X \tau h'(w_c) C \left[ \frac{T}{L + \tau h(w_c) C} \right]^{1-\alpha} - (1 + \theta)C = 0$$
\[
\frac{d\Pi_X}{dT} = (1-\alpha)p_X \left[ \frac{T}{L + \tau h(w_c)C} \right]^{-\alpha} - r_T = 0
\]  

(24)

If we combine equations (22) and (23), we get the standard result in the nutritional efficiency wage literature:

\[
h'(\overline{w}_c) = \frac{h(\overline{w}_c)}{\overline{w}_c}
\]  

(25)

where the child wage, \( \overline{w}_c \), is fixed in the steady-state equilibrium for a given nutritional efficiency function. For agrarian firms to maximize profits, they pay child workers a wage that equates their marginal productivity to their average productivity.

Combining (21), (22), and (25), solves for the adult unskilled wage in terms of the child wage, the parental premium, and the child’s productivity:

\[
\overline{w}_L = \frac{(1+\theta)\overline{w}_c}{\tau h(\overline{w}_c)}
\]  

(26)

To determine the relationship between the child wage and the rental of land, we combine (21) and (24) to determine the relative rental of land in proportion to the unskilled adult wage:

\[
\frac{\alpha}{(1-\alpha)\overline{w}_L} \frac{r_T}{\overline{w}_L} = \left[ \frac{L + \tau h(\overline{w}_c)C}{T} \right]
\]  

(27)

Equations (21) and (27) lead to the zero-profit condition in terms of the unskilled adult wage, the productivity parameter, \( \alpha \), and the price of the agrarian good, \( p_x \):

\[
p_x = (1-\alpha)^{\alpha-1} \alpha^{-\alpha} \overline{w}_L r_T^{1-\alpha}
\]  

(28)

This zero-profit condition, along with (26), determines the rental of land:
\[
\bar{r}_t = (1 - \alpha)\alpha^{\frac{\alpha}{1-\alpha}} p_x^{\frac{1}{1-\alpha}} \left[ \frac{(1 + \theta)w_c}{\tau h(w_c)} \right]^{\frac{-\alpha}{1-\alpha}}
\]

(29)

and using (27), the demand for child labor, \( C^D \):

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

(30)

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 in the parental premium.

Substituting (17) and (26) in the household schooling decision, (14), the supply of child labor can be derived in terms of the parental premium and the parameters of the model:

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

(31)

The supply of child labor is increasing in the parental premium and in the supply of adult skilled workers, and decreasing in the amount of capital in the modern sector.

**Steady-State Equilibrium**

In the steady state equilibrium, \( C_t = C_{t-1} \) for all \( t > 1 \). 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 that 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 equal to:

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

Substituting these values into (30) and (31) and writing the equations in terms of the inverse supply and demand of child labor in the steady-state equilibrium yields:

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

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

These equations not only determine the incidence of child labor in the steady-state equilibrium, but they also ensure that we get 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 (33) and (34).
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 it turns its attention to the effects of domestic policies. When applicable, simulations were conducted to analyze the effect of the policies on welfare. The parameters used in the simulations were $\alpha = .75$, $p = .3$, $w_c = .2$, $h(w_c) = .7$, $\beta = .6$, $K = 10$, $L = .9$, $\delta = .5$, and $\tau = 1$. Using these figures, the incidence of child labor is roughly equal to 21% of the child population and the parental premium, $\theta$, is equal to 2, meaning that parents

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6 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, respectfully. The values of K and L were calculated using statistics from the Phillipines, where K is an approximation of the total capital divided by the population and L 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 impact results.
receive $\theta w_c = .4$ for sending their child to work, which is a little less than half of the adult unskilled wage for comparison.

**Foreign Direct Investment**

Globalization can impact an economy by increasing the amount of foreign capital and investment. In this model, foreign direct investment impacts the parent’s schooling decision by increasing the wage of skilled workers. The increase in the skilled wage, $w_h$, shifts the supply of child labor leftward as shown in Figure 2.

![Figure 2: Increase in FDI](image-url)
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 families’ income from sending the child to work, but it also increases the adult unskilled wage through the relationship in (26). 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. This result can better be seen by comparing the indirect utility of households, (2), before and after the increase in foreign direct investment in Figure 3.

![Figure 3: Welfare with increase in FDI among households](image)

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7 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.
The increase in capital reduces the incidence of child labor from 22% to 19% (since a uniform distribution of abilities is assumed and the population of children is normalized to 1) and all households are better off than they were before. Households with the highest abilities benefit the most from an increase in foreign direct investment as their greater productivity results in higher income. These results are dependent upon the fact that capital is used in only the production of the modern good. If capital were used in the production of both goods, then there would be ambiguity in the results.

*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 effectively lower the international demand, which corresponds to a drop in the price of the agrarian good in the model. The fall in $p_x$ lowers the demand for child labor, (33), and lowers the incidence of child labor in the steady-state equilibrium. A drawback to trade sanctions is that it may punish families with low ability since it lowers their nominal incomes by decreasing the parental premium and the adult unskilled wage.
As shown in Figure 4, the effect of trade sanctions on unskilled household utility is ambiguous due to the fact that the lower agrarian price reduces the price level and can therefore 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 experience an increase due to the fall in the price of the agrarian good.

**Education Improvements**

One of the efforts that governments can take to increase child enrollment in schools is to improve the efficiency of the education system which make 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 (16), the amount of skilled adult labor in terms of efficiency units, to:

$$H = \int_{\lambda}^{1} (1 + \lambda + \sigma) da$$

(35)

where $\sigma$ represents improvement in education that increases the productivity of skilled workers. The supply of child labor then becomes:

$$C^s = \frac{(1 + \theta)w_c}{\tau h(w_c)} + \frac{1}{\delta} \frac{\theta w_c}{\beta K^{1-\beta}} - 1 - \sigma$$

(36)

which is unambiguously less than the supply of child labor in (31). 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, as the gains for adult skilled households are greater due to the increase in their productivity.

**Migration**

Emigration of skilled workers is common in developing countries as wages for skilled workers are higher in developed economies. Here we examine how this migration affects the incidence of child labor. First, let’s assume that the skilled workers who migrate are those with the highest abilities since they would benefit the most from leaving. Let $\bar{\lambda} \in (\lambda, 1)$ represent the skilled worker with the lowest ability that decides to relocate. Therefore, the effective units of skilled labor, (32), becomes:

$$H_t = \int_{c_t}^{\bar{\lambda}} (1 + \lambda) d\lambda = \frac{\bar{\lambda}^3 + 2\bar{\lambda}}{2} - \frac{C_{t-1}^t + 2C_{t-1}}{2}$$

(37)
which is unambiguously smaller than (32) since $\overline{\lambda} < 1$. Replacing (37) in the supply of child labor equation, (34), gives us:

$$C^S = \left[ \frac{(1+\theta)\overline{w}_c}{\tau h\left(\overline{w}_c + s\right)} + \frac{1}{\delta} \theta \overline{w}_c \right] \left[ \frac{\overline{\lambda} + 2\overline{\lambda}}{2} - \frac{C_{t-1}^2 + 2C_{t-1}^{1-\beta}}{\beta K^{1-\beta}} \right] - 1 \quad (38)$$

which is less than (34) 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 incomes of unskilled families.

Figure 5: Welfare of households with emigration of skilled workers

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 their wage. The increase in the returns to education reduces the number of parents that are willing to forgo sending their child to school. As shown in Figure 5 (where it is assumed that $\overline{\lambda} = .9$), the welfare of unskilled households is unchanged, but the welfare of the remaining skilled households will increase.
**Subsidies**

Lastly, we examine how two different types of subsidies affect the employment of children in the economy. The first type, which was analyzed by Dinopoulos and Zhao (2007), looks at financial assistance given directly to child workers in the form of meals. The second type of subsidy, which has been empirically tested, deals with subsidies given directly to low income families to encourage families 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 developing 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. A direct subsidy given to children in the form of meals effectively changes an agrarian firm’s profit maximizing problem, (20), to:

\[
\Pi_c = p_c \left[ L + \tau h(w_c + s^w)C \right]^{\alpha} T^{1-\alpha} - w_c L - (1 + \theta)w_c C - r_c T
\]

where \( s^w \) is the value of the wage subsidy. 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:

\[
\frac{h'(w_c + s^w)w_c}{h(w_c + s^w)} = 1
\]

This child wage subsidy increases the average productivity while decreasing the marginal productivity. This will result in firms lowering the child wage that they pay in terms of food and changing the steady-state equations to:
The demand for child labor, (41), will increase while the supply of child labor, (42), decreases:

\[
C^D = \left[ \alpha p_x \right]^{\frac{1}{1-\alpha}} \left[ \tau h \left( \frac{w_c}{w_c + s^w} \right) \right]^{\frac{\alpha}{1-\alpha}} \left[ (1+\theta)w_c \right]^{\frac{1}{\alpha-1}} T - \frac{C^D}{\tau h \left( \frac{w_c}{w_c + s^w} \right)} \tag{41}
\]

\[
C^S = \left[ \frac{(1+\theta)w_c}{\tau h \left( \frac{w_c}{w_c + s^w} \right)} + \frac{1}{\delta} \theta w_c \right]^{\frac{1}{2} \left[ 3 - \left( C^S \right)^2 - 2C^S \right]} - 1 \tag{42}
\]

The effect of the child wage subsidies on the incidence of child labor is ambiguous as the increase in the parental premium is countered by a decrease in the child wage. Child wage subsidies lead to a decrease in the adult unskilled wage and its effect on the skilled wage depends on whether there is a change in the level of child labor.

Figure 6: Child wage subsidies
This result differs from that found in Dinopoulos and Zhao (2007). In that paper, the supply of child workers is perfectly elastic. This amounts to the supply of child labor being represented by a horizontal line at the exogenous parental premium. The child wage subsidy would therefore only increase the demand for child labor, leading to an increase in child labor in the agrarian sector. With land instead of skilled labor in the agrarian sector and an endogenous supply of child labor, the opposite holds true. The increase in the average productivity of child laborers decreases the wage of 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

Education subsidies have been used by some countries 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 when compared to similar localities that did not. Similarly, 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 an effect in reducing the incidence of child labor.

To incorporate an education subsidy in the model, one has to look back to the supply of child labor equation, (13), and add the subsidy, $s^E$, that parents would receive if they send their child to school. The maximization problem becomes:
The education subsidy becomes an opportunity cost to parents who send their child to work. This lowers the supply of child labor equation:

$$\bar{\lambda} = \text{Max} \left\{ 0, \frac{w_L + \frac{1}{\delta} \theta w_c - \frac{s^E}{\delta}}{w_H} - 1 \right\}$$  \hspace{1cm} (43)$$

An education subsidy will cause a leftwards shift of the supply of child labor 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 static results and the effect 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 may reduce the wage of unskilled workers. If the utility function had diminishing marginal utility of income instead of a constant return, policies that reduced the incidence of child labor and led to an increase in the adult unskilled wage would reinforce the reduction in child labor. Policies like trade sanctions, which lead to a decrease in the adult unskilled wage, would therefore have ambiguous results on the incidence of child labor.
Supply of Child Labor | Demand for Child Labor | Incidence of Child Labor | Welfare of Unskilled Households
--- | --- | --- | ---
**Domestic Policies**
Education | Decreases | Unchanged | Decreases | Increases
Migration of Skilled Workers | Decreases | Unchanged | Decreases | Increases
Child Wage | Decrease | Increase | Ambiguous | Increases
Education Subsidies | Decrease | Unchanged | Decrease | Increases
**Trade Policies**
Foreign Direct Investment | Decreases | Unchanged | Decreases | Increases
Trade Sanctions | Unchanged | Decrease | Decreases | Ambiguous

Table 1: Summary of Comparative Static Results

4 Conclusion

Child labor is a major problem in developing countries, but one that looks to be regressing around the world. Still, some forms of child labor might always exist as long as parents fail to sustain their family using 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 make certain that families are able to sustain adequate incomes without the need of child labor and that there be high rewards for schooling so that families can escape the vicious circle of poverty that plagues parts of the developing world.

This paper develops a dynamic general-equilibrium model of child labor that incorporates the parental schooling decision that determines the supply of child labor and the profit maximizing conditions of private firms that 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 towards
educating their children. This allows us to study the impact of domestic and foreign policy and its effect on both the demand 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 findings by Dinopoulos and Zhao (2007). This paper differs from Dinopoulos and Zhao in regards 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


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