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Endogenous Technical Progress and the Emergence of Child Labor Laws

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Abstract: I develop a theory of technical progress that uncovers sufficient conditions for opposition to the adoption of child labor laws to disappear over time. The supply of child labor comes exclusively from unskilled parents, because of their inability to help their children benefit from formal education, while its demand originates from capitalists-the firms' owners. Because child labor crowds out adult employment, there are always social pressures to ban it. However, such pressures are met by capitalists' opposition. Capitalists oppose the adoption of a ban on child labor because such a ban reduces opportunities for earning a high return on capital. Technical progress, induced by skill accumulation, improves the earning prospects of firm hiring adult workers only, while it reduces those of firms hiring children only. As a result, more capitalists are drawn into the adult labor markets, and industrial opposition to a ban on child labor eventually vanishes over time. Provided child labor exhibits skill-enhancing learning-by-doing, policy action to speed up the emergence of child labor laws should therefore focus on education reforms that raise the quality of education school-goers receive, and on political reforms that raise the cost of lobbying legislators against adopting a ban on child labor. However, in countries where child labor provides little or no opportunities for learning-by-doing, no law will emerge unless appropriately targeted poverty alleviation mechanisms are designed, in order to induce unskilled parents to allocate a positive fraction of child's time to schooling.

JEL Classification: D31, I21, J22, O12

1 Introduction

Until a little more than 150 years ago, child labor was a common practice in most countries, including the United States and Great Britain. Today, these countries, along with many other developed countries have successfully enforced laws banning or restricting child labor. A simple explanation for the adoption and enforcement of these laws is based upon the general perception that child labor hinders children's education which many believe is in the best interest not only of children's own lives, but also of the society as a whole, in terms of the quality of its future labor force. While this is understood, opposition to child labor, however, is yet to become the norm in many developing countries. According to the World Bank, many developing countries still report high incidences of child labor, suggesting that tolerance of this phenomenon is still prevalent in these countries. In reaction to this evidence, the international community led by rich countries has demanded the immediate abolition of the practice of child labor in developing. ILO convention 138 and 182 and the *United Nation Convention on the Right of Children* are a few illustrations of the intolerance of the international community, which urges immediate legislative reforms in developing countries to deal with child labor.

Yet, a number of historical accounts based upon the experiences of the nineteenth century United States and Great Britain, have revealed that even in the case of child labor, social reform legislation, instead of preceding and precipitating social change, actually followed and was a response to social change (Carolyn Moehling

1999). Citing these historical accounts, Moehling maintains that the decline of child labor in the United States was not primarily due to the effectiveness of state child labor laws but rather to factors that reduced the importance of child labor to both industry and families. Technical progress is one such factor. But technical progress itself is endogenous. Why did some countries experienced technical progress that led eventually to the elimination of child labor, while others are yet to follow suit? This question is crucial to consider for the following reasons: on one hand, education, through the skills it imparts, is viewed as a source of technical progress; but, on the other hand, child labor and schooling are competing claims on child's time, which implies that sending a child to work rather to school, can have consequences not only on the child's own life, but also on the society as a whole, in terms of the quality of the future labor force. Moreover, in many countries, poverty is still forcing many parents to prefer work over schooling as their offspring's childhood occupation. How can these countries experience the type of technical progress that will eventually lead to the emergence of laws banning child labor?

The purpose of this paper is to examine the relationship between endogenous technical progress and the decline of the opposition to child labor laws. We use a dynamic heterogeneous-agents general equilibrium model that features a labor-market-based explanation for the incentive to restrict children participation in the labor market. We use this model to study the dynamics of industrial opposition to child labor laws in an environment where formal education and on-the-job learning-

by-doing are two potential sources of skill acquisition. We argue that only in an economy where learning-by-doing and formal education are two alternative engine of skill acquisition can opposition to the adoption of child labor laws decline over time.

2 Some Stylized Facts

In this section, we discuss empirical evidence for three key assumptions of the model we use in this paper. Two of these assumptions are captured by the aggregate production function postulated in this paper, while the other is a feature of the state transition matrix characterizing intergenerational social mobility.

A. Sources of Opposition to Child Labor Laws

It is well-understood that pressure for the elimination of child labor can have either a domestic source or a foreign source. Domestically, in many countries including the nineteenth century US, social movements of various origins have emerged in defense of children's rights (Moehling 1999). In the international arena, several international organizations (the *International Labor Organization* and the *World Trade Organization* are examples) have joined hands to combat child labor, often with the support of rich countries. But not much attention is given to the rise and fall of the opposition to child labor laws. Available evidence reveal that in the United States and Great Britain, for example, child labor was an important component of the manufacturing workforce in the first half of the 19th century. Moehling (1999) maintains that in the 19th century US, legislative efforts that sought to prohibit the employment of

children in certain manufacturing activities met the resistance of manufacturers who saw in the use of child labor a means to cut down on costs, by replacing more costly adult workers with children. Goldin and Sokoloff (1982) estimate that in 1820, a time where industrial opposition to child labor legislation was particularly high, children accounted for over 20% of manufacturing employment in the Northeast of the US. However, as Moehling observes, legislative progress in the US only came in the last few decades of the 19th century after the share of children in national manufacturing employment had fallen below 7%. These facts suggest that the decline of manufacturing interests that blocked and weakened States legislative proposals to eliminate child labor in fact only mirrored the decline in the relative share of children employed in industries. In this paper, we draw on this evidence and endogenize the demand for child labor. In our paper, this demand comes from capitalists who must choose the market in which to hire labor for production. There are two labor market: a market for adult labor which is perfectly competitive and a market for child labor which exhibits some monopsonistic market power. The latter feature echos the documented evidence that children workers are often exploited in the sense that they are paid less than the value of their marginal product. Supporting this idea of cheap child labor is the evidence that children employed in the Indian hand-knotted carpet industry in general were paid about half of the adult wage, even when they had the same productivity (Deborah Levison et al. 1998). Anecdotal evidence also exists.

B. Substitutability between Adult Labor and Child Labor

To capture the feature that child labor crowds out adult employment, child labor and adult labor are modeled as being substitutable. Note that ours is not the first study to assume the substitutability between adult and child labor. Basu and Van (1998) make a similar assumption. Opponent of this view have put forward a number of arguments. The most remarkable one is perhaps the so-called "nimble-finger" argument. According to this argument, children and adults differ in work characteristics which lead to market segmentation. However, Levison et al. (1998) reject this "nimble finger" argument based upon a case study of the hand-knotted carpet industry in the Indian state of Uttar Pradesh. They argue that child labor was not really necessary in the Indian carpet industry, and that its existence only succeeded in creating high levels of adult unemployment and/or under-employment. They also conclude, based upon that case study, that developing countries's tolerance of child labor could only come at the expense of adult jobs.

C. Education and Learning-by-Doing as Sources of Skill Acquisition

A distinguishing feature of our model is that both education and child labor are potential sources of skill-acquisition. There is a significant number of studies that formalize education as a mechanism of skill accumulation. Lucas (1988) and Kremer and Chen (2000) are only a few examples. According to the World Bank, countries with the highest levels of average educational attainment are also the richest (see for example *World Development Report 2002*), thus providing evidence of the key role played by education as a mechanism skill acquisition.

In contrast, evidence that child labor entails learning-by-doing is somewhat mixed in the existing literature. Some empirical studies (for example, Galbi 1997) lend support to this assumption.[1] Others, in contrast, reject the learning-by-doing hypothesis based upon the view that working children in developing countries are usually involved in hazardous labor activities such as drug-dealing, street-begging, child prostitution and pornography which provide virtually no basis for learning valuable productive skills (see for example Lim 1998). What this literature really suggests is that not all forms of child labor entail learning-by-doing. While one cannot imagine child prostitution or pornography as an activity that teaches valuable skills to children, nor can one hope to see such skills acquired by a child involved in street-begging or drug-dealings, it is generally accepted that, in the case of manufactory employment, child labor, if done under appropriate conditions, can help a child acquire valuable experience in the operation of modern industrial technology. The case of the industrial revolution in England (Galbi 1997) and that of the nineteenth century United States (Goldin and Sokoloff 1982) offer support for this theory.[2]

[1] Galbi (1997) reveals that in the beginning of the industrial revolution in Britain, children were preferred to adults for manufacturing employment. However, as early cohorts of children laborers gained more experience in the use of modern technology and became skilled adults, this led to a decline, over time, in the use of child labor in that industry.

[2] Goldin and Sokoloff (1982) reveal that in the United States, child labor was an important component of the manufacturing workforce in the first half of the nineteenth century. They estimated that children accounted for over 20% of manufacturing employment in the Northeast in 1820.

3 Literature Review

Recent theories of child labor in the literature include Glomm (1997), Dessy (2000), and Ranjan (2001) but these models do not imply a theory of the emergence of child-labor laws. Other approaches to analyzing child labor however could also yield a theory of child-labor laws. For instance Basu and Van (1998), rely on the hypothesis of multiple equilibria in the market for unskilled labor to explain why in some countries banning child-labor could be welfare-enhancing. To the extent that child labor and adult labor are substitutes, child labor laws may increase efficiency, by averting a poverty-inducing crowding out of adult employment. However if the economy is too poor, there may not be such a role for child labor laws. As their model is static, it does not lend itself to analysis of the emergence of child labor laws over time, for an initially poor economy. This is also a difficulty in other theoretical model including Baland and Robinson (2000), Dessy and Pallage (2001) and Dessy and Vencatachellum (2003).

More closely related to our paper are works by Dirk Krueger and Jessica Tjornhom (2001) and Matthias Doepke and Fabrizio Zilibotti (2002). Krueger and Tjornhom (2001) use a quantitative model to assess the welfare effect of child labor/education laws on different groups of the population in an environment where there are human capital externalities in the production process. In their models, even the poorest parents benefit from compulsory education, which seems to suggest that even poor countries can benefit from this legislation. Their model therefore cannot explain

opposition to education/child labor laws in poor countries.

Doepke and Zilibotti (2003) develop a theory of child labor restrictions (CLR) that emphasizes endogenous fertility, and parental investment in education. In their model, poorer parents with few children have little to gain from child labor and are therefore likely to favor CLR, while poorer parents with many working children would be expected to oppose CLR. Perhaps because of its focus on endogenous fertility and inequality, their model leaves the demand for child labor unexplained. In order to account for the emergence of child labor laws, our paper endogenizes both the supply and the demand for child labor drawing on the documented evidence about the positive association between the decline of opposition to child labor laws and the decline in the share of children employment in industry.

4 The Model

Consider an overlapping-generations economy where economic activity extends over an infinite discrete time. Each generation of individuals lives for two periods: first as a child who makes no decision, then as a decisionmaking adult parent. For simplicity, each household consists of one parent and his child, and each generation of individuals has a unit measure so that there is no population growth. In every period, the economy produces a single homogenous good which we take as the *numeraire*. The good is produced using physical capital and labor in efficiency units. At the beginning of every period, a number $\bar{k}$ of childless, one period-lived capitalists is born. Each cap-

italist is endowed with one unit of capital. There is no physical capital accumulation and capital, for simplicity, completely depreciates after its use, so that in each period, $\bar{k}$ is also the time-invariant, economy-wide stock of capital. This is just a simplifying assumption.

Adult workers differ in their skill status (skilled or unskilled), which depends upon whether they acquired valuable productive skills when young. Skill acquisition has two potential sources: schooling and child labor. Each child is endowed with one unit of time. If no child labor law is passed in the beginning of the period, child time will have two competing claims: work and formal schooling. In that case, the income of a household is the sum of parental income, ω_i^a, which depends upon his skill status i $(i = s, u)$, and the income from child labor $(1 - e_i)\,\omega^c$, where e_i denotes child time allocated to schooling for a child whose parent has skill status i, and ω^c is the child labor wage.

Upon entering adulthood in the second period, each worker learns his skill realization. The transition probability for a child whose parent has skill status i, is described by $\pi_{ij} = \Pr(j \mid i, e_i)$, where π_{ij} denotes the probability that a child whose parent is in a state characterized by a skill status i transits to a state characterized by a skill status j, when adult. For simplicity, we specialize the 2×2 probability transition matrix $\Pi\,(i, j)$ to

$$\begin{bmatrix} \pi_{uu} & \pi_{su} \\ \pi_{us} & \pi_{ss} \end{bmatrix} = \begin{bmatrix} 1 - \delta\,(1 - e_u) - \lambda_u e_u & 1 - \delta\,(1 - e_s) - \lambda_s e_s \\ (1 - e_u)\,\delta + \lambda_u e_u & \delta\,(1 - e_s) + \lambda_s e_s \end{bmatrix}$$

where $\lambda_i \in [0,1]$ denotes a measure of the productivity of education as a skill-imparting mechanism for a child whose parent has skill status i; and $\delta \in [0,1]$ denotes the productivity of on-the-job learning-by-doing as a skill imparting mechanism.

A. Preferences and Budget Constraints

Parents have identical preferences, and are expected utility maximizers, who derive utility from consumption of the numeraire good (C) and from raising a child who transits to a skill status j, when adult. The expected utility of a parent with skill status i ($i = s, u$) is thus given by:

$$U = \ln C_i + \rho E\left[\ln \omega_j^a\right], \qquad \rho \in (0,1) \tag{1}$$

where ρ denotes the intergenerational discount factor, ω_j^a denotes the labor income of a child who transits to a state characterized by a skill status j when adult, and E is an expectation operator conditional on current period information.

The budget constraint faced by each parent is given by:

$$C_i \leq \omega_i^a + (1-e)\,\omega^c \tag{2}$$

where ω_i^a denotes the labor income of an adult worker with skill status i, and ω^c denotes the child labor wage.

B. Production and Wages

For simplicity, assume it takes one unit of capital to start a firm. Firms are owned by capitalists who are residual claimants. In each period, capitalists must

decide in which market to hire labor. There are two types of markets: a market for adult labor (market a) and a market for child labor (market c). The first is perfectly competitive, with firm hiring skilled and/or unskilled adult labor at market determined wages, while the second exhibits monopsonistic market power. A possible explanation for the monopsonistic market power in the child labor market is that children's labor contract are mostly informal in nature and that children are more readily exploitable due to their immature age.

The technology chosen by the firm determines the market in wich it will hire labor. For a firm that chooses to employ adult labor, its output is described by

$$y_i = H_a^{\gamma}, \qquad 0 < \gamma < 1$$

where

$$H_a = \phi(\eta_s) l_s^a + l_u^a$$

$\phi(\eta_s) > 1$ denotes a skill-biased labor-augmenting technical progress, η_s denotes the proportion of skilled workers in the labor force. It will be assumed that the function ϕ satisfies $\phi' > 0$. Perfect competition in the adult labor market implies that each adult is paid the value of his marginal product: $\omega_s^a = \gamma\phi(\eta_s) H_a^{\gamma-1}$ for skilled labor and $\omega_u^a = \gamma H_a^{\gamma-1}$ for unskilled labor.

Let $k_a \in \left[0, \bar{k}\right]$ denotes the number of firms (or capitalists) hiring adult labor. Since all adults inelastically supply their unit endowment of time, market clearing implies $l_s^a = (k_a)^{-1} \eta_s$ and $l_u^a = (k_a)^{-1} \eta_u$, where η_i denotes the proportion of adult

workers with skill status $i = s, u$, with $\eta_s + \eta_u = 1$. Furthermore, since $k_a + k_c = \bar{k}$, where k_c denotes the number of capitalists hiring child labor, the market-clearing adult wages can be rewritten as functions of the pair (η_s, k_c) :

$$w_s(\eta_s, k_c) = \gamma\phi(\eta_s)\left(\frac{\phi(\eta_s)\eta_s + 1 - \eta_s}{\bar{k} - k_c}\right)^{\gamma-1} \tag{3}$$

$$w_u(\eta_s, k_c) = \gamma\left(\frac{\phi(\eta_s)\eta_s + 1 - \eta_s}{\bar{k} - k_c}\right)^{\gamma-1}. \tag{4}$$

Clearly, as long as $\phi(\eta_s) > 1$, there is a productivity premium for skills. Furthermore, given the above structure of adult wages, an increase in the number of capitalists hiring child labor tends to cause both types of adult labor wages to fall. This negative relationship captures the feature that child labor crowds out adult labor, at least in an economy-wide sense. This feature of the model is supported by empirical evidence (e.g. Levison et al. 1998 and Moehling 1999).

Next, in the market for child labor, it will be assumed that each capitalist (or firm) is matched with l_c children for production of the homogenous good. The matching generates a surplus $A(\eta_s) l_c$, where $A' < 0$, implying that the surplus from the match decreases with the level of technical progress in the adult sector. This surplus is shared between the capitalist and the children workers according to an exogenously determined rule, α, where $\alpha \in (0, 1)$ is interpreted as the fraction of the surplus that goes to children workers. Assuming that children are homogenous in labor market characteristics, and given that each capitalist employes l_c children, equal surplus

sharing between children workers implies that each child earns

$$\omega_c = \alpha A(\eta_s). \tag{5}$$

The capitalist's share of the surplus is given by $(1-\alpha) A(\eta_s) l_c$. The smaller α, the higher the level of child exploitation in this economy. Since there are k_c firms hiring children, and n_c is the total number of children workers, clearly firms' homogeneity implies that each firm hires

$$l_c = \frac{n_c}{k_c} \tag{6}$$

children.

C. Parental Allocation of Child Time

For simplicity, assume child time allocated to schooling, e_i, is a binary variable which takes values in the set $\{0,1\}$. Therefore, each parent's problem is to decide on child's time allocation between schooling and work, so as to maximize his expected life-time utility. Let $V(i, e_{it}, \eta_{st}, k_{ct})$ denotes the value of being a generation t parent with skill status i who makes the child time allocation decision e_{it}: for $t = 0, 1, ...$

$$\begin{aligned} V(i,0,\eta_{st},k_{ct}) &= \ln\left[w_i(\eta_{st},k_{ct}) + \omega_l^c\right] + \rho\delta \ln\left[w_s\left(\eta_{st+1},k_{ct+1}\right)\right] \\ &\quad + \rho(1-\delta)\ln\left[w_u\left(\eta_{st+1},k_{ct+1}\right)\right] \end{aligned} \tag{7}$$

$$\begin{aligned} V(i,1,\eta_{st},k_{ct}) &= \ln\left[w_i(\eta_{st},k_{ct})\right] + \rho\lambda_i \ln\left[w_s\left(\eta_{st+1},k_{ct+1}\right)\right] \\ &\quad + \rho(1-\lambda_i)\ln\left[w_u\left(\eta_{st+1},k_{ct+1}\right)\right] \end{aligned} \tag{8}$$

where $\omega_t^c = \alpha A(\eta_{st})$. For a parent who chooses to send his child to school, it must be that

$$V(i,1,\eta_{st},k_{ct}) \geq V(i,0,\eta_{st},k_{ct}),$$

otherwise the household will be better off with the child working full time. The followoing assumption will prove useful the rest of the analysis:

A.1 The skill acquisition mechanism satisfies: $\delta = \lambda_u < \lambda_s$.

This assumption, made for simplicity, implies that for a child whose parent is unskilled, schooling and work are equally productive as skill-imparting mechanisms, while for a child whose parent is skilled, schooling is always more productive than on-the-job learning-by-doing. This assumption can be justified, for example, by the fact that educated adults are more able to create a better learning environment for their school-age children than can their uneducated counterparts. A similar assumption is made by Kremer and Chen (2000). Hence the following result.

Proposition 1 *Let assumption A.1 hold. Then in absence of a law banning child labor, children with unskilled (respectively skilled) parents will always work (attend school) instead of attending school (working).*

Proof. Define $\triangle_i \equiv V(i,0,\eta_{st},k_{ct}) - V(i,1,\eta_{st},k_{ct})$. It suffices to show that $\triangle_u > 0$ and $\triangle_s < 0$. First, using (7) and (8), it follows that

$$\triangle_u = \ln\left[w_u(\eta_{st},k_{ct}) + \omega_t^c\right] - \ln\left[w_u(\eta_{st},k_{ct})\right] > 0$$

for all $\omega_t^c > 0$. Hence the optimality of the unskilled parent's decision to send his child to work.

Second, consider the difference $\triangle_s = V(s, 0, \eta_{st}, k_{ct}) - V(s, 1, \eta_{st}, k_{ct})$. Using (3) and (4), it can be shown that

$$\triangle_s = \ln\left[\frac{w_s(\eta_{st}, k_{ct}) + \omega_t^c}{w_s(\eta_{st}, k_{ct})}\right] - \rho(\lambda_s - \delta)\ln\left[\phi\left(\eta_{st+1}\right)\right].$$

Since the maximum income level a working child can contribute to the household is $\bar{\omega}^c = \alpha A(0)$, clearly one can always choose α, λ_s and δ, such that $\triangle_s < 0$. Hence the result ■

Because unskilled parents are unable to provide their children with an adequate learning environment at home, they derive, as result, a smaller gain from their child's education ($\lambda_u = \delta$). For these parents, to the extent that child labor exhibits skill-enhancing learning-by-doing, sending the child to work is always an optimal decision. For educated parents, in contrast, their ability to provide a better learning environment for their children allow them to benefit greatly from sending their children to school. As a result, it is always optimal for them to choose schooling over work as their children's childhood occupation. For the purpose of the analysis to be carried here, an interesting question is which category of parents benefit from supporting a ban on child labor. We will establish further below that, since child labor crowds out adult employment, by biding capitalists away, at least one of the two groups of adult workers has a vested interest in ending child labor.

Proposition 1 implies that $e_{ut} = 0$ and $e_{st} = 1$ for all t ($t = 0, 1, ...$). Therefore,

the transition probabilities matrix is time invariant and looks as follows:

$$\Pi = \begin{bmatrix} 1-\delta & 1-\lambda_s \\ \delta & \lambda_s \end{bmatrix}.$$

Since there is no population growth, we can characterize the law of motion of the distribution of adult workers by skill status as follows:

$$\begin{bmatrix} \eta_{ut+1} \\ \eta_{st+1} \end{bmatrix} = \begin{bmatrix} 1-\delta & 1-\lambda_s \\ \delta & \lambda_s \end{bmatrix} \begin{bmatrix} \eta_{ut} \\ \eta_{st} \end{bmatrix} \tag{9}$$

with $\eta_{st} + \eta_{ut} = 1$ all t.

Another implication of proposition 1 is that since each parent has one child, in all periods t, the total proportion of children who will supply child labor is equal to the proportion of unskilled parents: $n_{ct} = \eta_{ut}$.

D. The Capitalist's Problem

When there are political pressures to ban child labor, capitalists may have an incentive to block such pressures by lobbying legislators against adopting such a ban. In the beginning of each period, the sequence of events is as follows. Unless a law banning child labor has already been adopted (the law is irreversible), in the beginning of the period a legislative proposal to ban child labor is put forward for adoption (possibly by a group of adult workers who gain from such a ban). Then before they each choose the market in which to hire labor, capitalists first collectively decide whether or not to block the legislative proposal to ban child labor. In the affirmative they will each incur a per capita cost, θ, necessary to effectively block the proposal.

The legislative proposal can only be block one period at a time. If capitalists vote to block the proposal, they will each choose between two hiring strategies, so as to maximize the return to capital. If, instead, they decide against blocking the legislative proposal, it will become a law from that period on, in which case capitalists would have no choice but to hire adult workers only.

I assume that capitalists cast their vote on whether or not to block the legislative proposal banning child labor by anticipating the effect their vote will have on the return to capital. Hence they solve their problem by backward induction. First, they each compute the return to capital for two different scenarios. In the first, they have each two hiring options: either children only or adults only. In the second, they are restricted by law to hire only adult labor. They cast their vote by comparing the return to capital under these two alternative scenarios. Therefore, I characterize below the retrun to capital under these two alternative scenarios.

First, assuming that no law is passed, let r_m denotes the net return to capital for the hiring strategy $m \in \{a, c\}$. A capitalist who plays the hiring startegy $m = a$ will hire adult labor only, while one who plays the strategy $m = c$ will hire children only. Using (3) and (4) as well as resource constraints, I characterize the return to capital for each of the two hiring strategies as follows:

$$r_m(\eta_s, k_c, \theta) = \begin{cases} (1-\gamma)\left(\frac{\phi(\eta_s)\eta_s + 1 - \eta_s}{k - k_c}\right)^{\gamma} - \theta & \text{for } m = a \\ (1-\alpha) A(\eta_s)\left(\frac{1-\eta_s}{k_c}\right) - \theta. & \text{for } m = c \end{cases}, \tag{10}$$

where η_s denotes the proportion of skilled adult workers in the economy. Each capi-

talist chooses the market in which to hire labor so as to solve the following problem:

$$\max \left\{ r_a \left(\eta_s, k_c, \theta \right), r_c \left(\eta_s, k_c, \theta \right) \right\}.$$

Since all capitalists are identical, more capitalists will continue to move from the adult labor market into the child labor market until returns to capital are equalized between the two hiring strategies. In absence of a law restricting child labor, I therefore define a market equilibrium as a situation in which all capitalists are indifferent as to the market in which they hire labor:

$$r_a \left(\eta_s, k_c, \theta \right) = r_c \left(\eta_s, k_c, \theta \right). \tag{11}$$

If the conditions underlying the Implicit function theorem can be shown to hold, then in equilibrium, the distribution of capitalists between the two markets is entirely determined by the economy-wide proportion, η_s, of skilled adult workers: $k_c^* = \kappa \left(\eta_s \right)$. We are interested in the properties of the function κ defined by the equation (11).

Proposition 2 *There exists a continuously differentiable function* $\kappa : [0,1] \to \left[0, \bar{k}\right]$, *such that for all* $\eta_s \in [0,1]$, $k_c^* = \kappa \left(\eta_s \right)$ *and* $\kappa' < 0$.

Proof. The proof follows from the Implicit function theorem ■

The above result is quite intuitive since a rise in the proportion of skilled adult workers raises total factor productivity in firms using adult labor. This, in turn, attracts more capitalists in the adult labor market, thus pooling them away from the child labor market, as they seek to earn the highest possible return on their capital.

Given the above result, the optimal level for the return to capital when capitalists can choose between two hiring options is given by

$$\bar{r}\left(\eta_s, \theta\right) = r_a\left[\eta_s, \kappa\left(\eta_s\right), \theta\right] = r_c\left[\eta_s, \kappa\left(\eta_s\right), \theta\right]. \tag{12}$$

Next, suppose, instead, that a law banning child labor is adopted, so that hiring children is no longer an option. In that case, $k_c = 0$ and $k_a = \bar{k}$, so that the return to capital is given by

$$\widetilde{r}_a\left(\eta_s\right) = (1-\gamma)\left(\frac{\phi\left(\eta_s\right)\eta_s + 1 - \eta_s}{\bar{k}}\right)^{\gamma}. \tag{13}$$

Given the pair (η_s, θ), if $\bar{r}\left(\eta_s, \theta\right) > \widetilde{r}_a\left(\eta_s\right)$, capitalists will block the proposal, otherwise it will become a law banning child labor from then on.

5 Equilibrium Analysis

In this section, I define and characterize both a sequential market equilibrium and a voting equilibrium for this economy. In particular, I characterize both the time path for the economy-wide distribution of adult labor by skill status and the distribution of capitalists between markets.

Definition 1(A Sequential market Equilibrium). *An intertemporal equilibrium for this economy is a sequence of economy-wide distributions of capitalists* $\{k_{ct}^*\}_{t=0,1,....}$, *and a sequence of economy-wide distribution of adult workers by skill status* $\{\eta_t^*\}_{t=0,1,....}$ *such that at each date* t *and given* $(k_{ct}^*, \eta_t^*, x_t)$,

(i) the law of motion of the economy-wide distribution of adult workers by skill status is given by (9);

(ii) given $\eta_t^* = (\eta_{st}^*, \eta_{ut}^*)$*, the equilibrium number of capitalists who employ children only is given by*

$$k_{ct}^* = \begin{cases} 0 & \text{if} \quad x_t = 0 \\ \kappa(\eta_{st}^*) & \text{if} \quad x_t = 1 \end{cases} \tag{14}$$

with

$$r_a[\eta_{st}^*, \kappa(\eta_{st}^*)] - r_c[\eta_{st}^*, \kappa(\eta_{st}^*)] \equiv 0, \tag{15}$$

where $k_{at}^* = \bar{k} - \kappa(\eta_{st}^*)$*, and* k_{at}^* *denotes the equilibrium number of capitalists who employ adults only at time* t*.*

Definition 2 (A Voting Equilibrium) *A voting equilibrium is a winning vote* x_t^* *such that*

$$x_t^* = 1 \quad \textit{if} \quad \bar{r}(\eta_{st}^*, \theta) > \widetilde{r_a}(\eta_{st}^*)$$

and

$$x_t^* = 0 \quad \textit{if otherwise.}$$

Definition 3 (Steady State Equilibirum) *A steady state equilibrium is an intertemporal equilibrium which in addition satisfies* $\eta_{st+1}^* = \eta_{st}^* = \eta_s^*$ *and* $k_{ct}^* = k_c^*$ *all* t*.*

Conditions (i) of equilibrium combined with the constraint $\eta_{st} + \eta_{ut} = 1$, implies

that the law of motion of the economy-wide proportion of skilled labor is given by:

$$\eta_{st+1} = (\lambda_s - \delta)\,\eta_{st} + \delta. \tag{16}$$

Two important observations can be made from the structure of this law of motion. First, since unskilled parents prefer work over schooling as their offspring's childhood occupation, unless child labor exhibits skill-enhancing learning-by-doing (i.e., $\delta > 0$), there is no steady equilibrium with a positive proportion of skilled workers. Second, since $(\lambda_s - \delta) \in (0, 1)$, clearly, as long as $\delta > 0$, the system's dynamics characterized by (16) converges monotonically to a steady state with a positive proportion of skilled workers. Hence the following proposition:

Proposition 3 *Let assumption A.*1 *hold. If child labor exhibits skill-enhancing learning-by-doing ($\delta > 0$), then there exists a steady state equilibrium with a positive proportion, η_s^*, of skilled adult workers.*

Proof. The steady state proportion of skilled workers is given by $\eta_s^* = \psi(\lambda_s, \delta)$, where

$$\psi(\lambda_s, \delta) = \frac{\delta}{1 - \lambda_s + \delta}. \tag{17}$$

Clearly, only if $\delta = 0$ will $\eta_s^* = 0$ be the unique steady state, since $1 - \lambda_s > 0$ ■

Proposition 3 implies that in countries where labor performed by children does not provides opportunities for learning-by-doing, if a significant proportion of children work instead of attending school, clearly such an economy will eventually fall into a

poverty trap with no skilled labor. As long as $\delta > 0$, for economies that begin with intially a very low proportion of skilled workers, convergence to the unique steady with a positive proportion of skilled workers will be from below.

A. Who Gains from Banning Child Labor?

Recall that in this environment, work and schooling are the only competing claims on child time. In addition, there are no direct costs for education, in the sense that school attendance is free. In such an environment, a ban on child labor and a compulsory education law coincide, for if a child is not in school, it must be that he works, and vice versa. Let $\widetilde{V}(i, \eta_{st})$ denotes the equilibrium value of being a parent with skill status i when a ban on child labor is enforced. Using (3) and (4), it follows that

$$\widetilde{V}(i, \eta_{st}) = \ln\left[w_i(\eta_{st}, 0)\right] + \rho\left(\lambda_i \ln\left[w_s\left(\eta_{st+1}, 0\right)\right] + (1-\lambda_i)\ln\left[w_u\left(\eta_{st+1}, 0\right)\right]\right)$$

for all i $(i = s, u)$.

Now, let $\bar{V}(i, \eta_{st})$ be the equilibrium value for being a parent with skill status i

when there is no law banning child labor. Using (7) and (8), it follows that

$$\begin{aligned}\bar{V}(s,\eta_{st}) &= \ln\left[w_s(\eta_{st},\kappa(\eta_{st}))\right]+\rho\lambda_s\ln\left[w_s\left(\eta_{st+1},\kappa\left(\eta_{st+1}\right)\right)\right]\\ &\quad+\rho(1-\lambda_s)\ln\left[w_u\left(\eta_{st+1},\kappa\left(\eta_{st+1}\right)\right)\right]\end{aligned}$$

$$\begin{aligned}\bar{V}(u,\eta_{st}) &= \ln\left[w_u(\eta_{st},\kappa(\eta_{st}))+\omega_t^c\right]+\rho\delta\ln\left[w_s\left(\eta_{st+1},\kappa\left(\eta_{st+1}\right)\right)\right]\\ &\quad+\rho(1-\delta)\ln\left[w_u\left(\eta_{st+1},\kappa\left(\eta_{st+1}\right)\right)\right].\end{aligned}$$

Let μ_{it} denotes the net gain from supporting a ban on child labor:

$$\mu_{it}=\widetilde{V}(i,\eta_{st})-\bar{V}(i,\eta_{st}).$$

Proposition 4 *Let assumption A.1 hold. Then, skilled adult workers always gain from a ban on child labor, while unskilled adult workers may or may not benefit from supporting the ban.*

Proof. It suffices to show that $\mu_{st}>0$ while the sign of μ_{ut} is indeterminate. ■

Proposition 4 implies that social pressures to end child labor will come at least from one group of adult workers. This justifies our earlier assumption that in every period, unless a law banning child labor is already adopted, there always will be social pressures to end this practice.

B. The Emergence of Child Labor Laws

In this subsection, we formalize the emergence of laws banning child labor, when opposition to such laws is organized by firms. Recall that in the period in which the

law banning child labor is adopted, it must be that $\bar{r}(\eta_{st}^*, \theta) > \widetilde{r_a}(\eta_{st}^*)$. Therefore, to understand the emergence over time of laws banning child labor, it is important to determine sufficient conditions for the above inequality to hold. Since, for an economy with initially too low a proportion of skilled individuals, convergence is toward a higher proportion, for simplicity, I restrict attention to the case where no law is adopted during the economy's transition to the steady state. Given this assumption, I address the following question: under what conditions will the law banning child labor emerge in the steady state? The answer to this question is obtained by computing the difference $D = \widetilde{r_a}(\eta_s^*) - \bar{r}(\eta_s^*, \theta)$. A law will not emerge in the steady state, unless $\sigma > 0$.

Using (10), (14), (13), and (17), and setting $\bar{k} = 1$,

$$D = \theta - (1-\gamma)\frac{\left[\left(\phi\left[\psi(\lambda_s, \delta)\right] - 1\right)\psi(\lambda_s, \delta) + 1\right]^{\gamma}}{\left(1 - \kappa\left[\psi(\lambda_s, \delta)\right]\right)^{\gamma}}\left[1 - \left(1 - \kappa\left[\psi(\lambda_s, \delta)\right]\right)^{\gamma}\right].$$

The above equation suggests three main determinants of the emergence of child labor laws namely, the productivity of child labor as a mechanism of skill acquisition (δ), the productivity of education as a skill-imparting mechanism (λ_s), and the cost of lobbying (θ). Since $\psi_\delta > 0$, $\psi_\lambda > 0$, and $\phi' > 0$, it can be established that $D_\delta > 0$, $D_\lambda > 0$, $D_\theta > 0$, where D_j denotes the partial deirivative of D with respect to j ($j = \delta, \lambda, \theta$). I have just established the following proposition.

Proposition 5 *Let assumption A.1 hold. Then, countries in which a significant proportion of working children acquire productivie skills on the job (i.e. $\delta > 0$) will*

eventually eliminate child labor if (i) a sufficiently high proportion of school-goers acquire productive skills through schooling, and/or (ii) the cost of lobbying legislators against banning child labor is sufficiently high.

The above proposition suggests that, provided child labor exhibits learning-by-doing, policy action to eliminate it has essentially two dimensions: an *education reforms* dimension and a *political reforms* dimension. On one hand, education reforms should aim at improving the productivity of education as a skill-enhancing mechanism. Policy reforms, on the other hand, should aim at raising the cost of lobbying legislators against adopting laws banning child labor. However, in countries where child labor provides little or no opportunities for learning-by-doing, appropriately targeted poverty alleviation mechanisms may need to be designed in order to induce unskilled parents to allocate a positive fraction of child's time to schooling.

6 Concluding Remarks

My purpose in this paper has been to reconcile the historical evidence on the emergence of laws banning child labor with the ongoing debate on policy response to child labor. I developed a positive theory of the emergence of child labor laws, in an environment where social pressures to eliminate child labor come from adult workers whose jobs are crowded out by children's participation in the labor market. One of the major contributions of this paper is the formalization of the historically documented industrial opposition to the adoption of laws restricting children's labor force

participation. Capitalists oppose the adoption of a ban on child labor because such a ban reduces opportunities for earning a high return on capital. Technical progress, induced by skill accumulation, improves the earning prospects of firms hiring adult workers only, while it reduces those of firms hiring children only. As a result, more capitalists are drawn into the adult labor market, and industrial opposition to a ban on child labor eventually vanishes over time. My model therefore emphasizes endogenous demand to child labor, a feature that is missing in existing dynamic models of child labor, despite abundant empirical evidence supporting it (e.g., Nardinelli 1988, Galbi 1997, and Moehling 1999). To study the determinants of the emergence of laws banning child labor, I restricted the analysis to the steady state, which was shown to be unique, depending on the characteristics of the economy considered. Economies where child labor exhibits skill-enhancing learning-by-doing converge to a steady state with a positive proportion of skill workers, while those where child labor entails no learning-by-doing converge to a poverty trap with no skill workers. A sufficient condition for child labor laws to emerge in the steady state is that child labor exhibits skill-enhancing learning-by-doing. Historical evidence supporting this condition is found in Galbi (1997). Where this condition is not met, the analysis suggests that appropriately targeted poverty alleviation mechanisms need to be designed in order to induce unskilled parents to allocate a positive fraction of child's time to schooling. Education reforms that raise the quality of education and political reforms that raise the cost of lobbying legislators against adoption of laws banning child labor can speed

up the emergence of such laws.

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