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Child Labor and Coordination Failures *

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Abstract:

In this paper, we show how coordination failures may explain the prevalence of child labor in developing countries. We do so within a simple game-theoretic setup. Child labor arises in our environment because of the lack of a coordination mechanism between parental decisions to invest in the human capital of their children and firms' decisions to invest in skill-intensive technology. Governmental policies that help coordinate expectations should lead to the disappearance of child labor.

Keywords:

Child labor, welfare, equilibrium selection, coordination

JEL classification: I20, J20, D60

1 Introduction

In this paper, we show that child labor may arise because of the lack of a coordination mechanism between parental decisions of sending their children to school and firms' decisions to invest in the adoption of skill-intensive technology.

Our argument relies on the following facts. First, in an environment in which children's time has an economic value, educating children presents the parents with an opportunity cost [Rosenzweig (1990)]. Second, the reward from children's education will arise in the long term provided firms have invested in technology that requires high-skill workers in the meantime. Third, investing in an economy with low human capital is a risky venture.

The simple one-shot game depicted in Figure 1 between a firm and parents captures the above facts and may be used to guide our argument. In each box, the first and second numbers are respectively the payoffs of parents and the firm. We should think of them as utils.

Figure 1:

		Firm	
		Invests	Does not
Parents	Child labor	$2, -20$	$2, 0$
	Education	$5, 100$	$-1, 0$

In this game, there are two Nash equilibria in pure strategies.[1] In the first one, parents choose not to invest in human capital and the firm not to invest in skill-intensive technology. The second, which Pareto dominates the first, has both parents and the firm invest. Although both equilibria are trembling-hand perfect in the sense of Selten (1975), reaching the Pareto superior equilibrium is no easy matter. In addition to the usual assumptions on the rationality of agents and the common knowledge of that rationality,[2] it requires no less than the following propositions:

[1]Note that there is also a Nash equilibrium in mixed strategies in which the firm invests with probability $\frac{1}{2}$ and parents send their children to work with probability $\frac{5}{6}$.

[2]A proposition is *common knowledge* among players if it is known to all players, it is known to all players that all players know it, and so on *ad infinitum*.

1. The firm believes that parents are investing in the education of children.
2. Parents believe that the firm is willing to invest.
3. Both the firm and parents think that the other thinks that they think the above, etc.

Short of any of these requirements, the Pareto optimal Nash equilibrium may not be attained. In particular, it is sufficient that parents do not quite trust the firm for a socially bad outcome to arise. Each player would want the other to move first, yet investment in physical or human capital requires substantial time-to-build. For these reasons, coordination may be at fault. Governmental intervention may be necessary to help coordinate expectations. By establishing mandatory education programs, for example, the government will send a signal to firms that investments in human capital are being made. Without such coordination mechanism, parents and firms may never choose the socially optimal actions.

Naturally, this simple game is hardly a good representation of the actual game between parents and entrepreneurs. Yet it provides a good illustration of the coordination problem. The necessary coincidence of beliefs and iterations such as "I-think-that-he-thinks-that-I-think-that..." to reach the Pareto optimal Nash equilibrium may simply be too much to ask, especially if the costs of foregone child labor are large for parents in the short-run.[3]

Pointing to the Pareto optimal Nash equilibrium as a focal point in the sense of Schelling (1960) is not sufficient for it to be reached. For many African countries, for example, the status quo is the "bad" Nash equilibrium. In 1980 the average years of schooling among individuals aged 25 and up was 1.5 in Sub-Saharan Africa, compared to 9.1 in industrialized countries. Ten years later, in 1990, the gap in average years of schooling between these regions has increased from 7.6 in 1980 to 8.4 in 1990.[4] On the other hand, according to the World Bank (see *World Development Report* 1999/2000), during the period 1980-1990, average annual growth of industrial value added was a dismal 0.9% in Sub-Saharan Africa, compared to 9.5% in East Asia and the Pacific for the same period, suggesting a lack of technological change in the former. Finally, the International Labor Organization (1998) reports that child labor is mostly a rural phenomenon: 70% of all child laborers are involved in agricultural production, in regions where firms are typically non-existent. All these reasons support our argument that the status quo in African countries is an equilibrium with child labor and no investment in skill-biased technology. Seeking the "good" Nash equilibrium implies a change of behavior by all players. The good equilibrium will only be reached if all

[3]The Pareto optimal Nash equilibrium is even more difficult to achieve if we consider the need for coordination among parents. Indeed, parents may face free riding incentives in the following sense: removing your child from the labor market, *ceteris paribus*, has a positive effect on the wage of children remaining on the job.

[4]Source: UNDP annual report, 1991, 1992, 1993.

players have the proper expectations about the behavior and the expectations of the others. Since the cost involved in the transition from the first to the second equilibrium is substantial, it may act as a deterrent for some or all of the players. The weight of past behaviors and the risk involved in changing behavior may make the status quo a much better focal point than the Pareto optimum, in this particular case.

For parents to find it optimal to choose education in the game of Figure 1, it is necessary that they assign a subjective probability to the firm investing, higher than one half. This is the only range of beliefs consistent with a choice of sending children to school in this game. Reasons why beliefs could be different abound.

First, since in most African countries there isn't a past history of firms investing in technologies that require skilled labor, parents may be inclined to consider this event a low-likelihood event. Moreover, since the firm itself is able to infer that, for education to be a rational decision, parents need to assign a subjective probability of at least one half to its choice of investing, the firm may itself put a low subjective probability on this possibility given the history behind the game. In such case, given its beliefs, and its beliefs of the others' beliefs, the firm may find it optimal not to invest in the economy. Parents are able to infer the reasoning of firms, which pushes further down the subjective probability that the firm will invest. Given their beliefs parents may find it optimal to stick to child labor. We have thus illustrated a way the coordination of expectations may take place, leading to the Nash equilibrium with low human capital and no investment.

Second, parents in the game of Figure 1 are able to observe that investment on behalf of the firm is far more risky than no investment. Parents' assessment of the subjective probability that the firm will invest will reflect this observation. Similarly, the firm is able to observe that child labor for parents is a less risky choice than education. Again, the firm's subjective probability that parents will send their children to school will reflect this observation. Now the firm knows that parents know that investing is risky. Parents know that the firm knows that education is risky. If anyone has any reason to suspect the others to be quite risk-averse, the former's subjective probability that the latter will take a risky decision will be downplayed substantially. As a consequence, they themselves will make the low risk decision as a best response to their belief of the others' behavior.

Child labor arises in this environment, not necessarily because of a failure to coordinate expectations and actions, but rather because of either a coordination of players to the Pareto dominated equilibrium, or an inability of players to coordinate towards the Pareto superior equilibrium.

Our argument relies on the assumption that education is only worthwhile if there is a market for high-skill labor at the exit. This market, however, will only develop if firms invest in technology that requires skilled labor. That an economy's deficiency in skill-intensive technologies may be related to deficiencies in individuals' investment in human capital has long been recognized. Works by Lucas (1988, 1990) lend substantial support to this fact. Because of the interdependence in the incentives for both forms of investment, an economy can become trapped in a low-skill, child-labor equilibrium, due to the market failure to coordinate agents' complementary investment decisions.

How economic agents coordinate their choices and their beliefs so as to converge to one outcome rather than others, is a very difficult question. A large body of research has focused on this issue. Bicchieri (1993) provides a thorough survey of that field and establishes the necessary requirements for a given Nash equilibrium to be reached. Beliefs have center stage in the process of coordination.[5]

The rest of the paper is organized as follows. In Section 2, we briefly discuss other possible explanations for child labor that have been raised in the literature. In Section 3, we build a more general model in the spirit of this introduction, and characterize the set of equilibria. In Section 4, we discuss policy implications and conclude.

2 The origins of child labor

Several explanations have been proposed for the use and prevalence of child labor in developing countries. In Basu & Van (1998), parents dislike child labor, but are driven to it to make ends meet. Dessy & Vencatachellum (2000) develop a model where child labor in equilibrium comes from network externalities. Pallage & Zimmermann (2000), in a two-country model where child labor in one country exerts a negative externality on the other, explore the possibility that child labor or rather its ban may be used strategically so as to extract a form of compensation from the other country. Basu (1999) provides a survey of possible other causes, including social norms [a model that incorporates social stigma and the need to conform is found in López-Calva (1999)]. Genicot (1998) builds a theory of child labor based on efficiency wages. Baland & Robinson (2000) show that child labor may arise because of commitment problems between parents and children. In the present paper, we explore another explanation for the prevalence of child labor in poor countries which is likely to be key in the presence of multiple equilibria: the absence of explicit coordination mechanisms.

Our paper differs from previous studies also in other dimensions. On the welfare side, eliminating child

[5] Coordination and the selection of equilibria are the motivations behind Aumann (1987) and Harsanyi & Selten (1988)'s essays. Aumann adopts the Bayesian view that beliefs about the strategies opponents are playing can be formalized by probabilities, and offers his correlated equilibrium concept as a way to reconcile game theory and Bayesian rationality. The origin of beliefs is not explained, however. Harsanyi & Selten suggest a game solution concept that always reduces the number of equilibria to one. Uniqueness of equilibrium, however, without an appropriate set of beliefs by the players, is no guarantee, that that equilibrium will be reached.

labor is a Pareto improvement in our model: both parents and firms benefit from its elimination, while in Basu & Van (1998), it is not clear where the interest of firms stands. Moreover, we show that compulsory education, combined with the proper incentives, is often sufficient to warrant the disappearance of child labor in our model. In Baland & Robinson (2000), banning child labor can be a Pareto improvement in an environment where children cannot credibly commit to transfer part of their (higher) income to their parents in order to compensate them for not having sent them out to work as children. However, since the emergence of alternative mechanisms for financing parents' retirement consumption can solve the transfer problem in the parent-children relationship, it is not clear in their model whether banning child labor Pareto dominates the public provision of retirement benefits.

3 The model

We study an economy with two types of agents, workers and entrepreneurs, a formal market where adults work and an informal sector, where child labor takes place.

3.1 The labor market

1. Workers

The working population is made of overlapping generations of workers. In every period, a continuum 1 of workers is born. Each worker belongs to a household consisting of one adult (the parent) and one child. Workers are identical within each generation. As a child each individual has an endowment of one unit of time outside leisure time. This time endowment is allocated either to work, or to schooling from which the child gains productive skills which may enable him to work as a skilled worker, when adult. The decision on children's time use is made by the parent, and for simplicity children's consumption is normalized to zero. We denote by $e_1 \in [0,1]$ the fraction of a child's time allocated to receiving education. Education is free of charge. Henceforth, all variables with subscript 0 (respectively, 1) denote adults' (respectively, children's) variables.

If a child spends a fraction e_1 of his time receiving an education, upon entering adulthood, he will gain a level of productive skill given by the function $\phi(e_1)$, where $\phi' > 0$, $\phi'' \leq 0$, and $\phi(0) = 0$. The remaining fraction of the child's time, $1-e_1$, will be allocated to work in the informal sector. For simplicity, we assume that income from child labor sources is given by the relation $y_1 = 1 - e_1$ describing the units of the unique consumption good that a child who devotes an amount of time $1 - e_1$ to unskilled labor can produce.[6]

[6]This corresponds to a situation where children take employment in the informal sector, for example, as street vendors, shoe

The representative parent is risk-neutral and altruistic toward his child in the sense that he cares about his child's income when adult, in addition to caring about his own consumption. The von Neumann-Morgenstern utility function describing parents' payoffs associated with each outcome, is given by:

$$U_0 = (c_0 - s)\left[\eta + \beta \log(\omega_1)\right], \qquad \eta > 0,\ 0 < \beta < 1,$$

where c_0 denotes the representative parent's consumption level, s is the subsistence level for adult consumption, ω_1 denotes the next period realized labor income, η is a positive preference scaler, β is the time discount factor. Each parent also has an endowment of one unit of time which is inelastically supplied to work. A strategy for a parent is a choice of child's time allocated to education, $e_1 \in [0,1]$. A parent with labor income ω_0 faces the following budget constraint:

$$c_0 \leq \omega_0 + (1 - e_1).$$

This budget constraint implies that the foregone income from child labor sources, e_1, is the only (indirect) cost of educating a child in this environment.

2. Entrepreneurs

On the production side, there is a continuum 1 of identical entrepreneurs who produce a homogeneous final good according to either a skill-biased technology or one that uses unskilled labor. We assume that entrepreneurs are born in sequences of non-overlapping generations and live for two periods.

The structure of the formal adult labor market follows Acemoglu (1994): assignment is governed by a two-sided random matching process with an exogenous matching function and an exogenous surplus sharing rule.[7] The two-sided random matching is one-to-one between entrepreneurs and adult workers. The surplus generated by a match, which we denote as Y, is divided between the two agents, with a fraction $\alpha \in (0,1)$ going to the entrepreneur, while the remainder, $1 - \alpha$, goes to the worker. The labor matching is such that no formal productive resource is left idle. Children do not enter this matching process. When working, they do so on the informal market.

Assume that in period 0, the first period of life of the first generation of entrepreneurs, all entrepreneurs are only operating the unskilled-labor technology. Denote by $Y_0 = A$, the total surplus generated by a match between a worker and an entrepreneur operating the unskilled-labor technology, where $A > 0$. In period 0, the representative entrepreneur decides whether or not to devote an exogenous fraction γ of his share of

polisher, luggage carriers, etc, which does not require any skill, nor contribute to skill formation [see Swaminathan (1998)].

[7]For a similar model, see Redding (1996). The author analyzes the relationship between R&D investments and human capital accumulation within an endogenous growth model and shows that multiple equilibria can exist.

period 0 surplus to the acquisition of a skill-biased technology which it will operate in period 1. Acquiring a skill-intensive technology will yield period 1 total surplus $Y_1 = A \exp[\phi(e_1)]$. Once investment has taken place, the technology will last forever and it will be transmitted to the next generation of entrepreneurs. Since $\phi(0) = 0$, if the representative entrepreneur decides to devote resources to acquiring the skill-intensive technology, she faces the risk of a loss in the event that the representative parent, at period 0, elected not to invest in his child's acquisition of productive skills (i.e., full time work is preferred to schooling).

In the coming lines, we characterize the set of equilibria in this economy. To do so, we solve successively the parents' problem and the firms'.

Definition 1 (Equilibrium) *A Nash equilibrium in pure strategies in this model is a choice of pure strategies for parents and for firms such that (i) the choice of parents solves their maximization problem given the choice of entrepreneurs, and (ii) the choice of entrepreneurs maximizes their objective given the strategy of parents.*

3.2 Best responses

1. The representative parent

To decide how much education the child should receive (if any), the representative parent chooses a best response to all possible choices by entrepreneurs. For the sake of presentation, we define an indicator function μ taking value 1 if entrepreneurs adopt skill-intensive technologies, 0 otherwise. Alternatively, μ can be understood as the realized probability associated with the event that the representative entrepreneur will operate a skill-intensive technology in period 1.

The next period labor income of a child who attends school in the current period for a fraction of time e_1 is

$$\omega_1(e_1; \mu) = \begin{cases} (1-\alpha) A \exp[\phi(e_1)] & \text{if } \mu = 1 \\ (1-\alpha)\, A & \text{if } \mu = 0 \end{cases}$$

Since a child's time has an economic value in this environment, any strategy $e_1 > 0$ is risky for parents: in the event that no firm invests in the acquisition of the skill-intensive technology, the household will lose income because of the foregone child labor.

Let $\phi(e_1) = e_1$. Using the budget constraint, we can rewrite the representative parent's utility as follows:

$$U_0 = [\omega_0 + 1 - e_1 - s]\,[\eta + \beta \log(\omega_1(e_1; \mu))]$$

Now, suppose the representative entrepreneur plays the strategy $\mu = 1$, then the representative parent's best response is described as follows, depending on the subsistence parameter s:

$$e_1 = \begin{cases} 0 & \text{if } \varpi \leq s \\ 2^{-1}(\varpi - s) & \text{if } \underline{\omega} < s < \varpi \\ 1 & \text{if } \underline{\omega} \geq s \end{cases} \tag{1}$$

where $\underline{\omega} = (1-\alpha)A - 1 - \bar{\eta}$, $\varpi = (1-\alpha)A + 1 - \bar{\eta}$, and $\bar{\eta} = [\eta + \log(1-\alpha)A]\,\beta^{-1}$. Equation (1) is obtained by taking the first order conditions for the maximization of U_0 subject to the constraint that $\mu = 1$.

Equation (1) implies that, even when $\mu = 1$, it may still be optimal for the representative parent not to send his child to school. In particular if $\varpi \leq s$, it is optimal, from the point of view of the parent, to favor child labor (i.e., $e_1 = 0$). This result is consistent with the so-called *Luxury Axiom* [Basu & Van (1998)]. It implies that household survival considerations temper the extent to which coordination problems are an issue when it comes to deciding on children's time use. The Luxury Axiom in this environment implies that for very poor households, coordination problems are less of an issue.[8]

Suppose next that the representative entrepreneur plays the strategy $\mu = 0$. Then the representative parent's best response is to choose $e_1 = 0$, even when $s < \varpi$. Clearly, subsistence is no longer an issue, so the only reason why parents do not send their children to school is that they anticipate that the firms will not invest. Coordination of investment decisions is at fault in this case. Therefore in order to keep the focus on the issue of investment coordination between agents, we specialize the analysis to the case where $s \leq \underline{\omega}$. The following assumption guarantees that this condition is always satisfied:

Assumption 1 $s = 1$ and the parameters α, β, η, and A satisfy $(1-\alpha)A - \bar{\eta} > 2$.

Assumption 1 also implies that if the representative entrepreneur plays the strategy $\mu = 1$, the representative parent's best response is to play the strategy $e_1 = 1$.

2. The representative entrepreneur

Let $V(\gamma)$ denote the net value of the entrepreneur when she chooses to invest (i.e., a fraction γ of the period 0 surplus is devoted to the acquisition of the skill-intensive technology). Then:

$$V(\gamma) = \begin{cases} \alpha A\,[1 - \gamma + \beta \exp(e_1)] & \text{if } e_1 > 0 \\ \\ \alpha A\,[1 - \gamma + \beta] & \text{if } e_1 = 0 \end{cases} \tag{2}$$

[8] Although coordination is never guaranteed, the conditions necessary for coordination are more likely to be satisfied when there is a unique equilibrium.

where α denotes the constant fraction of the realized surplus going to the entrepreneur, β is the time-discount factor, common to the parents. The term $\alpha(1-\gamma)A$ denotes the representative's entrepreneur's period 0 surplus net of the amount $\alpha\gamma A$, invested in the acquisition of the skill-intensive technology. The term $\alpha\beta A\exp(e_1)$ is the present discounted value of the period 1 surplus accrued to the representative entrepreneur.

On the other hand, if the representative entrepreneur chooses not to invest (i.e. $\gamma = 0$), the value for her of playing this strategy is given by:

$$V(0) = \alpha A\,(1+\beta)\,, \tag{3}$$

whatever the strategy played by the representative parent. Since $V(0) > \alpha A\,[1-\gamma+\beta]$, if the representative parent plays the strategy $e_1 = 0$, the representative entrepreneur's best response is to play $\mu = 0$. And as long as e_1 satisfies $[\exp(e_1)-1]\,\beta > \gamma$, $\mu = 1$ is the representative entrepreneur's best response.

3.3 Equilibria

Let $\psi = [\exp(1)-1]\,\beta$. We are now ready to state the following proposition:

Proposition 1 *Let assumption 1 hold. (i) If $\gamma > \psi$, there exists a unique pure strategy Nash Equilibrium, where no agent invests (i.e., $\mu = 0$ and $e_1 = 0$). (ii) If $\gamma = 0$, there exists a unique pure strategy Nash equilibrium, where both types of agents invest (i.e. $\mu = 1$ and $e_1 = 1$). (iii) If $0 < \gamma \leq \psi$, there exist two pure strategy Nash equilibria, one where no agent invests and one where both types of agents invest.*

Proof. The proof follows from assumption 1. ■

In case of a unique equilibrium, though coordination is not guaranteed, it requires much fewer assumptions than in the case of multiple equilibria. All that is needed for a coordination of expectations and actions towards the unique equilibrium, is that players be rational and that the rationality of other players be common knowledge. Since these assumptions are typically made in economics, we will ignore the coordination problems in case of a single equilibrium. In the following section, we discuss the policy implications of our results.

4 Policy implications and concluding remarks

Our results read as follows: if the cost of investing in skill-intensive technology is either prohibitive or nil, then only one equilibrium exists, with no investment in the first case, and investment in the second. If the cost of such investment is reasonable compared to its future returns, then two equilibria stand out, one is a no-education/no-investment equilibrium, the other one is Pareto superior and characterized by both types of investments. There, the problem of coordination is at its peak. We have all reasons to believe that investment in skill-intensive technology is seldom being made in Africa [World Bank (2000)]. The state of education in Africa is very poor [UNDP (1994)] and child labor is abundant [International Labor Organization (1998)]. Given the bulk of evidence on these facts, we argue that parents and possible investors have formed beliefs consistent with these facts, in which case coordination will take place, but actions and beliefs will be directed towards the Pareto inferior equilibrium. As we have argued in the introduction, this equilibrium is also the status quo for many African countries. Moreover, a player who deviates from this equilibrium assumes all the risks. For all these reasons, we think that the Pareto inferior equilibrium is the most likely in absence of governmental intervention.

The government can exert a key role in helping expectations to coordinate. Compulsory education, bans on child labor and investment subsidies are three instruments at its disposal. On the one hand, compulsory education and bans on child labor, will help send a signal to possible investors that investments in human capital are in the process of being made and that highly skilled labor will be available in the future. Investment subsidies, on the other hand, can modify parents' perception that firms are not investing in skill-biased technology.

We investigate the usefulness of either instrument, depending on the set of equilibria. Legislative intervention alone, either in the form of a ban or of compulsory education, will be counter-productive in case (i) of Proposition 1, that is if the cost of investment is very high. Instead, an intervention that sufficiently subsidizes technology adoption and imposes compulsory education can jolt the economy from the bad equlibrium to the good one. In that case for example, a subsidy equal to γ, if implementable, will be sufficient to take the economy from the 'bad' equilibrium where no one invests to the 'good' one where both types of agents invest. On the other hand, a subsidy that is just large enough to bring the adoption costs within the interval $(0,\ (\exp\left[(1-\alpha)A-\bar{\eta}\right]-1)\,\beta]$ can, when accompanied with compulsory education laws, also jolt the economy from the 'bad' equilibrium to the 'good' one.

In case (ii) of Proposition 1, legislative intervention is redundant, while this legislation alone can be sufficient in case (iii). In case (iii), moving to make education compulsory will send the signal to entrepreneurs that human capital will be available in period 1, which will induce them to invest in acquiring skill-intensive technologies.

Note that all these results rely on assumption 1, which guarantees that survival is not an issue in this environment. If this assumption does not hold, it is not clear that either subsidizing technology adoption or imposing compulsory education can successfully coordinate investment decisions since parents, in this case, need child labor to ensure survival. To move away from a poverty trap, a minimum requirement is that families need not focus on survival.

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