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Chengze, Simon FAN  
fansimon@ln.edu.hk

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the Quantity and Quality of Children

C. Simon Fan

Lingnan University  
Hong Kong

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Dr. C. Simon Fan is Associate Professor in Department of Economics, Lingnan University, Hong Kong.

Centre for Public Policy Studies  
Lingnan University  
Tuen Mun  
Hong Kong  
Tel: (852) 2616 7182  
Fax: (852) 2591 0690  
Email: [cpps@LN.edu.hk](mailto:cpps@LN.edu.hk)  
<http://www.LN.edu.hk/cpps/>

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# **Child Labor and the Interaction between the Quantity and Quality of Children**

**C. Simon Fan\***

## **Abstract**

This paper analyzes the impacts of child labor on the interaction between the quantity and quality of children in the spirit of Becker and Lewis (1973). It shows that without child labor, the quantity of children can be a normal good so that it increases with parental income under some fairly standard formulations. However, the correlation between fertility and parental income becomes negative when the role of child labor is considered. The model also implies that fertility increases with the wage rate of child labor. Moreover, it suggests that government intervention not only directly affects the supply of child labor, but also influences parents' decisions on fertility, which indirectly determines children's labor market participations.

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# 1 Introduction

*“Just as dogs were raised to hunt for their masters before they were pets, so in early traditional China children were raised as a source of income...”* (Cheung 1972, p.641)

Motivated by substantial empirical evidence on the negative correlation between fertility rate and income, Becker and Lewis (1973) formulated the idea that parents obtain utility from both the quality and the quantity of their children. Depending on the elasticity of substitution between quantity and quality of children in parents’ utility function, this framework yields the important theoretical implication that individuals may spend more on the quality improvement, rather than on the increase of the quantity, of their children as their incomes rise.<sup>1</sup> In fact, the Becker-Lewis model has become a pillar of population and family economics.

This paper attempts to provide a simple extension of the Becker-Lewis model by introducing child labor into this framework. The model implies that the negative correlation between fertility and income can be obtained with much less reliance on the property of parents’ utility function if child labor is considered. In particular, the model illustrates that if both the quantity and the quality of children enter symmetrically into parents’ utility function, without child labor, fertility may be a normal good so that it increases with parental income. However, when the role of child labor is taken into account, we obtain the opposite result: As parental incomes rise, fertility decreases and children are better educated.

The intuition for why child labor affects the interaction between the quantity and quality of children can be explained as follows. When children’s earnings are sufficiently high relative to their cost, raising children is cheap but sending them to school is expensive. So, even if the quantity and the quality of children enters symmetrically into parents’ utility function, parents may regard the quantity of children as a “necessity” and the quality of children as a “luxury” due to their “price difference.” As people demand for more “luxuries” and fewer

“necessities” when they become richer, fertility will decrease and children’s educational attainment will increase when parental incomes rise.

This paper also complements the recent theoretical literature on child labor started with Basu and Van (1998) in several aspects. First, it shows that fertility tends to increase with the wage rate of child labor, which provides an explanation for the empirical evidence on the close correlation between high fertility rate and high child labor productivity (e.g. Levy 1985; Weiner 1991). Second, it implies that the relative wage of child labor and parental income are both crucial in determining whether parents will send some of their children to work. Third, this paper yields some interesting policy implications. In particular, it suggests that government intervention and the law not only directly affect the supply of child labor, but also influence parents’ decisions on fertility, which indirectly determines children’s labor market participations.

## **2 Theoretical Antecedents**

This paper is related to the literature on fertility. For example, Willis (1973) extends Becker and Lewis (1973) by showing that the constraints of both time and material resources affect parents’ choices of the quantity and quality of children. Based on a dynasty model developed by Barro and Becker (1989), Zhang and Zhang (1997) show that in the steady state, fertility and wage rates are negatively related if bequests are operative. Galor and Weil (2000) develop a model in which an economy evolves from a Malthusian regime, where technological progress is slow and population growth is high, into a Post-Malthusian regime, where technological progress rises and fertility rate is low.

This paper is also related to the literature on child labor. For example, Basu and Van (1998) and Bardhan and Udry (1999) analyze the causes and consequences of child labor in a model of multiple equilibria in the labor market. They show that coordination failure may result in high rates of both fertility and children’s labor market participation. So, they suggest that banning child labor can solve the problem of coordination failure and eliminate

child labor. Baland and Robinson (2000) demonstrate the inefficiency of child labor and show that a legal restriction of child labor can reduce fertility. They also show that banning child labor, either a marginal ban or a complete ban, can lead to an outcome of Pareto improvement in a general equilibrium framework. Hazan and Berdugo (2002) assume that time is the only input required in raising children and they show that technological progress leads to a decrease in both child labor and fertility. Basu (2000) illustrates the intriguing effects of government policies on child labor by showing that a minimum wage law does not necessarily lead to a reduction of child labor.

### 3 Child Labor, Fertility, and Human Capital

An individual (i.e. an adult) obtains utility from three sources: her consumption of material goods ( $c$ ), the total number of children ( $n$ ), and the number of educated children ( $s$ ). We assume that an adult's utility function takes the following form:

$$V \equiv \ln(c) + \beta \ln(s) + \delta \ln(n) , \tag{1}$$

where  $\beta$  and  $\delta$  are positive coefficients. In the standard Becker-Lewis model,  $s$  stands for the human capital of each child. The above formulation modifies the Becker-Lewis model in such a way that it will be able to account for the empirical evidence of the unequal treatment of parents toward their children, which has been widely observed in the phenomenon of child labor.<sup>2</sup> Meanwhile, the assumption that the utility function is log-linear allows us to derive closed-form solutions without loss of generality. In fact, log-linear utility functions are most commonly used in the related existing literature.<sup>3</sup>

The cost of raising a child is constant and is denoted by  $\pi$ . Due to the altruism within the family, each child's consumption is also related to the level of her parent's consumption. Thus, each child's consumption,  $c^k$ , is

$$c^k = \pi + \alpha c , \tag{2}$$

where  $\alpha$  is a positive coefficient that measures the extent of parents' altruism towards their children.<sup>4</sup> Meanwhile, the cost of education is fixed and is denoted by  $b$ ,  $b \geq 0$ .

For simplicity, we assume that if a child goes to school, she cannot work at all. So, a child's cost of education includes not only the financial cost but also the opportunity cost of working. An adult's income and a child's wage rate are denoted by  $w$  and  $w_c$ , respectively. (Note that the Becker-Lewis model is the special case of the current model in which  $w_c = 0$ ). Then, a household's budget constraint is

$$c + n(\pi + \alpha c) + sb = w + (n - s)w_c . \quad (3)$$

A parent maximizes her utility subject to Equation 3. For the clarity of exposition, we analyze the optimization problem here by assuming that an adult makes decisions in two stages.<sup>5</sup> In the first stage she chooses the number of her offsprings. In the second stage, when her infants grow into school-aged children who have the capacity of studying and working, she makes decisions on her children's education and household consumption. To solve this problem, we first treat  $n$  as a parameter. Meanwhile, for simplicity, we assume that the constraint,  $s \leq n$ , is not binding until the discussions in the last part of this section. Then, from the first order conditions, we get

$$c = \frac{1}{(1 + \beta)} \frac{(w + nw_c - n\pi)}{(1 + n\alpha)} , \quad (4)$$

and

$$s = \frac{\beta}{(1 + \beta)} \frac{(w + nw_c - n\pi)}{(b + w_c)} . \quad (5)$$

Inserting Equations 4 and 5 into Equation 1, we get

$$V = \ln\left[\frac{1}{(1 + \beta)} \frac{(w + nw_c - n\pi)}{(1 + n\alpha)}\right] + \beta \ln\left[\frac{\beta}{(1 + \beta)} \frac{(w + nw_c - n\pi)}{(b + w_c)}\right] + \delta \ln(n) . \quad (6)$$

We assume the solution to Equation 6 is interior. (We will consider the biological constraint of fertility and its implications in the last part of this section). Then, the first order condition of Equation 6 is

$$\frac{dV}{dn} = \frac{(1 + \beta)(w_c - \pi)}{w + n(w_c - \pi)} - \frac{\alpha}{1 + n\alpha} + \frac{\delta}{n} = 0 . \quad (7)$$

Like the Becker-Lewis model, this paper intends to examine the relationship between fertility and parental income and that between parental income and the average level of children's human capital. In this model, the average level of children's human capital,  $h$ , is defined as

$$h \equiv \frac{s}{n} .$$

Then, from Equation 7, we get the following proposition:

**Proposition 1:** (i) *As parents' income increases, fertility will decrease (i.e.  $\frac{dn}{dw} < 0$ ) if and only if*

$$w_c > \pi . \tag{8}$$

(ii) *As parents' income increases, a higher proportion of children will receive an education (i.e.  $\frac{dh}{dw} > 0$ ) if  $w_c > \pi$ .*

**Proof.** (i) Totally differentiating Equation 7 with respect to  $n$  and  $w$  and rearranging, we get

$$\frac{dn}{dw} = \frac{(1 + \beta)(w_c - \pi)}{[w + n(w_c - \pi)]^2 V''} . \tag{9}$$

Note that the second order condition,  $V''$ , must be negative when  $n$  is at its optimal solution and the solution is interior. So, if  $w_c > \pi$  so that  $w_c - \pi > 0$ , we have

$$\frac{dn}{dw} < 0 .$$

(ii) From Equation 5, we get

$$\begin{aligned} \frac{ds}{dw} &= \frac{\partial s}{\partial w} + \frac{\partial s}{\partial n} \frac{dn}{dw} \\ &= \frac{\beta}{(1 + \beta)(b + w_c)} + \frac{\beta}{(1 + \beta)} \frac{(w_c - \pi)}{(b + w_c)} \frac{dn}{dw} . \end{aligned} \tag{10}$$

So, when  $w_c > \pi$  so that  $\frac{dn}{dw} < 0$ , noting Equations 10 and 5, we have

$$\frac{dh}{dw} = \frac{n \frac{ds}{dw} - s \frac{dn}{dw}}{n^2}$$

$$\begin{aligned}
&= \frac{1}{n^2} \left\{ \frac{\beta n}{(1+\beta)(b+w_c)} + \left[ \frac{\beta}{(1+\beta)} \frac{n(w_c - \pi)}{(b+w_c)} - s \right] \frac{dn}{dw} \right\} \\
&= \frac{1}{n^2} \left\{ \frac{\beta n}{(1+\beta)(b+w_c)} + \left[ \frac{\beta}{(1+\beta)} \frac{n(w_c - \pi)}{(b+w_c)} - \frac{\beta}{(1+\beta)} \frac{(w + nw_c - n\pi)}{(b+w_c)} \right] \frac{dn}{dw} \right\} \\
&= \frac{1}{n^2} \left[ \frac{\beta n}{(1+\beta)(b+w_c)} - \frac{\beta}{(1+\beta)} \frac{w}{(b+w_c)} \frac{dn}{dw} \right] \\
&> 0.
\end{aligned}$$

From Proposition 1, clearly, we have the following corollary:

**Corollary 1:** *If there is no child labor, then  $\frac{dn}{dw} > 0$  and the sign of  $\frac{dh}{dw}$  is ambiguous.*

**Proof.** When there is no child labor, it is equivalent to the special case of Proposition 1 in which  $w_c = 0$  ( $< \pi$ ). Then, from the proof of Proposition 1, trivially, we can get the results of this corollary.

Comparing Proposition 1 with Corollary 1, we can see that introducing child labor into the model can drastically change the conclusion about the correlation between fertility and parental income. Corollary 1 implies that when child labor is not considered, the correlation between fertility and parental income can be positive despite that the quality of children is incorporated into parents' utility function and the formulations are fairly standard. In other words, Corollary 1 illustrates that the interaction between the quantity and the quality of children in the spirit of Becker and Lewis (1973) does not always imply that fertility will decrease and children's human capital will increase as parental income rises. In fact, Becker and Lewis (1973) recognize that their model itself does not generate a clear-cut conclusion on the relationship between income and fertility. They point out that whether income and fertility are negatively correlated depends on the elasticity of substitution between quantity and quality of children in parents' utility function.

However, when child labor is taken into account, Proposition 1 yields the opposite result, that is, fertility and income are negatively related. The proposition shows that if child

labor productivity is sufficiently high, the negative correlation between fertility and parental income can be obtained with much less reliance on the property of parents' utility function in the Becker-Lewis model. Meanwhile, when child labor is considered, Proposition 1 shows that the relationship between the average quality of children and parental income becomes unambiguously positive. So, this paper extends the Becker-Lewis model and complements the existing literature on fertility and human capital.

The intuition of the previous results is as follows. Without child labor, the quantity and the quality of children may both be normal goods so that they are both positively correlated with parental income. When child labor is considered, however, the quantity of children is “cheap” when the earnings of a child are sufficiently high relative to its cost (i.e. when  $w_c > \pi$ ),<sup>6</sup> while the quality of children is “expensive.”<sup>7</sup> So, even if the quantity and the quality of children enters symmetrically into parents' utility function, parents may regard the quantity of children as “necessity” and the quality of children as “luxury” due to their “price difference.” When people become richer, they demand for more “luxuries” and fewer “necessities.” Thus, when child labor productivity is high enough, fertility will decrease and the average level of children's human capital will increase as parental incomes rise.

Next, we analyze the effect of the wage rate of child labor on fertility and children's human capital accumulation. This analysis is important not only because children's wage rate is crucial in our above analysis, but also because much empirical evidence suggests that child labor and the wage rate or productivity of child labor are closely related (Basu 1999).

Based on the previous analysis, the following proposition characterizes the relationship between fertility, the average level of children's human capital and children's wage rate.

**Proposition 2:** (i)

$$\frac{dn}{dw_c} > 0 .$$

(ii) *The correlation between the wage rate of child labor and the average level of children's education (i.e.  $\frac{dh}{dw_c}$ ) is ambiguous, depending on the parameters of the model.*

**Proof.** (i) Totally differentiating Equation 7 with respect to  $n$  and  $w_c$ , and rearranging, we get

$$\frac{dn}{dw_c} = -\frac{(1+\beta)w}{[w+n(w_c-\pi)]^2 V''} > 0. \quad (11)$$

(ii) From Equation 5, we get

$$\begin{aligned} \frac{ds}{dw_c} &= \frac{\partial s}{\partial w_c} + \frac{\partial s}{\partial n} \frac{dn}{dw_c} \\ &= \frac{\beta}{(1+\beta)} \frac{(bn+n\pi-w)}{(b+w_c)^2} + \frac{\beta}{(1+\beta)} \frac{w_c-\pi}{(b+w_c)} \frac{dn}{dw_c}. \end{aligned} \quad (12)$$

So,

$$\begin{aligned} \frac{dh}{dw_c} &= \frac{1}{n^2} \left( n \frac{ds}{dw_c} - s \frac{dn}{dw_c} \right) \\ &= \frac{1}{n^2} \left\{ n \left[ \frac{\beta}{(1+\beta)} \frac{(bn+n\pi-w)}{(b+w_c)^2} + \frac{\beta}{(1+\beta)} \frac{w_c-\pi}{(b+w_c)} \frac{dn}{dw_c} \right] - s \frac{dn}{dw_c} \right\} \\ &= \frac{\beta}{(1+\beta)n} \frac{(bn+n\pi-w)}{(b+w_c)^2} + \frac{1}{n^2} \left[ \frac{\beta n}{(1+\beta)} \frac{w_c-\pi}{(b+w_c)} - s \right] \frac{dn}{dw_c} \\ &= \frac{\beta}{(1+\beta)n} \frac{(bn+n\pi-w)}{(b+w_c)^2} - \frac{\beta}{(1+\beta)n^2} \frac{w}{(b+w_c)} \frac{dn}{dw_c}. \end{aligned} \quad (13)$$

Note that the first item of Equation 13 can be either positive or negative. So, the sign of  $\frac{dh}{dw_c}$  is ambiguous.

The first part of Proposition 2 means that fertility rises as the wage rate of child labor increases. It provides an explanation for the empirical evidence that an important determinant of high fertility is high child labor productivity. The second part of this proposition implies that the correlation between children's education and children's wage rate is ambiguous, which stems from the familiar interaction between the income effect and substitution effect. On one hand, as children's wage rate rises, *ceteris paribus*, household wealth will increase and the "income effect" will cause parents to send more children to school. On the other hand, as the wage rate of child labor rises, a child's opportunity cost of study increases and the "substitution effect" causes the parents to send more children to work. So, the net effect depends on the parameters of the model, and the correlation between children's human capital and children's wage rate is theoretically ambiguous.

Finally, we consider that, because of the biological constraints of fertility, there is an upper bound of the number of children that a parent can have. Meanwhile, if a parent wants to have children at all, there is also a positive lower bound of fertility. (In this model, note that from the formulation of the utility function (1), we can see that  $n = 0$  can never be the optimal solution). We might as well normalize the positive lower bound of fertility to be 1. And we denote a parent's maximal biological capacity of fertility by  $\bar{n}$ . Then, we can write a parent's biological constraint of fertility as

$$1 \leq n \leq \bar{n} . \quad (14)$$

Also, we define

$$\gamma \equiv \frac{w_c}{w} .$$

As shown by Basu and Van (1998), both  $w$  and  $w_c$  can be determined by the productivity of adult labor and child labor in a competitive labor market. So,  $\gamma$  measures the relative productivity between child labor and adult labor. Then, we have the following proposition:

**Proposition 3:** (i) *Parents will send some of their children to work if*

$$\gamma \geq \beta . \quad (15)$$

(ii) *Parents will not send any child to work if*

$$\gamma < \frac{\beta}{\bar{n}} , \quad (16)$$

and

$$w \geq \frac{[(1 + \beta)b + \beta\pi]\bar{n}}{\beta - \bar{n}\gamma} . \quad (17)$$

**Proof.** Because the objective function, Equation 1, is continuous with respect to its variables, and because the set of constraints as defined by Equation 3, Inequality 14,  $c \geq 0$  and  $0 \leq s \leq n$  is a compact set, the optimal solutions must exist. We denote the optimal

solution of  $n$  by  $n^*$ . Then, we know that parents will not send any child to work if and only if the constraint,  $s \leq n$ , is binding, namely, the following inequality holds (see Equation 5),

$$s = \frac{\beta}{(1 + \beta)} \frac{(w + n^*w_c - n^*\pi)}{(b + w_c)} \geq n^* . \quad (18)$$

Inequality 18 is equivalent to

$$\beta w \geq n^*w_c + (1 + \beta)bn^* + \beta\pi n^* .$$

Plugging  $w_c = \gamma w$  into the above inequality, we get

$$(\beta - n^*\gamma)w \geq (1 + \beta)bn^* + \beta\pi n^* . \quad (19)$$

Note that  $n^* \geq 1$  (see Equation 14). So, if  $\gamma \geq \beta$ , we have  $n^*\gamma \geq \gamma \geq \beta$ . Hence,  $(\beta - n^*\gamma)w \leq 0$ . So, in this case, Inequality 19 or 18 can never be satisfied. Thus, if  $\gamma \geq \beta$ , parents will always send some of their children to work.

On the other hand, if  $\gamma < \frac{\beta}{n}$ , noting that  $n^* \leq \bar{n}$ , we have  $n^*\gamma \leq \bar{n}\gamma < \beta$ . So, Inequality 19 is equivalent to

$$w \geq \frac{[(1 + \beta)b + \beta\pi]n^*}{\beta - n^*\gamma} . \quad (20)$$

Meanwhile, noting that  $n^* \leq \bar{n}$ , we have

$$\frac{[(1 + \beta)b + \beta\pi]n^*}{\beta - n^*\gamma} \leq \frac{[(1 + \beta)b + \beta\pi]\bar{n}}{\beta - \bar{n}\gamma} .$$

So, when Inequalities 16 and 17 are satisfied, Inequalities 20 and 18 are always satisfied. Thus, in this case, parents will not send any child to work.

Proposition 3 implies that a crucial determinant of child labor is the relative wage between child labor and adult labor. When the relative wage of child labor is sufficiently high, parents will send some children to work. On the other hand, if the relative productivity of child labor is sufficiently low and parents' income is sufficiently high, parents will not send any child to work.

## 4 Policy Intervention and the Law

In light of the previous analysis, the present section aims to investigate the impacts of government intervention and the law on child labor, fertility, and children's human capital formation. Note that the immediate impact of the implementation of the laws that punish or ban child labor is that the wage rate of child labor,  $w_c$ , will decrease. If child workers are the ones who would be fined if caught, their expected earnings will clearly decrease. If the fines are on employers, they would have to pay an extra cost (either the possible fines or the cost of bribing policemen) when they employ children. This extra cost will at least partially pass on to the child workers. Thus, in both cases, from the perspectives of parents and children, these laws will reduce the returns to child labor. And the more strictly these laws are enforced, the smaller  $w_c$  will become. In particular, if  $w_c$  becomes zero, child labor is completely banned. The effectiveness of the implementation of child labor law may depend on many factors, such as the relative size of the informal sector<sup>8</sup> and the level of corruption among policemen and other law-enforcers.

Referring to the analyses in the previous section, we consider two different scenarios in discussing the impacts of government intervention and legislation. First, government intervention takes place after parents' fertility decision is made and children are already born. Second, government policies are fully anticipated so that they affect fertility as well as the supply of child labor and children's human capital. Clearly, the former describes the effects of government intervention in the short run, while the latter is the case in the longer run. The following short-run and long-run analyses complement the existing literature on government policy and child labor.

In the short run, we treat  $n$  as a fixed parameter. Then, we have the following proposition:

**Proposition 4:** *In the short run, when fertility is already chosen, the banning of child labor*

will result in a decrease (increase) in the proportion of educated children if

$$w < (>)(b + \pi)n .$$

**Proof.** Because  $n$  is treated as a fixed parameter,  $\frac{dn}{dw_c} = 0$ . So, from Equation 13, we have

$$\frac{dh}{dw_c} = \frac{\beta}{(1 + \beta)n} \frac{(bn + n\pi - w)}{(b + w_c)^2} . \quad (21)$$

From Equation 21, clearly, if  $w < (b + \pi)n$ , then

$$\frac{dh}{dw_c} > 0 .$$

It implies that a ban of child labor, which reduces  $w_c$ , will reduce  $h$ .

On the other hand, if  $w > (b + \pi)n$ , then

$$\frac{dh}{dw_c} < 0 .$$

While the popular support for banning child labor may mainly stem from the concerns for children's education, Proposition 4 suggests that the ban may not always generate its intended outcome of increasing children's human capital. The intuition is straightforward: As pointed out by Galor and Zeira (1993) and Ranjan (2001), children in poor countries often face credit constraints in their schooling. So in a sense, an increase in children's wage rate and child labor increases the wealth of a poor household and consequently reduces the problem of credit constraint. Thus, under some circumstances, banning child labor may reduce children's human capital.

Proposition 4 implies that government intervention and legislation on child labor will result in an increase in the proportion of educated children only if the parental income is above a certain threshold level,  $(b + \pi)n$ , which is equal to the sum of the expenditure on the basic needs raising the children and the expenditure of educating all of the children. Clearly, in many poor economies, the incomes of most parents are below this threshold level.

In this case, the ban of child labor, either a partial ban or a complete ban, will lead to the unintended consequence that few children will get an education, at least in the short run when fertility is already chosen.

Next, we discuss the policy implications in the long run. In this section, for simplicity, we abstract from the consideration of the biological constraints of fertility. First, we have the following lemma:

**Lemma 1:** *If  $w_c > \pi$ , there exists a  $w^*$ , such that  $w > (<)(=)w^*$  if*

$$w > (<)(b + \pi)n^*(w) ,$$

where  $n^*(w)$  is the optimal level of fertility when parental income is  $w$ .

**Proof.** Plugging  $w = n(b + \pi)$  into Equation 7, we obtain the optimal solution of  $n$ , which we denote by  $n^o$ . Then, we define

$$w^* = n^o(b + \pi) .$$

From Proposition 1, we know that if  $w_c > \pi$ , then  $\frac{dn}{dw} < 0$ . So,

$$\frac{d(w/n)}{dw} = \frac{n - w \frac{dn}{dw}}{n^2} > 0 .$$

So, if  $w > (=) (<)w^*$ , then

$$\frac{w}{n} > (=)(<)\frac{w^*}{n^o} = b + \pi ,$$

namely,

$$w > (=)(<)(b + \pi)n .$$

Based on the previous analysis, the long-run impact of banning child labor is characterized by the following proposition:

**Proposition 5:** *In the long run, if  $w_c > \pi$ , we have the following results:*

(i) If  $w \geq w^*$ , then a marginal ban of child labor will result in an increase in the proportion of educated children.

(ii) If  $w < w^*$ , then the impact of banning child labor on the proportion of educated children is ambiguous.

**Proof.** (i) From Equation 13, we have

$$\frac{dh}{dw_c} = \frac{\beta}{(1+\beta)n} \frac{(bn + n\pi - w)}{(b + w_c)^2} - \frac{\beta}{(1+\beta)n^2} \frac{w}{(b + w_c)} \frac{dn}{dw_c}. \quad (22)$$

If  $w_c > \pi$ , then in the case of a marginal ban of child labor, we will still have  $w_c > \pi$ . So, from Lemma 1, we know if  $w \geq w^*$ , then  $bn + n\pi - w \leq 0$ . Meanwhile, recall that Proposition 2 implies that  $\frac{dn}{dw_c} > 0$ . Thus, if  $w \geq w^*$ ,

$$\frac{dh}{dw_c} < 0.$$

It implies that a marginal ban of child labor, which reduces  $w_c$ , will increase  $h$ .

(ii) From Lemma 1, if  $w < w^*$ ,  $bn + n\pi - w > 0$ . In this case, both of the items of Equation 22 are positive. So, the sign of its difference is theoretically ambiguous.

In the long run, government intervention and the law not only directly affect the supply of child labor, but also influence parents' decisions on fertility, which indirectly determines children's labor market participations and their average level of human capital. In particular, Proposition 5 implies that in the long run, depending on the value of the parameters of the model, it is possible that a restriction of child labor will always lead to an increase in the proportion of educated children regardless of the level of parental income. So, banning child labor may achieve the purpose of enhancing children's human capital more easily in the long run than in the short run. It is because in the long run, banning child labor reduces fertility as the earnings of child labor decreases. When fertility decreases, holding the absolute number of educated children constant, the proportion of educated children will increase. Thus, even when a restriction of child labor reduces the absolute number

of educated children (i.e., when  $w < w^*$ ), if the reduced fertility is much greater than the reduced number of educated children, the proportion of educated children will increase as a result of the legislation on child labor in the long run. Moreover, if we consider that child labor may substitute female labor, then the abolishment of child labor may result in an increase in the relative wage for women. Consequently, it will lead to an increase in women's labor market participation, which will further reduce fertility and hence child labor (Galor and Weil 1996).

Finally, we briefly discuss other types of government policies that may affect child labor, fertility and children's human capital formation. For example, government intervention can also take the form of increasing public educational expenditure. When the public expenditure on education increases, the private cost of education,  $b$ , will decrease. From Equation 5, clearly, more children will be sent to school and fewer to work if the cost of education,  $b$ , decreases. Meanwhile, from Equation 7, we can see that the change of  $b$  has no impact on fertility. So, both in the short run and in the long run, a pure educational subsidy will reduce child labor and enhance children's human capital.

However, if the educational subsidy is funded by collecting a tax from households, by Proposition 1, fertility may increase as people's disposable income decreases. As fertility increases, a higher proportion of children will work. Thus, the policy of an educational subsidy that is fully funded or even partially funded by the households may only reduce child labor and increase children's human capital in the short run, but may have an ambiguous effect on children's welfare in the long run.

## 5 Empirical Discussions

Child labor has long been an important social and economic phenomenon. For example, back in 1861, 36.9% of boys and 20.5% of girls in the 10-14 age group in England and Wales were laborers (Basu 1999). Child labor is still prevalent in many developing countries of the present time. For example, according to the estimation of International Labor Organization,

there were more than 200 million children under the age of 15 who worked in 1995 (Ashagrie 1998; Basu 1999). Also, Fyfe (1989) finds that as many as 20% of African children work, with child workers constituting as much as 17% of the workforce in some African countries. In the following, we will discuss the empirical implications of the model in three parts.

### *Child Labor Productivity and Child Labor*

From the previous sections, we can see that the productivity of child labor plays an important role in our theoretical analyses. In particular, Proposition 3 indicates that the relative wage of child labor as well as parental income is crucial in determining whether parents will send some children to work. The implications of the model are largely consistent with much historical and contemporary evidence.

It is first documented in the writings of some classical economists and the empirical research of many economic historians that high child labor productivity and children's labor market participation are closely correlated. For example, at the beginning of the Industrial Revolution, the rise of new technology and simple machinery enhanced the relative productivity of child labor (e.g., Marx 1867; Lavalette 1998). Hence, many firms employed those "whose bodily development is incomplete, but whose limbs are all the more supple. The labor of women and children was, therefore, the first thing sought by capitalists who used machinery" (Marx 1867, p.372). In fact, Mantoux (1983, p.410) believes that in early Industrial Revolution, not only were children an adequate substitute for men, in some aspects they were even preferable in some occupations:

"...for certain processes the small size of the children<sup>9</sup> and the delicacy of touch made them the best aids to machines."

In modern times, empirical evidence also shows that high child labor productivity causes many children to work. For example, Levy (1985) examines the relationship between the change of child labor productivity (due to technological progress) and the phenomenon of

child labor in rural Egypt. Before the mechanization of the agricultural sector in Egypt, the relative productivity of child labor was high in the production of cotton, which was Egypt's most important crop. During this period, Levy (1985) finds child labor was a crucial part of the agricultural labor force in Egypt. In particular, Levy (1985, p.778, p.782) reports that

“....cotton weeding and picking is better suited to children than tasks connected with cultivating rice, fruit, or vegetables....it is commonly believed that child labor does not have good substitutes in cotton-related work.”

On the other hand, since the mechanization of Egyptian agriculture began, Levy (1985) finds that the mechanization, especially the expanded use of tractors and irrigation pumps, significantly reduced the relative productivity of children; consequently, it contributed significantly to a diminution in child labor.

In the contemporary world, India is a large example of a nation where child labor has been widespread. Much empirical research indicates that the relative productivity of child labor versus adult labor in India has been high. For example, Mehra-Kerpelman (1996) shows that a child's income sometimes accounted for 34-37% of the total income of an Indian household. Nangia (1987) conducted a survey in the Delhi region of India, and shows that about 40% of child workers earn wages equal to adults. So, the high relative wage of child labor helps explain the widespread phenomena of child labor in India.

### *Child Labor and Fertility*

Our theoretical analyses imply that fertility tends to rise as the wage rate of child labor increases. This implication is supported by several empirical studies. For example, based on U.S. aggregate data covering the period 1939-1960, Rosenzweig (1977) finds that a reduction in the pecuniary returns from children within the agricultural sector, associated with capital-biased technological change, was a strong factor in the decline in farm birth rates for the period he studied. Meanwhile, based on the district-level data from the 1961 Census of

India, Rosenzweig and Evenson (1977) report that an important reason that Indian families chose to have relatively large numbers of children in the late 1950s was the high return to the use of raw labor power of children. Further, as labor and land are complementary inputs in agricultural production, Rosenzweig and Evenson (1977) suggest that a land redistribution program aimed at promoting equality, unaccompanied by other changes, would increase fertility and the incidence of child labor.

Also, Levy (1985) finds that in rural Egypt, a major determinant of fertility was child labor productivity. In particular, Levy concludes (p.789):

“....variations in labor contributions from children has an appreciable effect on farmers’ attitudes toward fertility and actual family size .... cotton labor intensity is one of the basic conditions motivating Egyptian farmers to have relatively large families....”

In fact, linking fertility to child labor helps explain the fact that rural fertility has exceeded urban fertility (e.g., Becker 1991). In rural areas, there are many jobs suitable for children, such as watching cows and other domestic animals, keeping birds away from crops, helping with the harvest, weeding and planting, and so on. In contrast, the jobs in urban areas require much more education and skills. Thus, the productivity of child labor in rural areas is higher than that in urban areas, so the fertility is also higher. For example, Fyfe (1989, p.24) notes:

“....children in rural areas can make an early work contribution. This, in turn, can positively influence fertility as the family views children as more hands rather than more mouths....”

#### *Child Labor and the Law*

In Section 4, we analyze the impacts of government intervention and the law on child labor, fertility, and children’s human capital formation. In the empirical literature, recent

studies on the effects of the child labor laws in the United States generally indicate that government interventions play an effective role in reducing child labor and enhancing children's human capital.

For example, by exploiting a “natural experiment” in the 1900 U.S. Census, Margo and Finegan (1996) show that the combination between compulsory schooling laws and child labor laws significantly raised school attendance for the children at age fourteen. Also, using data from the 1960-80 U.S. Census, Acemoglu and Angrist (1999) find that child labor laws significantly affected children's educational attainment. More recently, Lleras-Muney (2002) shows that compulsory school attendance and child labor laws contributed greatly to the large increase in secondary schooling in the United States from 1915 to 1939. However, similar to an earlier study of Margo (1986), Lleras-Muney (2002) shows that the laws had no impacts on blacks.<sup>10</sup>

Our theoretical analyses suggest that the existing literature can be extended further. Recall that the analyses in the previous section imply that government intervention and the law not only directly affect the supply of child labor, but also influence parents' decisions on fertility, which indirectly determines children's labor market participations in the long run. Thus, the empirical study on the impacts of the legislation on child labor both in the short run and in the long run can be an interesting venue for future research.

## 6 Summary

By incorporating child labor into the framework of Becker and Lewis (1973), this paper yields several interesting implications that complement the existing literature on fertility and child labor. As examined in some existing literature, the implied correlation between fertility and income in the original Becker-Lewis model depends on the elasticity of substitution between quantity and quality of children in parents' utility function. In particular, our model illustrates that if both the quantity and the quality of children enter symmetrically into parents' utility function, without child labor, fertility may be a normal good so that it

increases with parental income. However, when the role of child labor is taken into account, we obtain the opposite result: As parental incomes rise, fertility decreases and children get better educated.

The intuition for why child labor affects the interaction between the quantity and quality of children is as follows. When children's earnings are sufficiently high relative to their cost, raising children is cheap but sending them to school is expensive. So, even if the quantity and the quality of children enters symmetrically into parents' utility function, parents may regard the quantity of children as a "necessity" and the quality of children as a "luxury" due to their "price difference." As people demand for more "luxuries" and fewer "necessities" when they become richer, fertility will decrease and children's educational attainment will increase when parental incomes rise.

Also, this analysis shows that fertility will increase as the wage rate of child labor rises. So, it complements the existing literature to explain the empirical evidence on the close relationship between child labor and fertility. Meanwhile, it implies that the relative wage of child labor and parental income are both crucial in determining whether parents will send some of their children to work or not.

This paper generates several interesting policy implications. It suggests that the impacts of banning child labor on children's human capital accumulation may vary at different levels of economic development. Meanwhile, the model implies that government intervention and the law not only directly affect the supply of child labor, but also influence parents' decisions on fertility, which indirectly determines children's labor market participations. Thus, legislation on child labor may have different impacts on children's welfare in the short run and in the long run. Finally, this paper discusses various empirical implications of the theoretical analyses.

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## Endnotes

1. For a detailed investigation of the theoretical implications of the Becker-Lewis model, see Razin and Sadka (1995).

2. Much empirical evidence indicates that in many countries parents allow some children to specialize in child labor while others are able to acquire an education (e.g., Salaff 1981; Grootaert and Patrinos 1999). In particular, when parents have gender bias against girls, Parish and Willis (1993, p.866) note that “...one of the best things that can happen to a male, besides being born to rich, well-educated parents, is to have an older sister.”

3. For example, see Galor and Weil (2000), Hazan and Berdugo (2002), and Galor and Moav (2002).

4. As will be apparent, if we modify the utility function in Equation 1 into  $V \equiv \ln(c) + \zeta \ln(c^k - \pi) + \beta \ln(s) + \gamma \ln(n)$ , then  $\alpha$  can be derived as a function of  $\zeta$ . So, treating  $\alpha$  as a parameter substantially saves the algebra without materially changing any result of the paper.

5. It should be noted that this way of derivation is only for the clarity of exposition. It is easy to verify that we can get the same results by the standard Lagrangian method.

6. As observed by Dasgupta (1993) and Bardhan and Udry (1999), the condition,  $w_c > \pi$ , is usually valid in many developing countries. However, note that this condition does not imply the quantity of children is costless. Because a child’s consumption is a part of household consumption (i.e.,  $\alpha > 0$ ), the household consumption per person will decrease with the number of children under some reasonable conditions. (In fact, from Equation 4, it is easy to verify that  $\frac{dc}{dn} < 0$  if  $w_c < \alpha w + \pi$ ).

7. Recall that the cost of sending a child to school includes not only financial costs but also the opportunity cost of the child’s working.

8. The informal sector in many developing countries sometimes hires about 50% of the labor force and the vast majority of working children (Bonnet 1993). The informal section, by definition, is difficult to regulate and is often unreported.

9. Mantoux (1983) notes that the examples include the employment of children in mines (because the tunnels may be too small for adults to crawl through) and as chimney sweepers (for similar reasons).

10. Lleras-Muney (2002) interprets this result as that blacks were very likely to be exempted by law owing to the lack of schools and school resources at that time (e.g., Margo 1990).