Naive policies against child labor can harm the children of developing nations*

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Abstract

We argue that blanket child labor restrictions, as advocated in the ILO Convention No. 138, can harm the children of developing nations even in the long run. The central problem is that work and crime are two competing uses of children's time. Our main insight is that the social return to child labor can be higher than its private return if laws against crime and laws in favor of compulsory education are not enforced. The reason is that child labor crowds out child crime and, of the two, potential crime is the greater social problem. The perverse long-run consequences of otherwise well-intended policies against child labor are more likely in countries with poor institutions, where property rights are insecure and the returns to schooling are low. Furthermore, we argue that a combination of subsidies for child work and subsidies for school attendance maximizes social welfare in the long run. Such a combination of both subsidies is the optimal way to reduce child labor and crime simultaneously.

Keywords: child labor, child crime, economic development, enforcement of compulsory schooling, criminal law, international labor standards.

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1 Introduction

It is becoming increasingly recognized that blanket restrictions on child labor, as advocated in the International Labour Organization (ILO) Minimum Age Convention, 1973 (ILO Convention No. 138),[1] are likely to be harmful in the short run, but there remains the common presumption that they must be beneficial in the long run. In this paper, to the contrary, we argue that blanket child labor restrictions can harm the children of developing nations even in the long run. Our critique rests on the inextricable link between the problems of child labor and crime. According to the United Nations Human Settlements Programme (UN-HABITAT, 2011, p.23) "in Africa, 27 percent of youth are neither in school nor at work, a situation that can lead to frustration, delinquency and social exclusion". This concern is specific neither to Africa nor to the twenty first century, as depicted by Charles Dickens' famous portrayal of nineteenth century London in *Oliver Twist*.

To develop our argument, we analyze the allocation of children's time among school, work, and crime within a general equilibrium model with overlapping generations. We first use the model to address the long-run consequences of restrictions on child labor. We then characterize long-run optimal policies. Our analysis formalizes the view that work and crime are two competing uses of a child's time and, of the two, potential crime is the greater social problem. It also illustrates how the long-run effects of alternative policies are greatly shaped by the imperfect enforceability of laws against crime and compulsory schooling laws.

Our model assumes that child labor is a source of current household income involving the sacrifice of the child's future human capital. Since human capital determines future income, child labor is a source of future poverty. Arguably, it is this logic that underlies the common view that the abolition of child labor will benefit children and promote their nation's economic development. In our model, we go a step further and consider that *child crime* also involves a similar sacrifice of a child's future human capital in exchange for current income. By crime we mean the illicit appropriation of the wealth of others. It is therefore

[1] Article 1 of the ILO Convention No. 138 demands that member countries commit "*to pursue a national policy designed to ensure the effective abolition of child labour and to raise progressively the minimum age for admission to employment*", and Article 2(4) sets the initial minimum age for admission to employment at 14 years for member countries "*whose economy and educational facilities are insufficiently developed*".

an alternative source of current income. By child crime we mean crime committed by a child. Like child labor, it harms human capital accumulation because it also interferes with schooling. A distinguishing feature of child crime, however, is that it harms other people by taxing the returns to their work and possibly harming their human capital accumulation. Here we shall focus on child crime, taking as given the vulnerability of children to the clutches of organized crime and leaving aside crime against children more generally.

The simultaneous enforcement of laws against crime and the outright ban of child labor would be desirable in the long run, even though it would likely harm poor families in the short run, by lowering their income. Children would be forced to attend school, and the resulting increase in future human capital, together with the removal of the "crime tax", would be conducive to development. Similarly, one might expect the enforcement of compulsory full-time schooling to crowd out child labor and crime. However, neither laws against crime nor compulsory schooling laws seem enforceable in practice in the developing world.

In principle, child labor regulation is easier to enforce than either compulsory schooling or laws against crime. However, as long as the latter remain unenforced, what is the allocation of the time that is freed up by compulsory restrictions on child labor? At one extreme, if current and future time squeezed out of child labor were fully allocated to schooling, one would expect the policy to be desirable at least in the long run. At the other extreme, if all displaced child labor were instead driven to crime, one would expect the policy to be harmful even in the long run. The likely outcome lies between these two extremes, and consequently, it is necessary to understand the allocation of schooling, child labor and child crime in society jointly, rather than separately.

When we analyze this social allocation problem, our main insight is that the imperfect enforceability of laws against crime and laws in favor of compulsory schooling greatly shapes the relationship between the *social* return to child labor and its *private* return. If these laws were fully enforced, the social return to child labor would be lower than its private return, as commonly presumed. Otherwise, one must recognize that the social return to child labor can be higher than its private return. This feature has an intuitive explanation: child labor crowds out child crime, not just schooling.

This insight has remarkable policy implications. We show that restrictions on child labor are socially harmful, even in the long run, whenever the social return to child labor is larger than its private return. That restrictions on child labor have a negative short run effect is not surprising. Household income, consumption, and saving all fall in the short run, and so current households can be made worse off even if their children's human capital rises. Yet, we show that blanket restrictions on child labor can make future generations worse off as well, because restricting child labor interferes with its role in crowding out crime.

The perverse long-run consequences of otherwise well-intended policies against child labor are more likely in countries with poor institutions, where property rights are insecure and the returns to schooling are low. In this context, the short-run and the long-run effects of restrictions on child labor are linked through the intergenerational transmission of poverty. On the one hand, by lowering current and future child labor, these restrictions tend to increase human capital accumulation. On the other hand, this positive effect is counteracted by the negative effect of increased current and future crime on human capital accumulation. Moreover, current and future income fall, directly as the result of lower child labor income, and indirectly through the negative effect of lower incomes, and possibly higher crime, on saving and investment.

Once we have shown why blanket restrictions on child labor can be undesirable in the long run, we then ask how to address the problem of child labor. We argue that a combination of subsidies for child work and subsidies for school attendance maximizes social welfare in the long run. There are two main aspects to this. First, the key point is that combining both subsidies is the optimal way to *reduce* child labor and crime simultaneously, not that the optimal level of child labor is necessarily high. This is because school subsidies depress child labor and so they interfere with the social value of child labor arising from its role in crowding out crime. Indeed, even if the long-run optimal allocation requires eliminating child labor, we show that it is optimal to subsidize, as opposed to prohibit, child labor as long as compulsory education is not enforceable.

The second aspect concerns the implementation of our proposed optimal policy in developing countries. In the formal model, we focus on conditional income transfers (positive or negative) in order to illustrate the relevant incentive problems. In practice, this could translate into conditioning transfers, whether in cash or in kind, on an optimal mix of school and work designed to crowd out alternative activities that are relatively more harmful to children.

Previous analyses of child labor radicate the main sources of inefficiency in credit market imperfections (Baland and Robinson, 2000) and positive human capital externalities (Krueger and Donohue, 2005).[2] While our analysis takes as given the presence of credit market imperfections that prevent parents from borrowing against their children's future income, our main focus is on the negative externalities associated with crime.

We are not the first to warn against unintended consequences of standard policies to combat child labor. A central message of research on the economics of child labor during the last decade is that there is a wide variety of circumstances in which policies against child labor are likely to backfire. They may increase the incidence of child labor (Jafarey and Lahiri, 2002, Edmonds and Pavcnik, 2005a, Basu, 2005, Basu and Zarghamee, 2009)), cause households' welfare to fall (Basu and Van, 1998, Dessy and Pallage, 2005), and otherwise have perverse distributional consequences (Krueger and Donohue, 2005, Dinopoulos and Zhao, 2007, Baland and Duprez, 2009). However, while previous research has brought attention to the negative short-run effect of blanket child labor restrictions, emphasizing the loss of current income suffered by poor households, it has left unchallenged the popular view that such blanket restrictions are necessarily beneficial in the long run. By contrast, challenging precisely this view is central to our argument against enforcing the standards set in the ILO Convention No. 138.

Section 2 presents some evidence on child labor and child crime as it pertains to our argument. Section 3 presents the basic model, and Section 4 characterizes the *laissez-faire* equilibrium. Section 5 analyzes the effect of restrictions on child labor. In Section 6, we study the effects of alternative policies. We consider the effect of child labor tax policy in the absence of education policies. We then analyze the effect of education policies in the

[2] Basu (1999) and Edmonds (2008) are two excellent surveys of the literature on child labor. Doepke and Zilibotti (2005, 2010) and Dessy and Knowles (2008) consider the link between political support for child labor regulation and fertility decisions.

absence of child labor policy. Finally, we show that the unconstrained long-run optimal policy always consists of a combination of subsidies for school attendance and child work. Section 7 considers two extensions. Section 8 concludes. Proofs are relegated to the Appendix.

2 Some evidence on child labor and child crime

Child labor remains pervasive around the world. Edmonds and Pavcnik (2005b) report participation rates in various activities for 124 million children between 5 and 14 years old from 36 countries in the year 2000. About 51 percent of those children combine school and work; 19 percent attend school and do not work; 18 percent work and do not attend school; the remaining 12 percent neither work nor attend school. While reliable data on actual criminal activity is lacking, it is evident that youth crime — potential as well as actual crime — is a serious concern in developing countries. According to the United Nations Office on Drugs and Crime (UNODC, 2011), about 4 million children worldwide were "brought into formal contact with the police" (i.e., arrested or cautioned) each year during the 2003-2008 period. Children working in the informal sector seem particularly vulnerable. According to e-oaxaca (June 13, 2011) more than 158,000 children working in the streets of the Mexican state of Oaxaca are believed to be vulnerable to recruitment by organized crime.

Our main insight is that the social return to child labor can be higher than its private return, because child labor crowds out child crime. This assumes that laws against crime are unenforceable, which is hardly questionable. It also assumes that compulsory schooling laws are unenforceable, and that the poor have access to only low-quality education in developing countries. All 193 members of the United Nations have signed the 1990 Convention on the Rights of the Child, whose Article 28 states that State Parties shall make primary education compulsory and available free for all.[3] Yet, according to the United Nations Educational, Scientific and Cultural Organization (UNESCO), more than 67 million children worldwide — about 10 percent of all children of primary school age — were out of school in 2009, and furthermore, "millions of children emerge from primary school each year without having

[3] All members but the United States and Somalia have also ratified the convention.

acquired basic literacy and numeracy skills" (UNESCO, 2010, p. 104). Not surprisingly, in sub-Saharan Africa alone, for instance, about 10 million children drop out of primary school each year (UNESCO, 2011, p. 47).

Evidence of the consequences of child labor regulation draws mainly on the historical record of child labor in currently developed countries, particularly the U.S. and Britain. Arguably, the overall contribution of child labor and education laws to the decline of child labor and the increase in educational attainment in the U.S. and in Britain seems to have been relatively small, with the laws being enforced only after the rise of the factory system (see Moehling (1999) and Goldin and Katz (2011) on the U.S., and Kirbi (2003) on Britain).

In England, for instance, the 1815 Report of the Committee for Investigating the Causes of the Alarming Increase of Juvenile Delinquency in the Metropolis concluded that "the improper conduct of parents", "the want of education" and "the want of suitable employment" were the main causes of juvenile delinquency (Pinchbeck and Hewitt, 1973, p. 435). Indeed, it is well documented that child labor has been encouraged historically as an effective tool to combat child crime, for instance, in nineteenth century England and the U.S. (Watson, 1896, Myers, 1933, Davidson, 1939), and in Mexico during the 1920s (Sosenski, 2008). It is also worth noting that the first efforts to combat child labor emphasized access to education, rather than the prohibition of child labor (Hindman, 2002, p. 49).

Not only rigorous evidence in support of policies against child labor is lacking, but intervention-gone-awry cases of working children seem to be the rule, rather than the exception. For instance, the threat of the Child Labor Deterrence Act in 1993, advocated by Senator Harkin in the U.S., caused garment employers in Bangladesh to dismiss an estimated 50,000 children from their factories. The 1997 UNICEF State of the World's Children noted that "*follow-up visits by UNICEF, local non-governmental organizations (NGOs) and the International Labour Organization (ILO) discovered that children went looking for new sources of income, and found them in work such as stone-crushing, street hustling and prostitution*" (UNICEF, 1997, p. 60). Similar unintended outcomes were observed in the Morocco's garment industry in 1995 after a report of the British Granada TV's *World in Action*, which investigated the labeling of garment made in Méknès (see, e.g., Bourdillon et al., 2010).

In contrast, subsidies for school attendance have been successful in increasing school enrollment and reducing child labor incidence (Ravallion and Wodon, 2000, and Bourguignon, Ferreira and Leite, 2003). Programs such as Progresa in Mexico, Bolsa Escola in Brazil, and the Food-For-Education (FFE) program in Bangladesh are well known cases. Yet, the resulting increases in school enrollment tend to be significantly larger than the declines in child labor. With respect to this, our theory suggests that, where the potential for child crime is an important consideration, a relatively low response of child labor to targeted subsidies for school attendance is the counterpart of a relatively high response of child crime.[4]

3 The model

Consider an economy with overlapping generations. A continuum of identical agents, with mass 1, is born every period. Each agent lives for three periods, which we refer to as childhood, adulthood and old age. Only adults face non-trivial decisions. They have preferences over current consumption (equivalently, the consumption of the child-parent pair) c_a, consumption when old c_o', and their child's labor income next period, $w'h'$:

$$U = u(c_a) + u(c_o') + \delta v(w'h') \equiv \ln(c_a) + \ln(c_o') + \delta \ln(w'h'), \tag{1}$$

with $\delta \in (0,1]$, where w denotes an adult's wage per effective unit of human capital, h denotes an adult's effective human capital. Primed variables denote next-period values.

Only children and adults work, and each is endowed with one unit of time. Children make no decisions. Adults allocate their children's time among three alternative activities:

$$e + x + z \leq 1, \text{ with } e, x, z \geq 0, \tag{2}$$

where e is the time a child spends in school, x is the time she spends at work, and z is the time she spends in criminal activities (e.g., theft).

[4] The evidence for the U.S. strongly suggests that education is an effective tool to reduce juvenile crime. Lochner (2011) offers an excellent survey of the empirical evidence on education and crime.

Both child labor and crime harm human capital accumulation. We assume that

$$h' = Q(Z)(1 - ax - bz)^{\beta} h^{1-\beta}, \tag{3}$$

with $0 < \beta < 1$, and $0 < a \leq b < 1$, where we refer to $1 - ax - bz$ as *effective schooling*, and h is the stock of human capital children inherit from their parents. The term $Q(Z)$ in equation (3) reflects the fact that aggregate child crime may harm children's human capital accumulation, for a given choice of effective schooling. We assume that $Q(0) > 0$, and

$$Q(Z) = \left(\frac{Z}{\underline{Z}}\right)^{-\gamma}, \tag{4}$$

for all $Z > 0$, with $0 \leq \gamma < \beta$, where the term $\underline{Z} > 0$ is a normalization. It is convenient to assume $\underline{Z} \leq (1-p)\epsilon$ throughout, with $p \in [1/2, 1)$ and $\epsilon \in (0, 1/2)$, which ensures that the equilibrium level of child crime always exceeds the lower bound $\underline{Z}$. Below, $1-p$ is defined as a "crime tax". It is worth anticipating that some of our results below refer to the case with $\gamma > 0$, but we show in Section 7 that they also go through if, instead, the negative externality associated with crime works through the crime tax, or if the log-utility assumption is relaxed.

Human capital accumulation in the above specification is not determined by the actual time children spend in school ($e \leq 1-x-z$), but by effective schooling ($1-ax-bz$), where a is the opportunity cost of time allocated to work in terms of school, and b is the opportunity cost of time allocated to crime in terms to school. Thus, if a child devotes all of her time to school, effective schooling coincides with the actual time she spends in school. That is, $1 - ax - bz = 1$ if $e = 1$. At the other extreme, effective schooling remains positive even if a child does not attend school. Thus, if a child works full time, effective schooling amounts to $1 - a$ units. Our assumption that $1 - a > 0$ reflects the fact that children will retain some of their human capital even if they work full time. Similarly, effective schooling would be equal to $1 - b$ units whenever a child engages in crime full time, and our assumption that $1 - b > 0$ implies that even a full time criminal retains some human capital. Assuming that $b \geq a$ implies that crime harms human capital accumulation at least as much as work does.

There is a single final good that is produced according to the production technology

$$F(K, H+\phi H_c) = A\,K^{\alpha}\,(H+\phi H_c)^{1-\alpha}\,, \tag{5}$$

with $A > 0$ and $\alpha \in (0,1)$, where K is the aggregate stock of physical capital, $H = \int_0^1 h_i di$ is the aggregate stock of human capital provided by adults, $H_c = \int_0^1 x_i h_i di$ is the aggregate stock of human capital provided by children, and the productivity of children relative to that of adults is given by $\phi \leq 1$. We also maintain the assumption that $\phi > \frac{b-a}{1-b}$ throughout in order to rule out uninteresting scenarios. The aggregate production technology given by equation (5) reflects the fact that children and adults are perfect substitutes in production, the fact that children work x units of time rather than full time (i.e., one unit), and the fact that children are less productive than adults. We assume all markets are perfectly competitive. For simplicity, we also assume physical capital depreciates fully every period.

We model crime as the result of decentralized conflict over economic distribution,[5] and we assume, for simplicity, that crime taxes households' savings. We also assume that crime is fully unproductive, and only children engage in criminal activity. If there is some crime in the economy, a fixed proportion $1-p \in (0,1/2]$ of all the labor income that is not consumed is subject to appropriation. A household's labor income is the sum of the adult's labor income wh and the child's labor income $w_c hx$, which is the income that a child worker with human capital h, who works x units of time gets when her wage is w_c. To formalize the aggregate consequences of decentralized crime in a simple manner, we assume each household competes against the economy's average. In particular, if a child spends z units of time in criminal activity, she will secure a proportion z/Z of the economy-wide average crime rents $(1-p)(Y_L - C_a)$, where Z is the average level of crime in the economy and Y_L denotes average labor income. Throughout the paper we use capital letters to denote economy-wide averages, which coincide with aggregates since there is a unit mass of households.

Aggregate consistency of the distribution of crime rents requires that the aggregate re-

[5] See Gonzalez (2012) for a survey of research on insecure property rights, conflict and development.

sources lost to child crime every period add to aggregate crime rents, that is,

$$\int_0^1 (1-p)\left((w+w_c x_i)\, h_i - c_{a,i}\right) di = (1-p)\int_0^1 (Y_L - C_a)\, z_i/Z\, di, \tag{6}$$

where the subscript i denotes an individual household. Although our focus below is on symmetric equilibria with positive levels of child crime, it remains to specify the crime rents that accrue to a criminal whenever $Z = 0$. We simply assume they are a fraction $(1-p)$ of the average labor income net of consumption $Y_L - C_a$.

Old agents at time $t+1$ simply consume their capital income,

$$c_o' = (1+r')\, s, \tag{7}$$

where r' is the market rate of return on savings. For simplicity, we assume there are no school fees, and so a household's savings out of labor income is given by

$$s = p\left((w+w_c x)\, h - c_a\right) + (1-p)\frac{z}{Z}\left(Y_L - C_a\right), \tag{8}$$

whenever $Z > 0$, where $p \in [1/2, 1)$ reflects the security of effective property rights.

We restrict attention to *symmetric* equilibria with positive consumption, which are given by a sequence of allocations $\{x_{it}, z_{it}, s_{it}\}_{t=0}^{\infty}$ for all individuals $i \in [0,1]$, a sequence of average allocations $\{X_t, Z_t, K_{t+1}\}_{t=0}^{\infty}$, with $K_0 > 0$, and a sequence of prices $\{r_t, w_t, w_{ct}\}_{t=0}^{\infty}$ such that, given prices, individuals maximize utility, their time constraint (2) and budget constraints (7) and (8) are satisfied, firms maximize profits, human capital for each individual evolves according to (3), with $h_0 = H_0 > 0$, the distribution of crime rents satisfies (6), every market clears, and $\{x_{it}, z_{it}, s_{it}\} = \{X_t, Z_t, K_{t+1}\}$, for all $i \in [0,1]$ and for all $t \geq 0$.

4 Symmetric equilibrium

In this section we characterize the unique symmetric equilibrium with positive stocks of human and physical capital, and a positive level of child labor. We begin by considering the problem of an arbitrary household. First, note that optimal saving choices of the household are interior, and they satisfy the standard Euler equation

$$\frac{\partial u\left(c_{a}\right)/\partial c_{a}}{\partial u\left(c_{o}^{\prime}\right)/\partial c_{o}^{\prime}}=p\left(1+r^{\prime}\right),$$

which equates the marginal rate of substitution between current and future consumption of an adult and the corresponding marginal rate of transformation. The latter reflects the fact that the insecurity of property rights in the economy acts as a tax on savings.

Second, an optimal choice of child crime is always interior, equating the marginal benefits and the marginal costs of child crime:

$$\frac{\partial u\left(c_{a}\right)}{\partial c_{a}}\frac{\partial c_{a}}{\partial z}=-\delta\frac{\partial v\left(w^{\prime}h^{\prime}\right)}{\partial h^{\prime}}\frac{\partial h^{\prime}}{\partial z}.$$

The marginal benefits from child crime come from higher consumption, where

$$\frac{\partial c_{a}}{\partial z}=\left(\frac{1-p}{p}\right)\left(\frac{Y_{L}-C_{a}}{Z}\right)$$

is decreasing in the aggregate level of child crime, for given aggregate crime rents. The marginal costs of crime come from the reduction in future labor income associated with the negative impact of child crime on human capital accumulation, where

$$\frac{\partial h^{\prime}}{\partial z}=\frac{-b\beta h^{\prime}}{1-ax-bz}.$$

Third, the household's optimal choice of child labor satisfies

$$\frac{\partial u\left(c_{a}\right)}{\partial c_{a}}\frac{\partial c_{a}}{\partial x}+\delta\frac{\partial v\left(w^{\prime}h^{\prime}\right)}{\partial h^{\prime}}\frac{\partial h^{\prime}}{\partial x}\leq 0,$$

with equality whenever optimal child labor is interior. The marginal benefits from child labor come from increased current consumption associated with higher labor income, with

$$\frac{\partial c_{a}}{\partial x}=w_{c}h,$$

whereas the marginal costs come from the reduction in the child's future earnings associated with the negative impact of child labor on her human capital accumulation:

$$\frac{\partial h'}{\partial x} = \frac{-a\beta h'}{1 - ax - bz}.$$

Next, profit maximization implies that all units of human capital are paid according to their marginal product. Accordingly, the wage of an adult per unit of human capital is

$$w = (1 - \alpha) \frac{F(K, H + \phi H_c)}{(1 + \phi X) H}, \tag{9}$$

and the wage of a child is $w_c = \phi w$. Since markets are perfectly competitive, we also have:

$$1 + r = \alpha \frac{F(K, H + \phi H_c)}{K}. \tag{10}$$

Recalling that population is normalized to one, in a symmetric equilibrium we have that $x = X$, $z = Z$, $c_a = C_a$, $c_o = C_o$, $s = S$. Furthermore, the labor market for adult human capital clears every period ($h = H$) and so does the market for child labor ($xh = H_c$). Finally, market clearing in the final goods market implies that aggregate income is equal to aggregate output ($Y = F(K, H + \phi H_c)$), and market clearing in the capital market every period implies that aggregate savings and aggregate investment in physical capital are equal ($S = K'$). It is easy to verify that market clearing also implies that aggregate resources lost to child crime every period add to aggregate crime rents, so equation (6) is satisfied.

As usual, the market clearing conditions, together with symmetry of the equilibrium, can be used to characterize equilibrium dynamics as a function of aggregate variables alone, and equations (9)-(10) can be used to eliminate prices from the resulting equilibrium conditions. To that end, note that the above Euler equation for optimal savings, together with the fact that $C_o' = (1 + r') S$, imply that $S = pC_a$. Thus, the aggregate resources constraint implies that aggregate consumption by adults is a fraction $\frac{1}{1+p}$ of aggregate labor income $(1 - \alpha) Y$. Accordingly, aggregate investment is a fraction $\frac{p}{1+p}$ of aggregate labor income

$$K' = \left(\frac{p}{1 + p}\right) (1 - \alpha) Y. \tag{11}$$

Note that savings come only from labor income, because old agents are the owners of capital, do not work, and consume all of their income. With log utility, households save a constant fraction of their labor income. Intuitively, aggregate investment increases with the security of property rights, as parameterized by p. In the limit as p approaches 1, households would save exactly half of their labor income, because they do not discount future consumption.

The log-utility assumption simplifies the analysis by eliminating dynamics in child labor and crime. Noting that the resources subject to appropriation is given by $(1-\alpha)Y - C_a = pC_a$, it is easy to verify that the equality of marginal costs and benefits from child crime implies the following relationship between child labor and child crime every period:

$$Z = \frac{1 - aX}{b\left(1 + \frac{\delta\beta}{1-p}\right)} \equiv g(X). \tag{12}$$

The equilibrium relationship $Z = g(X)$ has $\partial g/\partial X < 0$ because the marginal benefit from child crime is decreasing in Z, independent of X, while the marginal cost of child crime to a household is increasing in x and z, since there are diminishing returns to effective schooling.

If the optimal choice of child labor is interior, the optimality of child labor and child crime, together, give a second equilibrium relationship between these two activities:

$$Z = \left(\frac{a(1-p)}{b\phi(1+p)}\right)(1 + \phi X) \equiv f(X), \tag{13}$$

which has $\partial f/\partial X > 0$ because the marginal benefit from child labor is decreasing in X, independent of Z, the marginal benefit from child crime is decreasing in Z, independent of X, while the ratio of marginal costs of child labor and child crime is constant.

An equilibrium with positive levels of child labor is such that $X^* > 0$ solves $g(X) = f(X)$, with $Z^* = g(X^*)$ every period. It is then easy to verify the following (see Appendix).

Proposition 1 *There exists a symmetric equilibrium with positive child labor and schooling if and only if* $\phi/a \in \left(m^L, m^H\right)$ *and* $b \in \left(b^L, b^H\right)$*, where* $m^L \in (0,1)$, $m^H > m^L$, $b^L \in (0,1)$, *and $b^H > b^L$ are given in the Appendix. This equilibrium is unique, with*

$$\begin{aligned} X^* &= \frac{1+p-(1-p+\delta\beta)\left(\frac{a}{\phi}\right)}{a(2+\delta\beta)}, \\ Z^* &= \left(1+\frac{a}{\phi}\right)\left(\frac{1-p}{b(2+\delta\beta)}\right), \\ K' &= \left(\frac{p}{1+p}\right)(1-\alpha)AK^{\alpha}H^{1-\alpha}(1+\phi X^*)^{1-\alpha}, \\ H' &= \left(\frac{Z}{\underline{Z}}\right)^{-\gamma}(1-aX^*-bZ^*)^{\beta}H^{1-\beta}, \end{aligned}$$

and it converges to a steady state for all initial conditions $K_0 > 0$ and $H_0 > 0$.

Intuitively, the existence of a symmetric equilibrium with positive child labor requires the productivity of child labor, ϕ, to be sufficiently high relative to the opportunity cost of child labor in terms of schooling, a ($\phi/a > m^L$), so there is an incentive for children to allocate some time to work. It also requires that the productivity of child labor be sufficiently low relative to the opportunity cost of child labor in terms of schooling ($\phi/a < m^H$), so there remains an incentive for children to allocate some time to school. In turn, the opportunity cost of child crime in terms of schooling, given by b, needs to be sufficiently low ($b < b^H$) for schooling not to be crowed out entirely ($m^H > 0$), and also sufficiently high ($b > b^L$) for child labor and schooling to coexist ($m^L < m^H$).

5 Long-run consequences of child labor restrictions

In this section we use the above model to argue that the presence of child crime can greatly shape the long-run implications of child labor restrictions. Formally, we consider an enforceable upper bound to the time a child can devote to work, which we denote by $\overline{x}$, with $0 \leq \overline{x} < X^*$. Larger values of $\overline{x}$ correspond to weaker child labor restrictions, which are binding as long as they constrain child labor to be below the equilibrium level X^*. The case where $\overline{x} = 0$ corresponds to an outright child labor ban.

That restrictions on child labor have a negative short run effect is not surprising. Even though the resulting fall in child labor comes with a rise in child crime, household income, saving, and investment all fall in the short run. Consequently, current households can be made worse off, even if their children's future human capital rises. More importantly, the following proposition shows that restrictions on child labor can make future generations worse off as well.

Proposition 2 ***(i)*** *A permanent cap* $\overline{x}$ *on child labor, with* $0 \leq \overline{x} < X^*$*, reduces long-run utility if and only if* $\overline{x} < x_U$*;* ***(ii)*** $x_U > 0$ *if and only if* $\phi/a > n_U$*;* ***(iii)*** x_U *rises with* γ*, and* $x_U \geq X^*$ *if and only if* $\gamma \geq \beta \left(1 - \frac{1-p+\delta\beta}{\left(1+\frac{\delta}{2}\right)(1+p)}\right)$*, where* x_U *and* n_U *are given in the Appendix.*

Part *(i)* of the proposition says that child labor restrictions harm long-run utility whenever they lower child labor sufficiently. Part *(ii)* provides the conditions for a full ban to be harmful. More generally, it says that there is a non-empty interval of child labor restrictions $[0, x_U]$ that harms long-run utility if and only if the productivity of child labor, relative to the opportunity cost of child labor in terms of schooling, is sufficiently high. Part *(iii)* implies that a given child labor restriction is more likely to be harmful when the effect of the human capital externality associated with child crime is stronger. It also says that even a marginal restriction on child labor may harm long-run utility.

The short-run and the long-run consequences of restrictions on child labor are linked through the intergenerational transmission of poverty. Following the enforcement of a permanent cap on child labor, increased current and future crime counteracts the positive effect on human capital accumulation of decreased current and future child labor. Moreover, current and future income fall, directly as the result of lower child labor, and indirectly through the negative effect of lower incomes on saving and investment.

It is somewhat remarkable that Proposition 2 holds even in the log-utility case, and even though the crime tax $1 - p$ is independent of aggregate crime. These two assumptions will be relaxed in Section 7. However, under these assumptions, not only child labor and crime are unaffected by the dynamics of capital accumulation, but the aggregate investment *rate* is independent of the levels of child labor and crime. Accordingly, the negative effect of lower income on investment is particularly weak, since the aggregate *investment rate* is unaffected by the enforcement of a cap on child labor.

The above two assumptions weaken the negative effect of crime on human capital accumulations as well. Thus, it is easy to verify that human capital increases, both in the short run and in the long run, following the enforcement of a permanent cap on child labor. However, the increase in human capital cannot compensate for the fall in capital accumulation if the human capital externality associated with crime is sufficiently strong.

The intuition behind the results given in Proposition 2 is better understood by contrasting the equilibrium of the model with two alternative benchmark planning problems, which will also play a useful role in our long-run optimal policy analysis in Section 6. The first one is the problem of a planner that allocates all resources in the economy in order to maximize the representative household's long-run utility over all feasible allocations. Formally, let the utility of the representative household in period t be

$$V_t = \ln(\theta_t C_t) + \ln((1-\theta_{t+1}) C_{t+1}) + \delta \ln\left(\frac{(1-\alpha) F(K_{t+1}, (1+\phi X_{t+1}) H_{t+1})}{(1+\phi X_{t+1})}\right),$$

where $\theta_t \equiv C_{at}/C_t$, and where the above objective function assumes that adult labor is rewarded according to its social marginal product every period. The relevant planning problem consists of choosing an allocation $\{X_t, Z_t, K_{t+1}, \theta_t\}_{t\geq 0}$ in order to solve:

$$\begin{aligned} \max \lim_{t\to\infty} V_t \text{ subject to } \quad C_t &= F(K_t, (1+\phi X_t) H_t) - K_{t+1}, \\ H_{t+1} &= \left(\frac{Z_t}{\underline{Z}}\right)^{-\gamma} (1 - aX_t - bZ_t)^{\beta} H_t^{1-\beta}, \\ X_t &\geq 0,\ Z_t \geq \underline{Z},\ X_t + Z_t \leq 1,\ \theta_t \in [0,1], \text{ for all } t \geq 0. \end{aligned} \tag{14}$$

It is easy to verify that any solution exhibits constant values of X and Z. As indefinitely maintainable values of C, K, and H satisfy $C = F(K, (1+\phi X) H) - K$ and $H = \left(\frac{Z}{\underline{Z}}\right)^{-\gamma/\beta} (1 - aX - bZ)$, Problem (14) reduces to the following two-step problem. First, suppose that the planner allocates aggregate consumption period by period between the old and the adults, with $C_a = \theta C$, and $C_o = (1-\theta) C$. It is easy to see that $\theta = 1/2$ solves:

$$\max_{\theta} \ln(\theta C) + \ln((1-\theta) C) \text{ for any } C > 0. \tag{15}$$

Now, Problem (14) reduces to:

$$\max_{X,Z,K} 2\ln\left(AK^{\alpha}H^{1-\alpha}(1+\phi X)^{1-\alpha}-K\right)+\delta\ln\left(\frac{(1-\alpha)AK^{\alpha}H^{1-\alpha}(1+\phi X)^{1-\alpha}}{(1+\phi X)}\right)$$

$$\text{subject to } H=(Z/\underline{Z})^{-\gamma/\beta}(1-aX-bZ),\ X\geq 0,\ Z\geq\underline{Z},\ X+Z\leq 1. \tag{16}$$

The second planning problem is just like Problem (14), except that the planner cannot control child crime, and so she faces the additional constraint $Z_t = g(X_t)$ every period, where $g(\cdot)$ is given by equation (12). The only difference between the two planning problems is that the second one must take into account that child crime decisions are made optimally by the households. The above argument now implies that the new planning problem also solves Problem (15). However, instead of solving Problem (16), it solves:

$$\max_{X,Z,K} 2\ln\left(AK^{\alpha}H^{1-\alpha}(1+\phi X)^{1-\alpha}-K\right)+\delta\ln\left(\frac{(1-\alpha)AK^{\alpha}H^{1-\alpha}(1+\phi X)^{1-\alpha}}{(1+\phi X)}\right)$$

$$\text{subject to } Z=g(X),\ H=(Z/\underline{Z})^{-\gamma/\beta}(1-aX-bZ),\ X\geq 0,\ Z\geq\underline{Z},\ X+Z\leq 1. \tag{17}$$

Let $\{X_1, Z_1, K_1\}$ and $\{X_2, Z_2, K_2\}$ solve Problem (16) and Problem (17), respectively. Comparing these allocations and the steady-state equilibrium allocation $\{X^*, Z^*, K^*\}$ implied by Proposition 1, one can show the following result (see Appendix).

Proposition 3 ***(i)*** *$X_1 < X^*$ if and only if $X^* > 0$, and $Z_1 = \underline{Z} < Z^*$.* ***(ii)*** *$X_2 > 0$ is a necessary condition for a permanent cap $\overline{x}$ on child labor, with $0 \leq \overline{x} < X^*$, to reduce long-run utility.* ***(iii)*** *The following three statements are equivalent: (a) $X_2 \geq X^*$, (b) $Z_2 \leq Z^*$, and (c) $x_U \geq X^*$, where x_U is given in Proposition 2.*

Part *(i)* says that equilibrium child labor and crime are both inefficiently large relative to the long-run optimal allocation $\{X_1, Z_1, K_1\}$. Thus, it is socially desirable to eliminate both child labor and crime. Part *(ii)* implies that child labor restrictions necessarily increase long-run utility if the constrained long-run optimal allocation $\{X_2, Z_2, K_2\}$ requires the elimination of all child labor. Part *(iii)* states that the condition that equilibrium child labor be inefficiently low relative to the *constrained* long-run optimal allocation $\{X_2, Z_2, K_2\}$ is equivalent to the condition given in Proposition 2 to have that even a marginal restriction on child labor will harm long-run utility. It also implies that equilibrium child labor is too low if and only if equilibrium child crime is too high, relative to $\{X_2, Z_2, K_2\}$.

To appreciate the full implications of Proposition 3, it is useful to consider the solutions to Problem (16) and Problem (17) in some detail. In both cases, optimal investments require equating the marginal product of capital to its cost:

$$\frac{2}{C}\left(\frac{\partial F}{\partial K}-1\right)=-\delta\frac{1}{Y}\frac{\partial F}{\partial K}.$$

Using the fact that $\frac{\partial F}{\partial K}=\alpha\frac{Y}{K}$ and $\frac{C}{K}=\frac{Y}{K}-1$, the long-run optimal investment rate is:

$$\frac{K_1}{Y_1}=\frac{K_2}{Y_2}=\alpha\left(\frac{2+\delta}{2+\alpha\delta}\right), \tag{18}$$

which is greater than the capital share in the production of output, α, because $\delta > 0$, and individuals do not care about their children's consumption, but rather about their labor income. It is easy to verify that the steady-state equilibrium investment rate is lower than the long-run optimal investment rate, that is, $K^*/Y^* < K_1/Y_1$, if and only if $\frac{p}{1+p} < \frac{\alpha}{1-\alpha}\left(\frac{2+\delta}{2+\alpha\delta}\right)$. For instance, $\alpha \geq 1/3$ ensures that this is the case for all $p < 1$.

Now, consider Problem (16). Since crime harms human capital accumulation, the long-run optimal choice of crime is simply $Z_1 = \underline{Z}$. Furthermore, if the long-run optimal level of child labor is interior, the *social* return to child labor in the long run must be zero:

$$2\phi\frac{\partial F}{\partial\left(1+\phi X\right)}-\left(2+\delta\right)\frac{\partial F}{\partial H}\left[-\frac{\partial H}{\partial X}\right]=0. \tag{19}$$

The first term in the left side of the equation is the *social* marginal benefit of child labor. The second term is its *social* marginal cost. For a comparison, in equilibrium, child crime satisfies $Z^* = g\left(X^*\right)$, and it is the *private* return to child labor that is zero:

$$\left(1+p\right)\phi\frac{\partial F}{\partial\left(1+\phi X\right)}-\delta\frac{\partial F}{\partial H}\left[-\frac{\partial H}{\partial X}\right]=0. \tag{20}$$

The first term in the left-hand-side is the *private* marginal benefit of child labor evaluated in utility terms. It accounts for the fact that individuals consume only a fraction $\frac{1}{1+p}$ of additional income from child labor. The second term is the *private* marginal cost of child labor, which reflects the marginal cost from the forgone future income, discounted by the factor δ, due to the fact that child labor harms the child's human capital.

Evaluated at the equilibrium allocation, the *social* marginal benefit of child labor is greater than the *private* marginal benefit. This comes from the fact that child labor increases output, which increases the consumption of both the adult and the old. Evaluated at the equilibrium allocation, the social marginal cost of child labor is also greater than its private marginal cost. This comes from the fact that child labor harms a child's human capital, which depresses consumption of both the adult and the old. It also depresses future labor income, and this cost is discounted by the factor δ. It is easy to see that the social return (that is, the social benefit net of cost) of child labor is always negative, when evaluated at the equilibrium allocation, since $\frac{2}{2+\delta} < \frac{1+p}{\delta}$. Accordingly, $X_1 < X^*$.

Now, consider Problem (17). Child crime satisfies $Z_2 = g(X_2)$ and X_2 satisfies

$$2\phi \frac{\partial F}{\partial (1+\phi X)} - (2+\delta) \frac{\partial F}{\partial H} \left[-\frac{\partial H}{\partial X} - \frac{\partial H}{\partial Z} \frac{\partial Z}{\partial X} \right] = 0. \tag{21}$$

As in Problem (16), it is the social return to child labor that is being maximized. The only difference is that Problem (17) takes into account the fact that child labor crowds out child crime, which in turn affects the calculation of the marginal cost of child labor in terms of human capital. Since $\frac{\partial g(X)}{\partial X} < 0$, this additional effect reduces the social marginal cost of child labor, relative to the unconstrained optimum, whenever the human capital externality associated with crime is present, which implies that $X_2 > X_1$ whenever $\gamma > 0$. Moreover, Proposition 2 and Proposition 3 together imply that the social (marginal) returns to child labor are positive (when evaluated at the equilibrium allocation) if and only if $X_2 > X^*$, which is the case if and only if the human capital externality associated with crime is sufficiently strong that even a marginal child labor restriction will harm long-run utility. Note that the harmful effects of child labor restrictions come from the *potential*, as opposed to the actual, participation of children in criminal activities.

It is easy to show that

$$X_1 = \begin{cases} \frac{(1-b\underline{Z})\frac{1}{a}-\left(1+\frac{\delta}{2}\right)\frac{1}{\phi}}{2+\frac{\delta}{2}} & \text{if} \quad \phi/a \geq \frac{1+\frac{\delta}{2}}{1-b\underline{Z}} \\ 0 & \text{if} \quad \phi/a \leq \frac{1+\frac{\delta}{2}}{1-b\underline{Z}}. \end{cases} \tag{22}$$

Recall that we have assumed that $\underline{Z} \leq (1-p)\,\epsilon$, with $p \in [1/2, 1)$ and $\epsilon \in (0, 1/3)$, in order to ensure that the equilibrium level of child crime exceeds the lower bound $\underline{Z}$. In addition, note that Z_1 converges to 0 as ϵ approaches 0, and so

$$\lim_{\epsilon \to 0} X_1 = \begin{cases} \frac{\frac{1}{a}-\left(1+\frac{\delta}{2}\right)\frac{1}{\phi}}{2+\frac{\delta}{2}} & \text{if} \quad \phi/a \geq 1+\frac{\delta}{2} \\ 0 & \text{if} \quad \phi/a \leq 1+\frac{\delta}{2}. \end{cases}$$

Similarly, it is easy to verify that

$$X_2 = \begin{cases} \frac{\frac{1}{a}-\left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right)\frac{1}{\phi}}{1+\left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right)} & \text{if} \quad \phi/a \geq \left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right) \\ 0 & \text{if} \quad \phi/a \leq \left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right), \end{cases} \tag{23}$$

where it is evident that $X_2 \geq X_1$ whenever $\gamma \geq 0$, with $X_2 = X_1$ if and only if $\gamma = 0$.

It should be noted that $X_2 > 0$ if and only if a/ϕ is sufficiently small, and also that this situation is compatible with $X_1 = 0$, which requires that a/ϕ be sufficiently large. In this sense, our main results apply to an economy where child labor is unambiguously harmful to children, but not too harmful. As a mater of interpretation, our argument against child labor restrictions therefore excludes the worst cases of *hazardous work* as well as all *unconditionally worst forms of child labor*.[6] Importantly, however, we think that our analysis does apply to many forms of child labor that harm children's human capital accumulation. An implication is that the fact that child labor is harmful to children does not justify the imposition of child labor restrictions. This is the case only if child labor is sufficiently harmful.

Consider the case in which property rights are perfectly secure. That is, suppose that $p = 1$, and $\gamma = 0$. In this extreme case, it is easy to verify that child labor restrictions

[6]Worldwide, about 115 million children (under 18 years old) are estimated to do *hazardous work* (ILO, 2011) — "work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of children" (ILO Convention 182 (1999), Article 3(d)). At least another 8.4 million children are involved in *unconditional worst forms of child labor*, including all forms of slavery, prostitution and pornography, and drug production and trafficking (ILO Convention 182 (1999), Article 3(a,b,c)).

unambiguously increase long-run utility. However, it should be noted that they also make current generations worse off. In particular, the current old suffers from decreased capital rents, and the current households forgo child labor income, which is not compensated by the increase in adult labor income. This scenario formalizes the common perception that child labor restrictions are desirable in the long run because they allow children to accumulate human capital, even though current generations may be worse off.

Arguably, the simultaneous enforcement of laws against crime and the outright ban of child labor would be desirable in the long run, and so would be the enforcement of compulsory full-time schooling. However, neither laws against crime nor compulsory schooling laws seem enforceable in developing countries. The following policy analysis recognizes these facts.

6 Analysis of long-run optimal policy

The following policy analysis is designed to highlight the long-run effects of education policy and child labor policy. We first introduce a class of policies rich enough to target the multiple distortions present in the above *laissez-faire* environment, without taxing crime directly. We then characterize the long-run consequences of alternative subsets of policies in turn. Our goal is to characterize the policy that maximizes social welfare in the long run.

6.1 The policy problem

Given our ultimate focus on steady-state equilibria, it is sufficient to consider linear tax instruments. We restrict attention to the class of policies $\{\tau_s, \tau_o, \tau_w, \tau_x, \tau_e\}$, where, for simplicity, we assume that every period t each adult faces a saving tax equal to $\tau_s s$, a tax on child labor equal to $\tau_x x w_c h$, and a tax on education equal to $\tau_e e w h$. In addition, each old individual in period $t+1$ faces a tax on capital gains equal to $\tau_o' (1+r) s$. Accordingly, individuals face the budget constraint

$$\begin{aligned}(1+\tau_s) s &= p\left(\left(w+\left(1-\tau_x\right) w_c x\right) h-c_a-\tau_e e w h\right) \\ &\quad +\frac{(1-p) z}{Z}\left[\left(w+w_c X\right) H-C_a-T_x-T_e\right],\end{aligned}$$

when adults, where we have assumed that crime competes for after-tax crime rents, and where T_x and T_e denote the aggregate tax revenue associated with the tax rates τ_x and τ_e, respectively, in period t. Individuals also face the budget constraint

$$c_o' = (1 - \tau_o)(1 + r') s,$$

when old. Moreover, firms face a payroll tax $\tau_w (wH + w_c H_c)$, and so after-tax profits are:

$$F(K, H + \phi H_c) - (1 + \tau_w)(wH + w_c H_c) - (1 + r) K,$$

Aggregate consistency of the distribution of crime rents requires the obvious analog of equation (6) to hold. Otherwise, the model economy is as before. Each of the above taxes can, in principle, be positive (i.e., actual taxes) or negative (i.e., subsidies). We restrict attention to the class of policies that balance the government budget period by period, so they satisfy

$$T_s + T_o + T_w + T_x + T_e = 0,$$

every period, where T_j is the aggregate tax revenue associated with the tax rate τ_j, in period t. We will continue to avoid time subscripts whenever possible.

For a given policy $T = \{\tau_s, \tau_o, \tau_w, \tau_x, \tau_e\}$, a *symmetric equilibrium* consists of a sequence of allocations $\{x_{it}(T), z_{it}(T), s_{it}(T)\}_{t=0}^{\infty}$ for all individuals $i \in [0,1]$, a sequence of average allocations $\{X_t(T), Z_t(T), K_{t+1}(T)\}_{t=0}^{\infty}$, with $K_0 > 0$, and a sequence of prices $\{r_t(T), w_t(T), w_{ct}(T)\}_{t=0}^{\infty}$ such that, given prices, individuals maximize utility, their time constraint and budget constraints are satisfied, firms maximize after-tax profits, human capital for each individual evolves according to (3), with $h_0 = H_0 > 0$, aggregate consistency of the distribution of crime rents is satisfied, every market clears, and $\{x_{it}(T), z_{it}(T), s_{it}(T)\} = \{X_t(T), Z_t(T), K_{t+1}(T)\}$, for all $i \in [0,1]$ and for all $t \geq 0$.

It is useful to anticipate that we shall adopt the standard primal approach to optimal taxation, by solving a series of primal planning problems and then show how to implement their solutions via policy instruments, instead of attacking directly the dual optimal taxation problems. Let $\left\{X_t^*(T), Z_t^*(T), K_{t+1}^*(T)\right\}_{t=0}^{\infty}$ denote a symmetric equilibrium allocation under the policy T. We say that a policy T implements allocation $\{X_t, Z_t, K_{t+1}\}_{t=0}^{\infty}$ if there is a symmetric equilibrium with $\left\{X_t^*(T), Z_t^*(T), K_{t+1}^*(T)\right\} = \{X_t, Z_t, K_{t+1}\}$, for all $t \geq 0$.

Our objective is to characterize the policy that maximizes the steady-state equilibrium level of utility within the class of feasible policies. Formally, letting $U_t^*(T)$ denote the adults' equilibrium utility at date t, and letting Ψ be the class of feasible policies, we aim to solve

$$\max_{T} \lim_{t \to \infty} U_t^*(T), \text{ subject to } T \in \Psi. \tag{24}$$

Recall that the class of feasible policies is restricted to those that balance the government budget every period. Of course, the solution to the policy problem also depends on the precise tax instruments available. To fix terminology, we say that a solution to Problem (24) is a long-run optimal policy within the class of feasible policies Ψ.

In order to understand the solution to Problem (24), it is useful to characterize first the steady-state equilibrium allocation that a policy $\{\tau_s, \tau_o, \tau_w, \tau_x, \tau_e\}$ implements, subject to the balanced-budget condition. This is easily done by proceeding as we did in the case of the *laissez-faire* equilibrium. One can then verify that equilibrium prices are given by

$$w = \left(\frac{1-\alpha}{1+\tau_w}\right) \frac{F(K, H + \phi H_c)}{(1+\phi X) H}, \; w_c = \phi w, \text{ and } 1 + r = \alpha \frac{F(K, H + \phi H_c)}{K}.$$

One can also verify that the optimality of child crime can be written as

$$\frac{1-p}{Z} + \tau_e \left(\frac{1+p}{1 + \phi(1-\tau_x) X - \tau_e (1 - X - Z)}\right) - \frac{\delta \beta b}{1 - aX - bZ} = 0. \tag{25}$$

The first term in the left side is the marginal benefit from crime rents, evaluated in utility terms. It accounts for the fact that the resources subject to appropriation are simply pC_a. The second term is the marginal effect on utility that child crime has on the education's tax burden through its effect on the level of education. The term in parentheses is simply the ratio wH/C_a, which depends on both τ_x and τ_e. The last term is the marginal cost of child crime, which reflects the utility cost associated with the foregone future income that comes from the fact that crime harms children's human capital.

Next, the optimality of child labor implies that

$$(\phi(1-\tau_x)+\tau_e)\left(\frac{1+p}{1+\phi(1-\tau_x)X-\tau_e(1-X-Z)}\right)-\frac{\delta\beta a}{1-aX-bZ}\leq 0, \tag{26}$$

with strict inequality only if $X=0$ is optimal. The term in the second parentheses is the ratio wH/C_a, as before. The term $\phi(1-\tau_x)(wH/C_a)$ is the marginal benefit from after-tax child-labor income, evaluated in utility terms. The term $\tau_e(wH/C_a)$ is the marginal effect on utility that child labor has on the education's tax burden through its effect on the level of education (i.e., the ratio wH/C_a). The last term on the left-hand-side of equation (26) is the marginal utility cost of child labor associated with lower human capital accumulation.

One can verify that the government budget each period can be written as

$$\frac{1+\tau_w}{1-\alpha}\left[p\tau_s\left(\frac{1-\alpha(1-\tau_o)}{1+p+\tau_s}\right)+\alpha\tau_o\right]+\tau_w=-\left(\frac{\tau_x\phi X+\tau_e(1-X-Z)}{1+\phi X}\right), \tag{27}$$

the Euler equation for optimal saving, evaluated in steady-state equilibrium, gives

$$\frac{C_o}{C_a}=\left(1+\frac{p}{1+\tau_s}\right)\frac{\alpha(1-\tau_o)}{1-\alpha(1-\tau_o)}, \tag{28}$$

and the steady-state equilibrium investment rate is given by

$$\frac{K}{Y}=p\left(\frac{1-\alpha(1-\tau_o)}{1+p+\tau_s}\right). \tag{29}$$

It will become clear that equations (25)–(29) convey the relevant information needed to understand the long-run optimal policy problem.

6.2 Policy analysis

In this section, we examine how alternative policies address the different distortions that are present in the steady-state equilibrium of the *laissez-faire* environment. We introduce, in turn, saving policy, child labor policy, and education policy, and then show that a combination of these policies is the long-run optimal policy. It will be convenient to define the class of balanced-budget policies

$$\Psi_0 = \{\{\tau_s, \tau_o, \tau_w, \tau_x, \tau_e\} : T_s + T_o + T_w + T_x + T_e = 0, \text{ for all } t \geq 0\}.$$

6.2.1 Saving policy

Consider the case where saving policy is feasible, but neither child labor policy nor education policy are. That is, consider the class of feasible policies

$$\widehat{\Psi} = \{\{\tau_s, \tau_o, \tau_w, \tau_x, \tau_e\} \in \Psi_0 : \tau_x = \tau_e = 0\}.$$

Clearly, these class of policies can solve the inefficiency of saving behavior and balance the government budget. It is also clear that the instruments $\{\tau_s, \tau_o, \tau_w\}$ alone cannot affect the allocation of children's time. Note that the two equilibrium conditions (25) and (26), when $\tau_x = \tau_e = 0$, coincide with the optimality conditions for child crime and child labor in the laissez-faire equilibrium. The arguments in Section 5 continue to apply here, and so it is easy to see that the long-run optimal policy within the class of policies $\widehat{\Psi}$ solves Problem (15), which gives the optimal intergenerational allocation of aggregate consumption, and it also implements the allocation that solves the constrained planning problem:

$$\max_{X,Z,K} 2\ln\left(AK^{\alpha}H^{1-\alpha}(1+\phi X)^{1-\alpha} - K\right) + \delta \ln\left(\frac{(1-\alpha)AK^{\alpha}H^{1-\alpha}(1+\phi X)^{1-\alpha}}{(1+\phi X)}\right)$$

$$\text{subject to } H = (Z/\underline{Z})^{-\gamma/\beta}(1 - aX - bZ), \; X \geq 0, \; Z \geq \underline{Z}, \; X + Z \leq 1, \tag{30}$$

and to equations (25)–(26), evaluated at $\tau_x = \tau_e = 0$.

Let $\left\{\widehat{X}, \widehat{Z}, \widehat{K}\right\}$ denote the allocation that solves this problem. Clearly, the allocation of children's time is exactly the *laissez-faire* equilibrium allocation, that is, $\widehat{X} = X^*$, and $\widehat{Z} = Z^*$, where X^* and Z^* are given in Proposition 1. Moreover, the investment rate $\widehat{K}/\widehat{Y}$ is identical to the unconstrained optimum K_1/Y_1 given by equation (18). It is easy to find the taxes $\{\widehat{\tau}_s, \widehat{\tau}_o\}$ that ensure that the equilibrium conditions (28) and (29) hold with $C_o/C_a = 1$ and $K/Y = \alpha\left(\frac{2+\delta}{2+\alpha\delta}\right)$, which give the efficient intergenerational allocation of aggregate consumption and also the efficient investment rate. One can then calculate the value of the payroll tax $\widehat{\tau}_w$ that balances the government budget every period.

Proposition 4 *The policy* $\{\widehat{\tau}_s, \widehat{\tau}_o, \widehat{\tau}_w, 0, 0\}$, *with*

$$\widehat{\tau}_s = \frac{p(1-\alpha)}{\alpha(2+\delta)} - 1,\ \widehat{\tau}_o = 1 - \frac{1-\alpha}{\alpha(2+\alpha\delta)},\ \textit{and}\ \widehat{\tau}_w = \frac{1-p+\alpha\delta}{1+p},$$

is the unique long-run optimal policy within the class of feasible policies $\widehat{\Psi}$. *It implements the solution to Problem (15), and also the allocation* $\left\{\widehat{X}, \widehat{Z}, \widehat{K}\right\}$ *that solves Problem (30).*

The tax rates $\{\widehat{\tau}_s, \widehat{\tau}_o, \widehat{\tau}_w\}$ ensure that the investment rate and the intergenerational allocation of consumption are long-run optimal, while balancing the government budget every period. Clearly, $\widehat{\tau}_w > 0$ always. Recalling that $K^*/Y^* < K_1/Y_1$, if and only if $\frac{p}{1+p} < \frac{\alpha}{1-\alpha}\left(\frac{2+\delta}{2+\alpha\delta}\right)$, it is easy to verify that $\widehat{\tau}_s < 0$ and $\widehat{\tau}_o > 0$ whenever $K^*/Y^* < K_1/Y_1$.

6.2.2 Child labor policy in the absence of education policy

Now, let us consider the case where saving policy and child labor policy are feasible, but education policy is not. That is, consider the class of feasible policies

$$\Psi_2 = \{\{\tau_s, \tau_o, \tau_w, \tau_x, \tau_e\} \in \Psi_0 : \tau_e = 0\}.$$

Clearly, the tax instruments $\{\tau_s, \tau_o, \tau_w, \tau_x\}$ are sufficient to ensure that the investment rate and the intergenerational allocation of consumption are long-run optimal, while balancing the government budget every period. However, access to child labor taxes (positive or negative) is insufficient to fully solve the problem of the inefficient allocation of children's time. Formally, in the absence of education policy (i.e., if $\tau_e = 0$), the tax τ_x influences the first-order condition for an optimal child labor choice (equation (26)), but it does not enter the first-order condition for an optimal choice of child crime (equation (25)). The latter equation, evaluated at $\tau_e = 0$ becomes exactly the optimality condition for child crime in the *laissez-faire* equilibrium, given by equation (12) ($Z = g(X)$), which is a constraint that any policy within the class of feasible policies Ψ_2 must respect. We have the following result.

Proposition 5 ***(i)*** *There is a unique long-run optimal policy* $\{\tau_{s2}, \tau_{o2}, \tau_{w2}, \tau_{x2}, 0\}$ *within the class of feasible policies* Ψ_2*. It implements the solution to Problem (15), and also the allocation* $\{X_2, Z_2, K_2\}$ *that solves Problem (17).* ***(ii)*** $\{\tau_{s2}, \tau_{o2}\} = \{\widehat{\tau}_s, \widehat{\tau}_o\}$*, as given in Proposition 4, and* $\tau_{x2} < 0$ *if and only if* $\gamma > \beta\left(1 - \frac{1-p+\delta\beta}{\left(1+\frac{\delta}{2}\right)(1+p)}\right)$.

Proposition 5 shows that the unique long-run optimal policy within the class of policies Ψ_2 implements the constrained optimal allocation discussed in Section 5, $\{X_2, Z_2, K_2\}$, and so it maps exactly into our previous analysis of child labor restrictions. In particular, it implies that the long-run optimal child labor policy, in the absence of education policy, requires a subsidy whenever the social return to child labor exceeds its private return.

6.2.3 Education policy in the absence of child labor policy

We now study the long-run effect of education policy when child labor policy is not feasible. A school subsidy is a useful instrument because it taxes child labor and child crime simultaneously. However, we shall be careful to restrict attention to policies that do not surreptitiously rely on taxes on child labor and criminal activity that are in fact unavailable. In particular, we wish to avoid the unrealistic case where sufficiently large school subsidies are in effect equivalent to a pair of distinct taxes on child labor and child crime. It will become clear below that this is not a concern whenever the unconstrained optimum has $X_1 > 0$. However, if the unconstrained optimum has $X_1 = 0$, a large enough school subsidy can (sometimes) implement the unconstrained long-run optimal allocation, by eliminating child labor entirely, then raising the school subsidy further, thereby taxing crime directly. In order to exclude this extreme case, we consider the following class of feasible policies:

$$\Psi_3 = \left\{\{\tau_s, \tau_o, \tau_w, \tau_x, \tau_e\} \in \Psi_0 : \tau_x = 0, \text{ equation (26) holds with equality}\right\}.$$

The requirement that equation (26) holds with equality is consistent with $X = 0$ as well as $X > 0$, but it does restrict the class of feasible policies by requiring that equilibrium child labor choices satisfy the corresponding first-order condition for an *interior* optimal choice.

Once again, the available tax instruments are sufficient to ensure that the investment rate and the intergenerational allocation of consumption are long-run optimal, while balancing the government budget every period. However, access to (feasible) education policy (taxes or subsidies) is insufficient to fully solve the problem of the inefficient allocation of children's time. Formally, in the absence of child labor policy (i.e., if $\tau_x = 0$), the tax τ_e enters both equation (25) and equation (26). Combining both equations to eliminate the tax, one can derive a constraint that any policy within the class of policies Ψ_3 must respect (the last constraint in Problem (31)), and verify that the long-run optimal policy within the class of policies Ψ_3 implements the allocation that solves the constrained planning problem

$$\max_{X,Z,K} 2\ln\left(AK^{\alpha}H^{1-\alpha}(1+\phi X)^{1-\alpha} - K\right) + \delta \ln\left(\frac{(1-\alpha)AK^{\alpha}H^{1-\alpha}(1+\phi X)^{1-\alpha}}{(1+\phi X)}\right)$$

$$\text{subject to } H = (Z/\underline{Z})^{-\gamma/\beta}(1-aX-bZ),\ X \geq 0,\ Z \geq \underline{Z},\ X+Z \leq 1, \text{ and} \tag{31}$$

$$\phi(1+p) = (1+\phi-\phi Z)\left[\frac{1-p}{Z} - \frac{\delta\beta b}{1-aX-bZ}\right] + (1+\phi X)\frac{\delta\beta a}{1-aX-bZ}.$$

Let $\{X_3, Z_3, K_3\}$ solve Problem (31). We have the following result.

Proposition 6 ***(i)*** *There is a unique long-run optimal policy* $\{\tau_{s3}, \tau_{o3}, \tau_{w3}, 0, \tau_{e3}\}$ *within the class* Ψ_3*. It implements the solution to Problem (15), and also the allocation* $\{X_3, Z_3, K_3\}$ *that solves Problem (31).* ***(ii)*** $\underline{Z} < Z_3 < Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$*, and* $X_3 \leq X_1$*, with* $X_3 = X_1$ *if and only if* $X_1 = 0$*.* ***(iii)*** $\{\tau_{s2}, \tau_{o2}\} = \{\widehat{\tau}_s, \widehat{\tau}_o\}$*, as given in Proposition 4, and* $\tau_{e3} < 0$*.* ***(iv)*** $U^*(\{\tau_{s3}, \tau_{o3}, \tau_{w3}, 0, \tau_{e3}\}) > U^*(\{\tau_{s2}, \tau_{o2}, \tau_{w2}, \tau_{x2}, 0\})$ *if and only if* $\gamma < \overline{\gamma}$*, for some* $\overline{\gamma} > \beta\left(1 - \frac{1-p+\delta\beta}{\left(1+\frac{\delta}{2}\right)(1+p)}\right)$*, where* $\{\tau_{s2}, \tau_{o2}, \tau_{w2}, \tau_{x2}, 0\}$ *is characterized in Proposition 5.*

Part *(i)* of the proposition states the existence and uniqueness of the optimal policy, and characterizes the corresponding optimal allocation, following our discussion above. Part (ii) implies that the *laissez-faire* levels of both, child labor and child crime, are too high, relative to $\{X_3, Z_3, K_3\}$, and not just relative to the unconstrained optimal allocation $\{X_1, Z_1, K_1\}$. It also implies that, whereas $Z_3 > \underline{Z}$, it is always the case that $X_3 \leq X_1$, with $X_3 < X_1$ whenever $X_1 > 0$. Part *(iii)* says that the presence of education policy does not distort the optimal saving policy, and it is optimal to subsidize school attendance, as one would expect.

Part *(iv)* says that the "education policy" $\{\tau_{s3}, \tau_{o3}, \tau_{w3}, 0, \tau_{e3}\}$ characterized in Proposition 6 dominates the "child labor policy" $\{\tau_{s2}, \tau_{o2}, \tau_{w2}, \tau_{x2}, 0\}$ characterized in Proposition 5 if and only if the externality associated with crime is not too strong. In particular, recalling that $\beta\left(1-\frac{1-p+\delta\beta}{\left(1+\frac{\delta}{2}\right)(1+p)}\right)$ is the cutoff value of γ at which the long-run optimal child labor policy has exactly $\tau_{x2}=0$, education policy dominates child labor policy whenever the optimal child labor policy is a positive tax on child labor.

To understand the nature of the optimal allocation in this case, it is useful to note that X_3 maximizes the social return to child labor. The corresponding first-order condition can be written as

$$2\phi\frac{\partial F}{\partial\left(1+\phi X\right)}-\left(2+\delta\right)\frac{\partial F}{\partial H}\left[-\frac{\partial H}{\partial X}-\frac{\partial H}{\partial Z}\frac{\partial Z}{\partial X}\right]=0.$$

This is exactly equation (21), which maximizes the social return to child labor in Problem (17). The difference is that the constraint in Problem (31) implies that $\frac{dZ}{dX}>0$, whereas the relevant constraint in Problem (17) implies that $\frac{dZ}{dX}=\frac{\partial g(X)}{\partial X}<0$. Our arguments in Section 5 continue to apply here, implying that $X_3 \leq X_1 \leq X_2$.

6.2.4 Long-run optimal policy

Finally, let us examine the interaction of child labor policy and education policy. To that end, consider the class of feasible policies

$$\Psi_1=\left\{\{\tau_s,\tau_o,\tau_w,\tau_x,\tau_e\}\in\Psi_0 : \text{equation (26) holds with equality}\right\},$$

where we maintain the requirement that child labor choices satisfy the relevant first-order condition for an *interior* optimal choice in order to avoid the unrealistic case where education subsidies alone can mimic perfectly the combined effect of taxes on child labor and crime.

Proposition 7 ***(i)*** *There exists a unique long-run optimal policy* $\{\tau_{s1}, \tau_{o1}, \tau_{w1}, \tau_{x1}, \tau_{e1}\}$ *within the class* Ψ_1. *It implements the solution to Problem (15), and also the allocation* $\{X_1, Z_1, K_1\}$ *that solves Problem (16), for* $\underline{Z} > \widetilde{Z}$, *where* $\widetilde{Z} \in (0, Z_3)$ *is given in the Appendix.* ***(ii)*** $\{\tau_{s1}, \tau_{o1}\} = \{\widehat{\tau}_s, \widehat{\tau}_o\}$, *as given in Proposition 4,* $\tau_{x1} < 0$, $\tau_{e1} < 0$, *and* $\tau_{w1} > 0$.

Part *(i)* implies that, although the optimal policy $\{\tau_{s1}, \tau_{o1}, \tau_{w1}, \tau_{x1}, \tau_{e1}\}$ implements the unconstrained optimal allocation $\{X_1, Z_1, K_1\}$, it does so only if the lower bound $\underline{Z}$ on criminal activity exceeds a certain level $\widetilde{Z} > 0$. This is so because child labor and school subsidies raise crime rents, and thus they encourage crime indirectly, effectively constraining their ability to crowd out crime. The fact that $\widetilde{Z} < Z_3$ implies that the optimal policy $\{\tau_{s1}, \tau_{o1}, \tau_{w1}, \tau_{x1}, \tau_{e1}\}$ does implement the unconstrained optimum in a large set of non-trivial cases, where $Z_1 < Z_3$. Part *(ii)* states that the unconstrained optimal policy involves a combination of subsidies to child labor as well as school attendance. School subsidies depress child labor and so they interfere with the social value of child labor associated with its beneficial role in crowding out crime. Consequently, combining child labor subsidies and school subsidies is the optimal way to reduce child labor and crime simultaneously.

One can also verify that if equation (26) were allowed to hold with strict inequality, the optimal school subsidy τ_{e1} would remain unchanged. The only difference is that the optimal child labor tax rate τ_x would become indeterminate, with any rate $\tau_x \geq \tau_{x1}$ being optimal.

It is worth noting that labor income taxes and child labor subsidies are in effect equivalent from the viewpoint of the maximization of long-run social welfare in the present environment. In particular, it can be shown that a positive labor income tax makes households poorer, which encourages child labor, which in turn crowds out crime. In this sense, labor income taxation has a useful role in the present environment only to the extent that it replicates the effect of child labor subsidies. Accordingly, the optimal combination of labor income taxation and education policy would involve a positive school subsidy and a positive income tax. In the context of actual developing countries, however, one would expect child labor subsidies to be politically feasible when labor income taxation would not be.

Finally, suppose that taxes on child crime as well as child labor are feasible. For instance, suppose that households face a tax on criminal activity equal to $\tau_z zwh$. Then, there is a feasible policy $\{\tau_s, \tau_o, \tau_w, \tau_x, \tau_z\}$ that implements the unconstrained long-run optimal allocation, for any $\underline{Z} > 0$. Moreover, such a policy necessarily involves a positive tax on child labor as well as a positive tax on criminal activity. The reason is that child labor in the *laissez-faire* equilibrium is always inefficiently high in first-best terms, and criminal activity can be taxed away. However, this is akin to assuming that laws against crime are perfectly enforceable, which is clearly at odds with the actual evidence on developing countries. Instead, the tax rate τ_z can be viewed as parameterizing the degree of enforcement of laws against crime. Cross-country differences may then be thought of in terms of variation in τ_z. One can easily extend our analysis to verify that higher tax rates τ_z are associated with long-run optimal policies featuring lower school subsidies and lower child labor subsidies. Only when the "tax" on criminal activity is sufficiently large, taxation of child labor becomes optimal from the viewpoint of maximizing long-run social welfare.

7 Extensions

The above formulation of the negative externalities associated with child crime, working through human capital accumulation, allowed for a simple analysis of the long-run effects of restrictions on child labor. In this section, we briefly discuss two extensions of our basic model that would lead to the same qualitative results, even in the absence of human capital externalities associated with child crime. The first one allows aggregate child crime to affect the magnitude of the "crime tax". The second one relaxes the assumption of log-utility.

There are various ways to think about how child criminality works. For example, it may teach children to be opportunistic. One implication is that it reduces the effectiveness of schooling, as in our basic model. The relevance of this channel is documented in studies of school violence.[7] Another is that it may lower institutional quality.[8] A way to formalize the latter is to allow aggregate child crime to affect the crime tax $1-p$ in our basic model. We have the following analog of Proposition 2.

Proposition 8 *Suppose that* $1-p = P(Z)$, *with* $P(0) = 0$, $\partial P/\partial Z > 0$, *and* $\partial^2 P/\partial Z^2 < 0$, *and consider an equilibrium with positive crime.* ***(i)*** *A binding permanent cap* $\overline{x}$ *on child*

[7] For instance, a study of school violence in ten developing countries concludes that *"violence at school is costly not only in financial terms, but also in terms of the long-term damage it inflicts on the individual's healthy personality growth and development, the loss of his and her quality of life, its interference with the individual's learning of pro-social behaviours, and, above all, its impact on the vital task of developing human resources for national development."* (UNESCO, 1997, p. 7).

[8] One instance of this is documented in Al Jazeera's (02/09/2012) broadcast on the river traders of Brazil, in particular, on the participation of children in both trade and piracy along the Tajaparu River (http://www.aljazeera.com/programmes/2011/05/201153142852595854.html).

labor reduces long-run utility if and only if $\overline{x} < \widetilde{x}_U$; ***(ii)*** $\widetilde{x}_U > x_U$, *where* $\widetilde{x}_U$ *is characterized in the Appendix, and* x_U *is given in Proposition 2.*

This proposition considers the case where the "crime tax" $(1-p)$ increases, at a decreasing rate, with the aggregate level of child crime, focusing on equilibria with positive crime. Part *(i)* of the proposition says that child labor restrictions harm long-run utility whenever they lower child labor sufficiently. Part *(ii)* says that the effect of crime on the crime tax makes any given child labor restriction relatively less desirable in the long run. The problem is that any restriction on child labor increases the aggregate level of child crime in the economy, which increases the crime tax, which in turn promotes crime. The resulting equilibrium level of crime is higher, while long-run investment, income, and utility all fall relative to the case where the crime tax is exogenous.

It is easy to construct numerical examples to ensure that any restriction on child labor will reduce long-run utility even in the absence of human capital externalities (i.e., even if $\gamma = 0$). One such example is the following: let $P(Z) = 1 - \exp\{-\eta Z\}$, with $\delta = 1$, $\alpha = 0.7$, $\beta = 0.8$, $\phi = 0.85$, $a = b = 0.95$, and let $\gamma = 0$ and $\eta = 1.28$, which gives $X^* = 0.38$, $Z^* = 0.03$, and $p = 1 - P(Z^*) = 0.96$, in the unique equilibrium with positive crime. In this case, a cap on child labor still leads to higher human capital in the long-run as well as in the short run. Relative to the case where the crime tax is exogenous, the counteracting effect of increased crime on human capital is larger; moreover, increased crime raises the crime tax, which in turn depresses the economy's investment rate; consequently, the negative impact that a cap on child labor has on investment, and thus on future income, is exacerbated.

Finally, it should be noted that the assumption of log utility in our basic model facilitates the analysis by eliminating dynamics in the allocation of children's time. Alternatively, suppose that an adult's utility is given by

$$U = \frac{c_a^{1-\sigma} - 1}{1-\sigma} + \frac{(c_o')^{1-\sigma} - 1}{1-\sigma} + \delta\left(\frac{(w'h')^{1-\sigma} - 1}{1-\sigma}\right),$$

where $\sigma \geq 0$, and where $\sigma = 1$ corresponds to log utility. One can verify that there is a continuum of equilibrium paths whenever $\sigma \neq 1$, which are parameterized by arbitrary initial conditions (X_0, Z_0). However, one can also show that this feature does not translate into a continuum of steady-state equilibrium allocations. It is not difficult to ensure that there exists a unique steady-state equilibrium, although it has no analytical solution.

Simulations of the model indicate that larger values of σ tend to exacerbate the negative consequences of restrictions on child labor, so much so that any restriction will lead to lower utility in the long run if the elasticity of intertemporal substitution $(1/\sigma)$ is sufficiently low, even in the absence of human capital externalities (i.e., even if $\gamma = 0$), and even if the crime tax $(1 - p)$ is exogenous. For example, simulations of the model, with $\delta = \phi = 1$, $\alpha = 0.7$, $\beta = 0.8$, $a = 0.45$, $b = 0.5$, $p = 0.95$, and $\gamma = 0$, indicate that even a marginal restriction on child labor causes utility to fall in the long run whenever $\sigma \geq 4$, with $X^* = 0.31$ and $Z^* = 0.004$, for $\sigma = 4$, and where X^* and Z^* decrease with σ.

Intuitively, the greater the value of σ, the less willing individuals are to sacrifice current consumption, either in exchange for future consumption, or for the sake of their children's future human capital. Accordingly, for greater values of σ, the loss of current income arising from child labor restrictions induces households to sacrifice relatively more of their child's future human capital, by increasing child crime. Indeed, it is possible to find numerical examples where the outright ban of all child labor would lower not only utility but also human capital in the long run. For example, simulations of the model, with $\delta = \phi = 1$, $\alpha = 0.5$, $\beta = 0.8$, $a = 0.3$, $b = 0.5$, $p = 0.93$, and $\gamma = 0$, indicate that banning all child labor would cause human capital to fall in the long-run if $\sigma \geq 15$ (with $X^* = 0.25$ and $Z^* = 0.007$ if $\sigma = 15$). This effect would reinforce, rather than offsetting, the negative welfare effect of reduced investment, and so it is sufficient to ensure that long-run utility would fall as well.

8 Conclusion

The dominant view within developed countries is that international labor standards aimed at the eradication of child labor must be immediately enforced. This view underlies significant international activism aimed at compelling developing countries to enforce the standards set in the ILO Convention No. 138. Thus, on August 29, 2012, the Union cabinet of India approved an amendment to existing child labor laws that, if adopted by parliament, would impose significant penalties to parents and employers of children younger than 14 in any work at all. Not surprisingly, it has been noted that "*[i]mage is very important now since India is promoting itself as the fastest-emerging economic power in the world, ...[t]hey can't afford legislation which goes against that image*" (Wall Street Journal, November 23, 2012).

Those welcoming India's proposed law rejoice that *"[t]hey've really recognised that the long-term benefits of education are far more consequential than the short-term gains of child labor*" (Financial Times, August 29, 2012). Dissenting voices regret that "*strategies have been designed for all children based on generalised examples of children in hazardous and intolerable forms of labour ... that account for a very small percentage of the child work force*", warning that "*[t]his new amendment will be even more difficult to enforce and will further push children into more invisible, unmonitored and therefore hazardous situations*" (Deccan Herald, September 4, 2012).

Evidently, arguments against blanket child labor restrictions have not found much support in the policy arena, even though it is increasingly recognized that they are likely to be harmful in the short run. We think this is because of the persistent belief that such blanket restrictions are likely to be beneficial in the long run. In this paper, to the contrary, we have argued that enforcing the standards set in the ILO Convention No. 138, as India is proposing to do, can harm the children of developing nations even in the long run. That some forms of child labor are abhorrent is not in dispute. Neither is the spirit of Convention No. 138. However, our analysis does call on policy makers to avoid blanket restrictions on child labor, lest they violate the well-known Hippocratic injunction to *do no harm*.

Not surprisingly, working children organizations across the world point out not only that child work does not necessarily interfere with schooling, but also that it may itself be an important source of human capital. Our analysis strengthens their case by formalizing the common observation that "*there are worse things that can happen to children than having to work*" (Basu, 1999, p. 1115) and analyzing the long-term implications. Formally, we have focused on criminal activity, recognizing both the vulnerability of children to the clutches of organized crime and the potential negative externalities associated with child crime.

Our main insight is that the imperfect enforceability of laws against crime and laws in favor of compulsory schooling greatly shapes the relationship between the *social* return to child labor and its *private* return. If these laws were fully enforced, the social return to child labor would be lower than its private return, as commonly presumed. Otherwise, one must recognize that the social return to child labor can be higher than its private return. This feature has an intuitive explanation: child labor crowds out child crime, not just schooling.

The perverse long-run effects of otherwise well-intended policies against child labor are more likely in countries with poor institutions, where property rights are insecure and the returns to schooling are low. It is in this context that the blanket restrictions advocated by the ILO, national ministries, trade unions and "ethical" consumers from developed countries are representative of the naive policies to which the title of this paper alludes. Our analysis illustrates that their case for the abolition of child labor is fallacious, not only because it presumes that high-quality education is the relevant alternative to child labor, but also because it fails to recognize how the short-term and the long-term effects of restrictions on child labor are linked through the intergenerational transmission of poverty.

Furthermore, we have analyzed the policy implications of our argument against the ILO Convention No. 138. Formally, in the context of our model, we have argued that a combination of subsidies for child work and subsidies for school attendance maximizes social welfare in the long run. Thus, the optimal complement to school subsidies is a targeted subsidy, as opposed to a tax, for child work. There are two main aspects to this.

First, the key point is that combining both subsidies is the optimal way to *reduce* child labor and crime simultaneously, not that the optimal level of child labor is necessarily high. Indeed, targeted subsidies to child labor would continue to be optimal even if the maximization of social welfare required eradicating child labor. This is because school subsidies depress child labor and thereby interfere with the social value of child labor arising from its role in crowding out crime.

The second aspect concerns the implementation of our proposed optimal policy in developing countries. In the formal model, we focused on conditional income transfers (positive or negative) in order to illustrate the relevant incentive problems. However, there are various options in terms of how to implement these policies. In practice, our policy proposal amounts to modifying conditional transfer programs such as the Mexican program Oportunidades to accommodate working children. Within existing programs, children's access to food and health care is ensured in exchange for the children's attendance to school. Instead, our analysis implies that an optimal mix of school and work ought to be designed in order to crowd out alternative activities that are relatively more harmful to children. Such programs ought to take into account the circumstances and the best interest of children, as advocated by an increasing number of grass-roots working children movements worldwide.

Finally, our analysis also implies that greater emphasis should be given to complementary interventions aiming at improving the quality of education, the children's work environment, and the enforcement of laws against crime. The problem of child labor is related not only to poverty, but also to poor institutions and poor school quality. While these issues remain unresolved in developing economies, it is the eradication of child abuse and neglect, rather than the eradication of child labor, that is imperative.

Appendix

Proof of Proposition 1

The analysis leading to Proposition 1 shows that an equilibrium with $X^* > 0$ and $Z^* > 0$ is such that (X^*, Z^*) solves equations (12) and (13), every period. Since both equations are linear, and they have different slopes, there is at most one solution. It is straightforward to verify that the solution (X^*, Z^*) is the one given in the proposition.

Next, one must ensure that $X^* > 0$, $Z^* > \underline{Z}$, and $X^* + Z^* < 1$. These three conditions are necessary and sufficient to ensure $X^* \in (0,1)$, $Z^* \in (\underline{Z}, 1)$, and $1 - X^* - Z^* \in (0,1)$. It is straightforward to verify that $X^* > 0$ if and only if $\phi/a > m^L$, with $m^L \equiv \frac{1-p+\delta\beta}{1+p}$, and also that $X^* + Z^* < 1$ if and only if $\phi < m^H a$, with

$$m^H \equiv \frac{\left(1 + \frac{\delta\beta}{1-p}\right)\frac{b}{a} - 1}{\left(\frac{1+p}{1-p}\right)\frac{b}{a} + 1 - b\left(1 + \frac{\delta\beta}{1-p} + \frac{1+p}{1-p}\right)}.$$

Note that $m^L \in (0,1)$, for all $p \in [1/2, 1]$. It remains to show that $m^H > m^L$, with $m^H > 0$. One can easily verify that $m^H > 0$ if and only if

$$b\left(1 + \frac{\delta\beta}{1-p}\right) < 1 + \left(\frac{1}{a} - 1\right)\left(\frac{1+p}{1-p}\right)b,$$

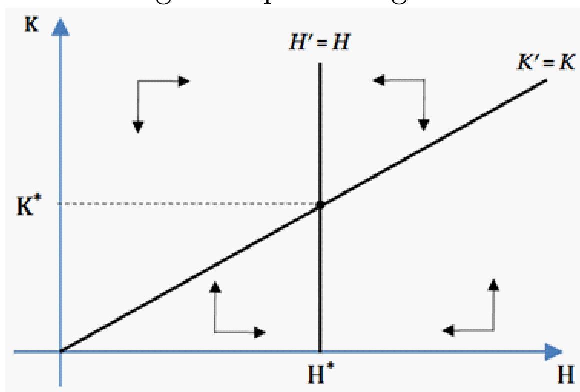
and also that $m^H > m^L$ if and only if $b\left(1 + \frac{\delta\beta}{1-p}\right) > 1$. The above conditions define the interval $\left(b^L, b^H\right)$ given in the proposition in the obvious way.

Next, recalling that $\underline{Z} \leq (1-p)\,\epsilon$, it is easy to verify that $Z^* > \underline{Z}$ if $\epsilon < \frac{1+\frac{a}{\phi}}{b(2+\delta\beta)}$, which is the case for all $\epsilon \in (0, 1/2]$ since $\phi < m^H a$. It is easy to verify that the above existence conditions are consistent with the assumption that $\phi > \frac{b-a}{1-b}$.

The difference equation for K follows from (5) and (11), and the difference equation for human capital accumulation follows from evaluating (3) in equilibrium. Equilibrium dynamics are characterized by these two difference equations, together with (K_0, H_0). Moreover, interior schooling allocations ensure that the equilibrium exhibits positive human and physical capital for all positive initial capital stocks. The equilibrium is obviously unique.

Furthermore, it converges to a unique steady state for all $K_0 > 0$ and $H_0 > 0$, as seen in the phase diagram depicted in Figure 1. The locus of points with $H' = H$ is given by $H = (Z^*/\underline{Z})^{-\gamma/\beta}(1 - aX^* - bZ^*)$, and the locus of points where $K' = K$ is given by $K = BH(1 + \phi X^*)$, where $B = \left(\left(\frac{p}{1+p}\right)(1-\alpha)\,A\right)^{\frac{1}{1-\alpha}}$. The sign of K'/K and that of H'/H in the different regions of the phase diagram can be easily inferred from the dynamic

Figure 1: phase diagram



equations for K and H that are given in the proposition. This concludes the proof. QED

Proof of Proposition 2

One can verify that steady-state equilibrium utility, for any given $\overline{x}$ with $X = \overline{x} \leq X^*$, is equal to $\ln[B_1 \Psi(\overline{x})]$, where $B_1 > 0$ is some constant, with $\Psi(\overline{x}) = (1 - a\overline{x})^{\left(1-\frac{\gamma}{\beta}\right)(2+\delta)} (1 + \phi\overline{x})^2$. The function Ψ is strictly concave, with its maximum at $\overline{x} = X_2$, where X_2 is given by (23), and where $X_2 > 0$ if and only if $\phi/a \geq (1 - \gamma/\beta)(1 + \delta/2)$. It is easy to see that there exists a number $x_U \in [0, X^*]$ such that $\Psi(\overline{x}) < \Psi(X^*)$ if and only if $\overline{x} < x_U$. Let $x_U = X^*$ if and only if $X_2 \geq X^*$. Else, if $X_2 < X^*$, let x_U be the unique solution to $\Psi(x_U) = \Psi(X^*)$ with $x_U \in (0, X^*)$. Note that $x_U > 0$ if and only if $X_2 > 0$ and $\Psi(0) < \Psi(X^*)$, where $\Psi(0) = 1$. Accordingly, let $x_U = 0$ if and only if $\Psi(0) \geq \Psi(X^*)$. This proves Part (i).

Consider Part (ii). It is easy to verify that the necessary and sufficient condition for $\Psi(X^*) > 1$ can be written as

$$\left(1 + \frac{a}{\phi}\right)^{\left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right)} \left(1 + \frac{\phi}{a}\right) > \left(1 + \frac{1+p}{1-p+\delta\beta}\right)^{\left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right)} \left(1 + \frac{1-p+\delta\beta}{1+p}\right).$$

The left side of the inequality falls with a/ϕ if and only if $\frac{\phi}{a} > \left(1 - \frac{\gamma}{\beta}\right)\left(1 + \frac{\delta}{2}\right)$, for $0 \leq \gamma < \beta$. Above, we have noted that this is the necessary and sufficient condition for $X_2 > 0$. Let n_U be the unique value of $\phi/a \geq (1 - \gamma/\beta)(1 + \delta/2)$ that equates both sides of the above inequality. A value of $n_U \geq (1 - \gamma/\beta)(1 + \delta/2)$ can always be found since the right side of the inequality is minimized at $\frac{1+p}{1-p+\delta\beta} = [(1 - \gamma/\beta)(1 + \delta/2)]^{-1}$. This proves Part (ii).

Now consider Part (iii). It is easy to verify that x_U, as defined above, is increasing in γ, for all $x_U \in (0, X^*)$. Recall that $x_U < X^*$ if and only if $X_2 < X^*$, and note that X_2 is an increasing function of γ, whereas X^* is independent of γ. Finally, one can verify that $x_U < X^*$ if and only if $\gamma < \beta\left(1 - \frac{1-p+\delta\beta}{(1+p)(1+\delta/2)}\right)$. This concludes the proof. QED

Proof of Proposition 3

Consider Part (i). First, as noted in the proof of Proposition 1, $\epsilon \in (0, 1/2]$ is a sufficient condition for $Z^* > \underline{Z}$. Next, to compare X^* and X_1, recall that $X^* > 0$ if and only if $\phi/a > m^L$, where $m^L \in (0,1)$ is given in the proof of Proposition 1. From equation (22), note that $X_1 > 0$ if and only if $\phi/a \geq (1+\delta/2)\,/\,(1-b\underline{Z})$, where $(1+\delta/2)\,/\,(1-b\underline{Z}) \geq 1$, for all $\underline{Z} \geq 0$. Next, note that $X_1 > 0$ solves the equilibrium condition (19) whenever $\phi/a \geq (1+\delta/2)\,/\,(1-b\underline{Z})$. Substituting equation (18) into (19) one can show that an interior solution $X_1 > 0$ must solve

$$\frac{\phi}{1+\phi X} = \left(1+\frac{\delta}{2}\right)\frac{a}{1-aX-b\underline{Z}}. \tag{32}$$

Moreover, taking into account that $Z^* = g\left(X^*\right)$, equation (20) can be written as

$$\frac{\phi}{1+\phi X} = \left(\frac{1-p+\delta\beta}{1+p}\right)\frac{a}{1-aX}. \tag{33}$$

Comparing equations (32) and (33), one can see that $X^* > X_1$ if and only if

$$\left(1+\frac{\delta}{2}\right)\frac{1-aX_1}{1-aX_1-b\underline{Z}} > \frac{1-p+\delta\beta}{1+p}, \tag{34}$$

which is always the case, since the left side is greater than 1 and the right side is lower than 1, for all $p \in [1/2, 1)$. It is easy to verify that existence of the allocation (X^*, Z^*, K^*) with $X^* > 0$ implies existence of (X_1, Z_1, K_1). This concludes the proof of Part *(i)*.

Part (ii) was shown in the proof of Proposition 2.

Consider Part (iii). Noting that $Z^* = g\left(X^*\right)$, $Z_2 = g\left(X_2\right)$, and $\partial g/\partial X_2 < 0$, it follows that $Z^* \geq Z_2$ if and only if $X^* \leq X_2$. Next, note that $X_2 > 0$ if and only if $\phi/a \geq (1-\gamma/\beta)\,(1+\delta/2)$, and also that $X_2 > 0$ solves the equilibrium condition (19). In turn, this condition implies that an interior solution $X_2 > 0$ must solve

$$\frac{\phi}{1+\phi X} = \left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right)\frac{a}{1-aX}. \tag{35}$$

Noting that $X^* > 0$ if and only if $\phi/a > \frac{1-p+\delta\beta}{1+p}$, and $X_2 > 0$ if and only if $\phi/a > (1-\gamma/\beta)\,(1+\delta/2)$, and comparing equations (35) and (33), one can see that, whenever $X^* > 0$, one has that $X^* \leq X_2$ if and only if $\left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right) \leq \frac{1-p+\delta\beta}{1+p}$. It is easy to verify that this condition holds if and only $x_U \geq X^*$, as shown in the proof of Proposition 1. It is now easy to verify that existence of the equilibrium allocation (X^*, Z^*, K^*) with $X^* > 0$

implies existence of the constrained optimal allocation $\{X_2, Z_2, K_2\}$, whenever $X^* \geq X_2$. Instead, if $X^* < X_2$, note that the existence of the allocation $\{X_2, Z_2, K_2\}$ requires that $X_2 + Z_2 < 1$, where $Z_2 = g(X_2)$. It is easy to see that $X + g(X)$ is an increasing function of X. Moreover, since X_2 is increasing in γ whenever $X_2 > 0$, it is easy to verify that there exists a number $\gamma_{\max} \in (\gamma_U, \beta)$, where $\gamma_U \equiv \beta\left(1 - \frac{1-p+\delta\beta}{(1+p)(1+\delta/2)}\right)$, such that the allocation $\{X_2, Z_2, K_2\}$ exists if and only if $\gamma \in [0, \gamma_{\max})$. Finally, to prove that $Z_2 > \underline{Z}$, note the minimum level of Z_2, denoted by $Z_2^{\min}$, is given by $X_2 + Z_2 = 1$ since $X + g(X)$ is increasing on X and $g'(X) < 0$. Note that $Z_2^{\min} = \frac{(1-p)(1-a)}{b(1-p+\delta\beta)-a(1-p)} > \underline{Z}$ for all $\epsilon \in (0, 1/2]$ since $\phi/a > \frac{1-p+\delta\beta}{1+p}$ and $b < \frac{a+\phi}{1+\phi}$. This concludes the proof. QED

Proof of Proposition 4

The discussion leading to Proposition 4 implies that the taxes $\{\tau_s, \tau_o\}$ ensuring that equations (28) and (29) hold with $C_o/C_a = 1$ and $K/Y = \alpha\left(\frac{2+\delta}{2+\alpha\delta}\right)$ solve Problem (15), and they also implement the allocation $\left\{\widehat{X}, \widehat{Z}, \widehat{K}\right\}$ that solves Problem (30). It is easy to verify that there are only two such values of the tax rates $\widehat{\tau}_s$ and $\widehat{\tau}_o$, which are given in the proposition. One can then verify that the payroll tax rate $\widehat{\tau}_w$ that balances the government budget is the unique solution to equation (27) evaluated at $\tau_s = \widehat{\tau}_s$, $\tau_o = \widehat{\tau}_o$ and $\tau_x = \tau_e = 0$. QED

Proof of Proposition 5

To prove Part *(i)*, note that equation (26), evaluated at $Z = g(X)$ and $\tau_e = 0$, gives $X^*(\{\tau_s, \tau_o, \tau_w, \tau_x, 0\})$ as a decreasing function of τ_x alone:

$$X^*(\{\tau_s, \tau_o, \tau_w, \tau_x, 0\}) = \frac{1 + p - (1 - p + \delta\beta)\frac{a}{\phi}\left(\frac{1}{1-\tau_x}\right)}{a(2 + \delta\beta)}.$$

Using equation (23), the unique tax rate τ_{x2} that solves $X^*(\{\tau_s, \tau_o, \tau_w, \tau_{x2}, 0\}) = X_2$ is:

$$\tau_{x2} = \begin{cases} 1 - \frac{\frac{a}{\phi}(1-p+\delta\beta)\left[1+\left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right)\right]}{\left(1+p-\frac{a}{\phi}(2+\delta\beta)\right)\left(1-\frac{\gamma}{\beta}\right)\left(1+\frac{\delta}{2}\right)-(1-p+\delta\beta)} & \text{if} \quad \phi/a \geq \left(1 - \frac{\gamma}{\beta}\right)\left(1 + \frac{\delta}{2}\right) \\ 1 - \frac{a}{\phi}\left(\frac{1-p+\delta\beta}{1+p}\right) & \text{if} \quad \phi/a \leq \left(1 - \frac{\gamma}{\beta}\right)\left(1 + \frac{\delta}{2}\right). \end{cases}$$

From equation (25), $Z^*(\{\tau_s, \tau_o, \tau_w, \tau_{x2}, 0\}) = g(X_2) = Z_2$. These facts, together with the discussion leading to Proposition 5, imply that τ_{x2} and the tax rates $\{\widehat{\tau}_s, \widehat{\tau}_o\}$ given in Proposition 4, implement the unique allocation $\{X_2, Z_2, K_2\}$ that solves Problem (15) and Problem (17). Obviously, no policy within the class Ψ_2 can do any better. Finally, one can verify that the payroll tax rate τ_{w2} that balances the government budget is the unique solution to equation (27) evaluated at $\tau_s = \widehat{\tau}_s$, $\tau_o = \widehat{\tau}_o$, $\tau_x = \tau_{x2}$, $\tau_e = 0$ and $X = X_2$. Hence, the optimal policy within the class Ψ_2 exists and is unique. This proves Part *(i)*.

Consider Part *(ii)*. *From Proposition* 2, $X^*(\{\tau_s, \tau_o, \tau_w, 0, 0\}) < X_2$ if and only if $\gamma > \beta\left(1 - \frac{1-p+\delta\beta}{(1+p)(1+\delta/2)}\right)$. The above arguments imply that $X^*(\{\tau_s, \tau_o, \tau_w, \tau_x, 0\}) < X_2$ if and only if $\tau_x > \tau_{x2}$. Therefore, $\tau_{x2} < 0$ if and only if $\gamma > \beta\left(1 - \frac{1-p+\delta\beta}{(1+p)(1+\delta/2)}\right)$, since $X^*(\{\tau_s, \tau_o, \tau_w, \tau_x, 0\})$ decreases with τ_x. The rest of Part *(ii)* is proven in Part *(i)*. QED

Proof of Proposition 6

Consider Part (ii) first. One can verify that there is an allocation $\{X_3, Z_3, K_3\}$ that solves Problem (31), with $X_3 \geq 0$ and $Z_3 \geq \underline{Z}$. Writing the last constraint in Problem (31) as $m(X, Z) = 0$, we know that X_3 satisfies equation (21), with $dZ/dX = \frac{-\partial m/\partial X}{\partial m/\partial Z}$. One can verify that the problem is nicely behaved, so the solution X_3 is unique. One can also verify that our assumption that $b < \frac{a+\phi}{1+\phi}$ implies that $dZ/dX > 0$, for all $Z \in (0,1)$. Since $dZ/dX > 0$, the solution Z_3 is unique. Comparing the above equation with equation (19), it follows that $X_3 \leq X_1$, and moreover, $X_3 < X_1$ if and only if $X_1 > 0$, since $dZ/dX > 0$, for all $Z \in (0,1)$.

Since $m(X^*(\{\tau_s, \tau_o, \tau_w, 0, 0\}), Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})) = 0$, and $X^*(\{\tau_s, \tau_o, \tau_w, 0, 0\}) > X_1 \geq X_3$, then $Z_3 < Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$, where $X^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$ and $Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$ are the equilibrium levels given in Proposition 1. It remains to prove that $Z_3 > \underline{Z}$. Since $m(X, Z) = 0$ implies that $dZ/dX > 0$, for all $Z \in (0,1)$, we know that $Z_3 > Z'$, where Z' is the unique value that solves $m(0, Z') = 0$ in the interval $(0,1)$. Next, taking into account that $b < \frac{a+\phi}{1+\phi}$, and noting that total differentiation of $m(0, Z) = 0$ with respect to Z and b gives $\frac{dZ}{db} < 0$, for $Z \in (0,1)$, one can verify that $Z' > \frac{(1-p)(1+1/\phi)}{2+\delta\beta+(1-p)(1+a/\phi)}$. One can also verify that $\frac{(1-p)(1+1/\phi)}{2+\delta\beta+(1-p)(1+a/\phi)} > \underline{Z}$ for all $\epsilon \in (0, 1/2]$ and for all $p \in [1/2, 1)$. This proves that $Z_3 > \underline{Z}$. This concludes the proof of Part *(ii)*.

Now consider Part *(i)*. From Part (ii), we know that there exists a unique allocation $\{X_3, Z_3, K_3\}$ that solves Problem (31), with $X_3 \geq 0$ and $Z_3 > \underline{Z}$. Obviously, an optimal policy within the class Ψ_3 cannot do better than to implement $\{X_3, Z_3, K_3\}$. Replicating our previous arguments, the only way to implement $\{X_3, Z_3, K_3\}$ is to choose the tax rates $\{\widehat{\tau}_s, \widehat{\tau}_o\}$ given in Proposition 4, together with

$$\tau_{e3} = \frac{-\left(\frac{1-p}{Z_3} - \frac{\delta\beta b}{1-aX_3-bZ_3}\right)}{1+p-X_3\left(\frac{1-p}{Z_3} - \frac{\delta\beta(b-a)}{1-aX_3-bZ_3}\right) - (1-X_3-Z_3)\left(\frac{1-p}{Z_3} - \frac{\delta\beta b}{1-aX_3-bZ_3}\right)}.$$

One can then verify that the payroll tax rate τ_{w3} that balances the government budget is the unique solution to equation (27) evaluated at $\tau_s = \widehat{\tau}_s$, $\tau_o = \widehat{\tau}_o$, $\tau_x = 0$, $\tau_e = \tau_{e3}$, $X = X_3$ and $Z = Z_3$. This concludes the proof of Part *(i)*.

Consider Part *(iii)*. The constraint $m(X, Z) = 0$ implies that the denominator in the above equation for τ_{e3} is positive. The numerator is negative because $X_3 < X^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$ and $Z_3 < Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$, and

$$\frac{1-p}{Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})} - \frac{\delta\beta b}{1 - aX^*(\{\tau_s, \tau_o, \tau_w, 0, 0\}) - bZ^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})} = 0.$$

The rest of Part *(iii)* is shown in Part *(i)*.

To prove Part *(iv)*, one can verify that $U^*(\{\tau_{s3}, \tau_{o3}, \tau_{w3}, 0, \tau_{e3}\}) > U^*(\{\tau_{s2}, \tau_{o2}, \tau_{w2}, \tau_{x2}, 0\})$ when $\gamma = 0$. Next, using the envelope theorem one can write

$$\frac{\partial}{\partial\gamma}\left(U^*(\{\tau_{s3}, \tau_{o3}, \tau_{w3}, 0, \tau_{e3}\}) - U^*(\{\tau_{s2}, \tau_{o2}, \tau_{w2}, \tau_{x2}, 0\})\right) = -\left(\frac{2+\delta}{2}\right)\left(\ln\left(\frac{Z_3}{Z_2}\right)\right),$$

where recall that Z_3 is independent of γ, whereas Z_2 is a decreasing function of γ. Part *(iv)* now follows from the fact that $Z_3 < Z_2$ for all $\gamma \leq \beta\left(1 - \frac{1-p+\delta\beta}{\left(1+\frac{\delta}{2}\right)(1+p)}\right)$. In turn, this follows from the facts that Z_3 is independent of γ, $Z_3 < Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$, Z_2 is a decreasing function of γ, and $Z_2 = Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$ when $\gamma = \beta\left(1 - \frac{1-p+\delta\beta}{\left(1+\frac{\delta}{2}\right)(1+p)}\right)$. QED

Proof of Proposition 7

Consider Part *(i)*. Equations (25) and (26) can be solved for a unique pair of tax rates

$$\tau_e = \frac{-\left(\frac{1-p}{Z} - \frac{\delta\beta b}{1-aX-bZ}\right)}{1 + p - X\left(\frac{1-p}{Z} - \frac{\delta\beta(b-a)}{1-aX-bZ}\right) - (1 - X - Z)\left(\frac{1-p}{Z} - \frac{\delta\beta b}{1-aX-bZ}\right)}, \tag{36}$$

$$1 - \tau_x = \frac{\frac{1}{\phi}\left(\frac{1-p}{Z} - \frac{\delta\beta(b-a)}{1-aX-bZ}\right)}{1 + p - X\left(\frac{1-p}{Z} - \frac{\delta\beta(b-a)}{1-aX-bZ}\right) - (1 - X - Z)\left(\frac{1-p}{Z} - \frac{\delta\beta b}{1-aX-bZ}\right)}, \tag{37}$$

as a function of X and Z alone, assuming that equation (26) holds with equality. Let τ_{e1} and τ_{x1} be given by the above two equations, evaluated at $X = X_1$ and $Z = Z_1$. Clearly, an optimal policy must give $wH/C_a > 0$, and it can be verified that $wH/C_a > 0$ implies that the denominator in the above equations must be positive. This, together with our previous arguments, implies that $\{\tau_{s1}, \tau_{o1}, \tau_{x1}, \tau_{e1}\}$ with $\{\tau_{s1}, \tau_{o1}\} = \{\widehat{\tau}_s, \widehat{\tau}_o\}$, implements the allocation $\{X_1, Z_1, K_1\}$ that solves Problem (15) and Problem (16), provided that

$$1 + p - X_1\left(\frac{1-p}{\underline{Z}} - \frac{\delta\beta\,(b-a)}{1 - aX_1 - b\underline{Z}}\right) - (1 - X_1 - \underline{Z})\left(\frac{1-p}{\underline{Z}} - \frac{\delta\beta b}{1 - aX_1 - b\underline{Z}}\right) > 0.$$

The left side of the inequality approaches $-\infty$ as $\underline{Z}$ approaches zero, and it is increasing in $\underline{Z}$. Hence, the above inequality is satisfied if and only if $Z > \widetilde{Z}$, where $\widetilde{Z}$ is the unique value that equates the left side of the above inequality to zero, and where X_1 is given by equation (22). To prove that $\widetilde{Z} \in (0, Z_3)$, recall that $\underline{Z} \leq (1-p)\,\epsilon$, with $p \in [1/2, 1)$ and $\epsilon \in (0, 1/2)$. Replacing $\underline{Z}$ with $(1-p)\,\epsilon$ in the above inequality, one can show that $Z > \widetilde{Z}$ if and only if $\epsilon > 1/\,(2+n)$, where n is a positive number, and $\widetilde{Z} = (1-p)\,/\,(2+n) > 0$. That $\widetilde{Z} < Z_3$ follows from the fact that $Z_3 > (1-p)\,\epsilon$, for $\epsilon \in (0, 1/2)$.

Finally, the optimal payroll tax rate τ_{w1} is the unique solution to equation (27) evaluated at $\tau_s = \widehat{\tau}_s$, $\tau_o = \widehat{\tau}_o$, $\tau_x = \tau_{x1}$, $\tau_e = \tau_{x1}$, $X = X_1$, and $Z = Z_1$. This proves Part *(i)*.

Consider Part *(ii)*. To prove that $\tau_{e1} < 0$ note that the numerator of the right side of equation (36) is negative when $(X, Z) = (X_1, Z_1)$, because the numerator is equal to zero when $(X, Z) = (X^*(\{\tau_s, \tau_o, \tau_w, 0, 0\}), Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\}))$, and $X_1 < X^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$ and $Z_1 < Z^*(\{\tau_s, \tau_o, \tau_w, 0, 0\})$. That $\tau_{e1} < 0$ now follows from the fact that the denominator of the right side of equation (36) is positive, as shown above. To prove that $\tau_{x_1} < 0$, totally differentiate equation (37) to get $d\tau_x = A_0 dZ + A_1 dX$, where $A_0 > 0$, and $A_1 < 0$ since $b < \frac{a+\phi}{1+\phi}$. The fact that $\tau_{x_1} < 0$ follows from noting that the right side of equation (37) is equal to one, when evaluated at $(X, Z) = (X_3, Z_3)$, and noting that $X_3 \leq X_1$, and $Z_3 > Z_1$. The rest of Part *(ii)* is proven in Part *(i)*. QED

Proof of Proposition 8

One can verify that the optimality of crime choices implies that $z = G(x, P(Z))$, where $G(x, 1-p) = g(x)$, and g is given by equation (12). Suppose there is an equilibrium with positive crime. Paralleling the arguments in the proof of Proposition 2, equilibrium long-run utility can be written as $\ln[B_2(1 - P(Z))\,\Psi(X)]$, where $B_2(p) = B_1$, and where B_1 and Ψ are the same as in the proof of Proposition 2. Moreover, note that the facts that $P(0) \geq 0$, $\partial P/\partial Z > 0$, and $\partial^2 P/\partial Z^2 < 0$, imply that $(\partial P(Z)\,/\partial Z)\,Z \leq P(Z)$, for $Z \in [0, 1)$, which in turn implies that $dZ/dX < 0$, with $dZ/dX = \frac{\partial G(X,P(Z))/\partial X}{1-\partial G(X,P(Z))/\partial Z}$. The rest of the proof parallels the proof of Proposition 2, noting that, if $dZ/dX < 0$, then $\ln[B_2(1 - P(Z))\,\Psi(X)]$ is a strictly concave function of X with its maximum at $X = \widetilde{X}_2$, where $\widetilde{X}_2 > X_2$, since $\frac{dB_2(1-P(Z))}{dZ}\frac{dZ}{dX} > 0$. QED

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