Why do Education Expenditures Fail to Reduce Child Labor? Looking for an Optimal Composition of the Social Expenditures*

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August 5, 2005

Abstract

In a framework, where child labor results from a risky choice between working and schooling, we study the reason why public education expenditures may fail to reduce child labor. We determine an optimal composition of social expenditures between education and health which minimizes child labor for a given government's budget. This is tested with panel data over 81 developing countries. It is evidenced that the unbalanced structure of the social spending favourable to education to the detriment of health often observed in the poor countries is inefficient to reduce child labor. More generally, our statements shed light on the need to reconsider the conventional wisdom viewing public health and education expenditures as substitutes.

Keywords: Child Labor, Education Expenditures, Health Expenditures.
JEL classification: J20, K31, D60.

*We thank Bertrand Crettez, Patrick Guillaumont, and the participants in the CEREGMIA conference, Université de la Martinique and in the "Journées de l'AFSE", Université d'Auvergne, CERDI, for stimulating suggestions. The usual disclaimer applies.

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1 Introduction

While achieving schooling for all by 2015 is one of the millenium development goals as defined by the United Nations, the International Labor Office (ILO) estimates that in 2000, 211 million children aged 5 to 14 work full-time, 48 million of which living in subsaharan Africa, 127 million others in the region Asia-Pacific, 73 million of them being less than 10 years old (ILO (2002)). Besides the issue of the ban of child labor (see Dessy and Pallage (2005)),[1] it is henceforth crucial to understand how the governments can act to reduce child labor through the social spending.

Special attention has to be paid to education expenditures, expected to impact directly child labor through an increase in the education return. However, among others, Dessy and Pallage (2005) enhance that public education has severely failed in increasing return to education, due to "uneconomic policies", while Schultz (1999) argues that education only benefit to an elite in the developping countries. Hence, public education expenditures would not provide the conditions for strong decreases in child labor. We attempt here to develop a possible reason for these "uneconomic policies", depending on the share of each kind of social expenditures on the whole social spending (social expenditures being resumed to education and health), arguing that due to their complementarity, health and education expenditures have to be studied jointly.[2]

On the empirical ground, the distribution of public expenditures between education and health in developing countries is much more favourable to the former as emphasized by Burgess and Stern (1993).[3] Actually, a structural difference between poor and rich countries seems to emerge with regard to the relative weight of each kind of spending: the poorer the countries, the more they invest on education related to health, which can be illustrated with Figure 1.

Insert Figure 1 here

This structural difference may be linked to the age structure of the population: a younger (older) population may invest relatively more in education (health) compared to health (education). Even if deepening this analysis in order to highlight the causes of this structural difference would

[1] Moreover, Edmonds and Pavcnik (2005) writes (p. 200):

> "If a more rapid reduction in the general incidence of child labor is a policy goal, improving educational systems and providing financial incentives to poor families to send children to school may be more useful solutions to the child labor problem than punitive measures designed to prevent children from earning income."

[2] Our approach falls under the child labor economic analysis (for a survey, see Basu (1999)), the studies of public spending efficiency (in particular that of health and education) and the economic analysis of longevity where child survival rate determines education and fertility choices (see Ehrlich and Lui (1991)).

[3] See their Table 1 and comments, p. 765-6.

be of great interest, it is beyond the scope of this paper. Here, we focus on the consequences of this structural difference with regard to child labor, and not on the possible explanations of that difference.

While education and health expenditures are often agregated as a composite social spending in the literature (see for instance Devarajan, Swaroop, and Zou (1996)), assuming the same impact for the both policies, we specify one transmission channel for each of them. A simple theoretical model is developped, where child labor results from a household's choice between working and schooling. This household's decision corresponds to a portefolio choice: child labor is the riskless asset, child education the risky one. This choice depends both on the return and on the risk of investing in education. The considered risk results here from the children death or disease. Education spending is expected to increase the return on education (investment), while health spending is supposed to reduce the risk of this investment by improving the health status.

We define an optimal composition of social expenditures which minimizes child labor for a given government's budget. A complementarity between social expenditures is established. The unbalanced structure of the social expenditures favourable to the education expenditures in the poor countries seems therefore not to be consistent. These hypothesis are tested with econometric panel data over 81 developing countries. More generally, our statements, which are validated, shed light on the need to reconsider the conventional wisdom viewing public health and education expenditures as substitutes.

The plan of the paper is as follows. Section 2 sets out the basic assumptions of our analysis. Section 3 studies the theoretical effects of the two kinds of policy (health and education) on the child labor. Section 4 provides some empirical validations. Section 5 summarizes the discussion and offers a few concluding comments.

2 Theoretical framework

Our theoretical framework relies on Baland and Robinson (2000) and on Dessy and Pallage (2001).[4] Following Strulik (2004), we go further the former since we take into account the risk in the parental decision to make the children work, including child mortality in the parental decision of child labor. However, we enlarge Strulik (2004) analysis by emphasizing the effects of public health and education spending. Similarly to Chakraborty and Das (2005) who establish

[4] Given the available data, we do not develop an overlapping generations model.

a positive relationship between parental health and children education, we set a link between child mortality and child labor. But, while adult mortality is for Chakraborty and Das (2005) a function of private health expenditures, child mortality is explained in our model by the public health expenditures.

The optimization process concerns the child time allocation between working and schooling.[5] Children own one unit of time which might be allocated to school ($\gamma \in [0,1]$) or to work ($1-\gamma$). This relevant choice is made by the parents since the children are supposed to be too young to make rational (schooling) decisions (see Glomm (1997)). If we consider children as an asset[6], the child time allocation between working and schooling is a risky investment for the household. The parental choice is then a portfolio decision, between a riskless investment (child labor) and a risky but more profitable one (schooling). However, we do not consider here the effects of credit constraints and financial market imperfections on child labor, while they are one of most important explaining factors according to Edmonds and Pavcnik (2005). The considered risk does not result here from crop losses or from household heads unemployment, but from the child survival.

We consider a two-period economy ($t = 1, 2$) with one single consumption good. There is no discount of the future by the agents. At the first period, the household consists of one working adult, the parent (p), and of one child (c); at the second period, there are two adults (p and a), each of them controlling his own income. Following Baland and Robinson (2000) or Dessy and Pallage (2001), we assume separable preferences, denoted $U(.)$, a normalization to zero of child consumption and some altruism from parents to their children (one-side altruism). We denote W_p, the parental utility, as $W_p\left(c_p^1, c_p^2, W_c\left(c_c\right)\right)$, where c_p^1, c_p^2 and $W_c\left(c_c\right)$ are respectively the consumption of first period, the consumption of second period and the child utility W_c depending on c_c, the child consumption of second period. It yields:

$$W_p\left(c_p^1, c_p^2, W_c\left(c_c\right)\right) \equiv U\left(c_p^1\right) + U\left(c_p^2\right) + \phi\delta W_c\left(c_c\right), \tag{1}$$

where U and W_c are strictly increasing and concave functions. The parameter δ is the degree of altruism, which induces the intergenerational link. The parameter ϕ is the child survival probability or the education investment level of risk.[7] Contrary to Kalemli-Ozcan (2003), this

[5] The fertility rate is assumed exogeneous.

[6] Dasgupta (1995) argues that "in poor countries children are also useful as income-earning assets." (p. 1895)

[7] Chakraborty (2004) and Chakraborty and Das (2005) also consider individual health status as an explanatory factor of the discount rate.

probability is certain and known. Its increase is equivalent to a decrease in the education investment degree of risk. In the next section, this parameter (ϕ) will be determined by the public health expenditures.

In the lack of saving and borrowing, consumption equalizes the available income at each period. At the first one, the household's income corresponds to the sum of the parental wage, denoted w, and of the child(ren) earning, $(1-\gamma)\,w_c$, which is the child's time spent at work $(1-\gamma)$ valued at the child's wage rate (w_c). At the second period, parents still earn w.[8] The remunerations of the children when adults depend on their educational level: a working child will earn the same wage as his parents (w), while an educated child will be a skilled worker, whom wage is denoted w_s. It yields:

$$c_p^1 \equiv w + (1-\gamma)\,w_c, \quad c_p^2 \equiv w, \quad c_c \equiv (1-\gamma)\,w + \gamma w_s. \tag{2}$$

We focus now on the labor demand side. We ignore the depreciating effect of the child labor on the parental wage as analysed by Basu and Van (1998). We assume a perfect competition between firms, which induces an equalization of the wages to the marginal productivity of the different kind of workers. More precisely, we consider that the child productivity is a fraction d ($d < 1$) of the parent productivity. The skilled worker, *i.e.* the former educated child, has a productivity that increases with the level of education, denoted e, which will be explained by the public education expenditures in the next section. Hence, these labor market conditions involve:

$$w_c = dw, \quad w_a = ew. \tag{3}$$

Substituting (2) and (3) in (1), the solution of the parent's maximization program, denoted γ^*, is given by:

$$\gamma^* \equiv \underset{\gamma\in[0,1]}{\arg\max} W_p\left(w + (1-\gamma)\,dw, w, W_c\left((1-\gamma)\,w + \gamma ew\right)\right).$$

If an interior solution exists, the First Order Condition (FOC) is equivalent to:[9]

$$-dU'\left((1+d-d\gamma^*)\,w\right) + \phi\delta\,(e-1)\,W_c'\left((1-\gamma^*+\gamma^* e)\,w\right) = 0,$$

[8] The assumption that parent are still working at the second stage has no impact on the equilibrium child labor's level. Alternatives would be to suppose that parent died or does not work anymore at the second period.

[9] The Second Order Condition (SOC) is valid:

$$w_c^2 U''\left(c_p^1\right) + \phi\delta\,(w-w_a)^2\,W_c''\,(c_c) < 0.$$

which is equivalent to:

$$\frac{\phi\delta\left(e-1\right)}{d}=\frac{U'\left(c_p^{1*}\right)}{W_c'\left(c_c^*\right)}\equiv f\left(\gamma^*;.\right). \tag{4}$$

where we denote $c_c^*\equiv\left(1-\gamma^*+\gamma^*e\right)w$ and $c_p^{1*}\equiv\left(1+\left(1-\gamma^*\right)d\right)w$. The equilibrium level of child schooling time (γ^*) equalizes the intertemporal consumption Marginal Rate of Substitution (MRS) to the net return of education. Indeed, even without any private cost of education, educating children remains costly for the parents, since the child time is valuable on labor market (see Rosenzweig (1990)).

By inspection of (4) it is immediate that $\frac{\partial f(\gamma^*;.)}{\partial\gamma^*}>0$.[10] We might also have two corner solutions. There is no school ($\gamma^*=0$) if and only if:

$$\begin{aligned}\forall\gamma &\in [0,1], \quad f\left(\gamma;.\right)>\frac{\phi\delta\left(e-1\right)}{d}\Leftrightarrow f\left(0;.\right)=\frac{U'\left(\left(1+d\right)w\right)}{W_c'\left(w\right)}>\frac{\phi\delta\left(e-1\right)}{d}\\ &\Leftrightarrow \quad e<1+\frac{d}{\phi\delta}\frac{U'\left(\left(1+d\right)w\right)}{W_c'\left(w\right)}.\end{aligned}$$

Similarly, there is no child labor ($\gamma^*=1$) if and only if:

$$\begin{aligned}\forall\gamma &\in [0,1], \quad f\left(\gamma;.\right)<\frac{\phi\delta\left(e-1\right)}{d}\Leftrightarrow f\left(1;.\right)=\frac{U'\left(w\right)}{W_c'\left(w_s\right)}<\frac{\phi\delta\left(e-1\right)}{d}\\ &\Leftrightarrow \quad d<\phi\delta\left(e-1\right)\frac{W_c'\left(ew\right)}{U'\left(w\right)}.\end{aligned}$$

There is no child labor (respectively no education) when the child wage, w_c, or child productivity, d, (respectively the wage of skilled workers, w_s, or the the return to education, e) is sufficiently low. Consider the partial inverse of $f\left(.\right)$ with respect to γ^*, which we shall denote by ψ, where $\psi\left(f\left(\gamma^*;w,d,e\right);w,d,e\right)=\gamma^*$. We then have the following Proposition:

Proposition 1 *The household's optimal decision is given by:*

$$\gamma^*\equiv\begin{cases}1, & \text{if} \quad d<\phi\delta\left(e-1\right)\frac{W_c'(ew)}{U'(w)}\\ 0, & \text{if} \quad e<1+\frac{d}{\phi\delta}\frac{U'((1+d)w)}{W_c'(w)}\\ \psi\left(\frac{\phi\delta(e-1)}{d};w,d,e\right), & \text{otherwise}\end{cases} \tag{5}$$

An implicit assumption has been set here: when the parents choose the schooling time of their children, they do not integrate the influence of this decision on the future wage of the skilled worker. Indeed, we consider that the parents are numerous enough to take the wages as

[10]
$$\begin{cases}\frac{\partial\left(U'\left(c_p^1\left(\gamma^*\right)\right)\right)}{\partial\gamma^*}=-w_cU''\left(c_p^1\left(\gamma^*\right)\right)>0\\ \frac{\partial\left(W_c'\left(c_c\left(\gamma^*\right)\right)\right)}{\partial\gamma^*}=\left(w_a-w\right)W_c''\left(c_c\left(\gamma^*\right)\right)<0\end{cases}\Rightarrow\frac{\partial f_{\gamma^*}\left(\gamma^*;.\right)}{\partial\gamma^*}=\frac{\partial\left(\frac{U'\left(c_p^1\left(\gamma^*\right)\right)}{W_c'\left(c_c\left(\gamma^*\right)\right)}\right)}{\partial\gamma^*}>0.$$

given at the decentralized equilibrium (contrary to Basu and Van (1998)).

3 Public intervention and optimal policy

In this section, we focus on two kinds of public incentives wich may impact negatively the child labor: public education and public health expenditures (respectively denoted E and H). We develop a specific mecanism for each policy: public education spending increases the return of investment in education, while health spending reduces the risk of this investment by improving the health status. However, the government's balanced budget constraint involves a relationship between the two kinds of public expenditures. We first present the effect of each public spending on child labor. Then, we develop the consequences of taxation on our results.

According to the literature, the impact of public health spending (H) on health outcome is questionable. The following studies, proxying health status by infant or child mortality, result in different appreciation of this impact. On one hand, Anand and Ravallion (1993) show a positive impact.[11] On the other hand, Filmer, Hammer, and Pritchett (2000) find no significant impact of public spending on health status on a cross-section over 100 countries. Finally, Bidani and Ravallion (1997) as well as Gupta, Verhoeven, and Tiongson (2001) emphasize a positive impact on health care of the poor, while they find a non significant impact on the aggregate health status. In our approach, we resume public health spending (H) by its impact on the child survival rate (ϕ). Contrary to Strulik (2004), Chakraborty (2004) or Chakraborty and Das (2005), we consider public rather than private health expenditures. More formally, we pose:[12]

$$\phi \equiv \phi(H), \quad \phi(0) = 0, \quad \lim_{H \longrightarrow \infty} \phi(H) = 1, \quad \phi'(H) > 0 \quad \text{and} \quad \phi''(H) < 0. \tag{6}$$

Even if substantial private resources are spent on education, the private share of educational expenditure is much smaller than the public one in virtually all countries (see Psacharopoulos and Woodhall (1986) or Glomm (1997)). Thus, we consider here the public education spending, denoted E, as the only mean to increase the education return and we assume that this spending increases the skilled workers' wage at the second period. If there is no public expenditure, then

[11] However, the econometric validation of this study relies on only 22 observations.

[12] Following Gupta, Verhoeven, and Tiongson (2001), we assume the concavity of $\phi(.)$: the impact of public health on labor child that runs through the health status will be all the stronger as health status (child survival) is low.

education does not improve the wages. It yields:

$$e \equiv e(E), \quad e(0) = 1, \quad e'(E) > 0 \quad \text{and} \quad e''(E) < 0. \tag{7}$$

For a given child survival rate, the higher the education return is, the bigger the incentive to choose schooling will be. For instance, Rosenzweig (1990) considers how exogenous changes in the rate of return to schooling influe on the schooling investment decisions.

We consider now the government's revenues. Following Barro (1990), most of the authors studying the impact of the public spending on economic growth assume that the government expenditures are financed contemporaneously by a proportional income tax.[13] We then assume that the budget is balanced on the first period, *i.e.* that at this period, the total collected tax equalizes the public spending. For convenience, we consider a per capita tax (more accurately, a tax per household), denoted T.[14] The budget constraint is then given by: $T = E + H$. The household's objective function becomes:

$$W(\gamma, E, H, T; w, d) = U((1 + d - \gamma d) w - T) + U(w) + \delta\phi(H) W_c((1 - \gamma + \gamma e(E)) w).$$

It yields the following maximization problem:

$$\gamma^{T*} \arg\max_{\gamma \in [0,1]} W(\gamma, E, H, T; w, d), \tag{8}$$

where γ^{T*} is the solution in a *per capita* tax system. The FOC is then:[15]

$$-dU'\left(\left[1 + d - \gamma^{T*} d\right] w - T\right) + \delta\phi(H)(e(E) - 1) W_c'\left(\left[1 - \gamma^{T*} + \gamma^{T*} e(E)\right] w\right) = 0, \tag{9}$$

which is equivalent to:

$$\frac{\delta\phi(H)(e(E) - 1)}{d} = \frac{U'\left(c_p^{1*} - T\right)}{W_c'(c_c^*)}.$$

[13] See for instance Devarajan, Swaroop, and Zou (1996) concerning the public expenditures, Glomm (1997) in the case of public education regime or Chakraborty (2004) for the public health expenditures.

[14] Moreover, income tax can not be considered as the representative tax of the fiscal system in developing countries (see Burgess and Stern (1993) or Chambas (2004)). According to Alm and Wallace (2004), it seems "unlikely" that these countries are able to manage a broad-based individual income tax.

[15] The SOC remains valid:

$$-d^2 w^2 U''((1 + d - \gamma^* d) w) + \delta\phi(H)(e(E) - 1)^2 W_c''((1 - \gamma^* + \gamma^* e(E)) w) < 0.$$

It yields:

$$\gamma^{T*} = \begin{cases} 1, & \text{if} \quad d < \phi(H)\,\delta\,(e(E)-1)\,\frac{W_c'(e(E)w)}{U'(w)} \\ 0, & \text{if} \quad e(E) < 1 + \frac{d}{\phi(H)\delta}\frac{U'((1+d)w)}{W_c'(w)} \\ \psi\left(\frac{\phi(H)\delta(e(E)-1)}{d}; w, dw, e(E)\,w\right), & \text{otherwise} \end{cases} \tag{10}$$

We focus now on the government behavior whose goal is to raise the schooling investment (γ^{T*}). We do not consider the coordination failures nor the time inconstency in the relationship between the government and the households. We denote α, the share of the tax ressources allocated to education: $E = \alpha T$ and $H = (1-\alpha)\,T$. We define $\gamma^{T*}(\alpha, T)$ the solution (10) with regard to α and T. Given the tax pressure (T), the optimal composition of public expenditures, denoted α^*, is the solution of the following programm:

$$\alpha^* \equiv \arg\max_{\alpha\in[0,1]} \gamma^{T*}(\alpha, T)\,. \tag{11}$$

The following PROPOSITION resumes our results:

Proposition 2 *Under a condition on the prudential attitude of household, there exists an optimal composition of social public spending between health and education (α^*) implictly given by the following equation:*

$$\frac{\phi'(\alpha^* T)}{\phi(\alpha^* T)} + \frac{e'((1-\alpha^*)\,T)}{e((1-\alpha^*)\,T)-1}\left[\gamma^{T*}\left(e((1-\alpha^*)\,T)-1\right)A(c_c^*)-1\right] = 0. \tag{12}$$

Proof: See Appendix.

An approximation of expression $\psi\left(\frac{\phi(H)\delta(e(E)-1)}{d}; w, dw, e(E)\,w\right)$ in (10) is given by a first order Taylor expansion of (9) with respect to γ at γ^{*T}:

$$-d\left[U'((1+d)\,w) - dw\gamma^{*T}U''((1+d)\,w)\right] + \phi\delta\,(e-1)\left[W_c'(w) + \gamma^{*T}(e-1)\,wW_c''(w)\right] = 0.$$

Substituting E and H by their expression in terms of α and T, it yields:

$$\gamma^{T*}(\alpha, T) = \frac{dU'((1+d)\,w) - \delta\phi(\alpha T)\left(e((1-\alpha)\,T)-1\right)W_c'(w)}{w\left[\phi(\alpha T)\,\delta\left(e((1-\alpha)\,T)-1\right)^2 W_c''(w) + d^2U''((1+d)\,w)\right]}. \tag{13}$$

In order to be more conclusive, we specify our utility functions ($U(.)$ and $W(.)$) in various forms from four different assumptions on the risk aversion. We obtain then the following figure with four specific functional forms (logarithmic, CRRA, CARA and HARA).

Insert Figure 2 here

Figure 2 shows how the optimal investment in education ($\gamma^{T*}(\alpha, T)$) varies depending to the composition of public expenditures ($\alpha \in [0,1]$) for different levels of tax pressure (T). The parents optimal choice ($\gamma^*(\alpha, T)$) is initially increasing and then decreasing, whatever the form of the utility function is. We deduce that an increase in the education expenditures, for a given budget (T) will only be efficient on the left side of the curve, i.e. when the ratio education expenditures related to the social expenditures is below a certain threshold. On the contrary, beyond this certain threshold any additional public education expenditures that increases the ratio is inefficient.

Figure 3 illustrates the impact of the parental risk aversion on $\gamma^*(\alpha, T)$, depending on both the level of tax pressure and the distribution of the social expenditures.

Insert Figure 3 here

Even if trivial, given the assumptions of our model, this figure highlights the crucial role of the parental risk aversion to send their children to school. At a fixed fiscal burden, we observe that a household whom the absolute risk aversion, denoted (σ) is less than a first threshold, denoted σ_1, reduces child labor as the share of the public education expenditure increases: $\gamma^*(0.1, T) \geqslant \gamma^*(0.5, T) \geqslant \gamma^*(0.9, T)$. When the coefficient σ belongs to the interval $[\sigma_1, \sigma_2]$, the relationship between the public education spending and children education is no monotonic (indeed, we have: $\gamma^*(0.5, T) \geqslant \max\{\gamma^*(0.9, T), \gamma^*(0.1, T)\}$). Finally, if the household is more risk averse ($\sigma > \sigma_2$), then an increase of the public education expenditure at the detriment of the public health spending involves paradoxically an increase in child labor: $\gamma^*(0.9, T) \geqslant \gamma^*(0.5, T) \geqslant \gamma^*(0.1, T)$.

4 Econometric validation

The following table presents the correspondance of theoretical and empirical symbols.

Insert Table 1 here

Our estimates rely on panel data over 81 developing countries for three averaged 5 year periods (1986-1990, 1991-1995, 1996-2000). The first assumption to be tested is the way the trade-off between working and schooling is impacted by the education investment level of risk, proxied by the health status and measured by the child survival rate: any increase in the latter modifies the trade-off in favour of schooling by decreasing the level of the risk.[16] The impact of public interventions in health and education sectors will then be tested (see regressions 15 in Table 3). We will then estimate the theoretical non-linear relationship, presented Figure 2, between child labor and the share of public education expenditures related to the social (health and education) expenditures. We show that if public education expenditures often fail in decreasing significantly child labor, it is because the share of public education expenditures related to social expenditures is too high.

4.1 Trade-off working versus schooling and the level of risk

The child labor results from a trade-off between schooling and working. It is measured as the ratio of the children part of the active population aged between 10 and 14 related to the total children aged between 10 and 14. Any increase (decrease) in that ratio reflects a move in the trade-off towards working (schooling). The basic assumption of our model is that this trade-off is negatively impacted by the education investment level of risk which is proxied by health status. Following the literature on macroeconomic and health, the health status is proxied by the under-five survival rate.[17] We use a logistic transformation of the child survival rate since it seems more adapted than the log-log specification to bounded indicator of development such as survival, literacy, etc (see Franses and Hobijn (2001), Grigoriou and Guillaumont (2003)).

We test the following equation:

$$lc_{it} = \alpha_0 + \alpha_1.y_{it} + \alpha_2.csr_{it} + \eta_i + \varepsilon_{it}, \tag{14}$$

where lc_{it} is the logarithm of the part of the children aged between 10 and 14 working; y_{it} is the logarithm of the per capita GDP (in 1995 dollars); csr_{it} is the logit transformation of the child survival rate, η_i the fixed effect, ε_{it} the error term.

Insert Table 2 here

Once controlled for the per capita GDP, the impact of which is significant and with the expected negative sign, and for the country specific effect, any increase in the health status, proxied by

[16] A variable reflecting the human capital stock, namely the adult literacy rate has been tested. This variable appeared to have a significant negative impact on labor child while other results remained unchanged. However, since this variable doesn't appear in our theoretical model, we did not present this result.

[17] See for instance the Report of the Commission on Macroeconomics and Health 2001, World Health Organisation (2001).

the logistic transformation of child survival, has a strong significant negative impact on child labor (14). This result validates our assumption that any change in the degree of risk, proxied by the child survival rate, implies a move in the trade-off between schooling and working. Child survival will be thereafter reflecting the education investment level of risk.

4.2 Trade-off working versus schooling, education investment level of risk and public intervention

We first test the impact of health and education public expenditures on child labor. It will then be evidenced that not only the level of each kind of expenditures (to impact child labor) but also their distribution matter.

4.2.1 The education and health expenditures model

Since we have assumed that health expenditures impact child labor through a decrease in the education investment degree of risk, health expenditures is not only included additively (he_{it}) but also interacted with the variable csr_{it}. Hence, the impact of health expenditures on child labor will be all the stronger as the education investment degree of risk (child survival rate) will be high (low). Then we add the public health expenditures, the impact of which is expected negative. However, given the litterature, a non-significant coefficient would not be very surprising.

The following model is to be tested:

$$lc_{it} = \alpha_0 + \alpha_1.y_{it} + \alpha_2.csr_{it} + \alpha_3.he_{it} + \alpha_4.he_{it}.csr_{it} + \alpha_5.ee_{it} + \eta_i + \varepsilon_{it}, \qquad (15)$$

where he_{it} and ee_{it} are respectively the logarithm of the public health expenditures and the logarithm of the public education expenditures both expressed in percent of GDP, η_i is the fixed effect and ε_{it} is the error term. We expect the following signs:

$$\alpha_1 < 0, \quad \alpha_2 < 0, \quad \alpha_3 < 0, \quad \alpha_4 > 0, \quad \alpha_5 < 0.$$

We obtain the following results:

Insert Table 3 here

Beyond their impact through child survival, health expenditures have a significant negative impact on child labor, but as expected, to a decreasing extent (regression 15 in table 3). This result is robust to the introduction of education expenditures. On the other hand, the coefficient associated to education expenditures is not significant: public education expenditures do not ensure a decrease in child labor. This empirical finding joins our theoretical framework, according to which not only the level of the education spending matters, but also the share of education expenditures related to the social spendings.

4.2.2 The education to social expenditures ratio model

In order to test whether or not the countries of our sample are on the right side of the curve (Fig.2), the variable child labor is to be regressed both on the ratio education expenditures related to education and health expenditures ($share_{it}$) and on that squared ratio ($sqshare_{it}$), just controlling for the income per capita (y_{it}), for the level of social expenditures related to the GDP (T_{it}) and for the country specific effect.

The following model is to be tested:

$$lc_{it} = \alpha_0 + \alpha_1 . y_{it} + \alpha_2 . share + \alpha_3 . sqshare_{it} + \eta_i + \varepsilon_{it}. \tag{16}$$

Four situations can occur depending on the sign of α_2 and α_3.

(i) α_2 and α_3 are both negative: ceteris paribus, any increase in the public education expenditures is always efficient to reduce child labor, and will be all the more efficient as the share of education expenditures related to education and health ones is high. This corresponds to the left side of the curve (Fig. 3) where massive investments in education (related to health) should result in a strong decrease in child labor.

(ii) $\alpha_2 > 0$ and $\alpha_3 < 0$: all other things being equal, any increase in the education to social expenditures ratio will first (for the low value of the ratio) be inefficient to decrease child labor but beyond a certain threshold it will become increasingly efficient. This would correspond to an inverted U-shaped curve, which is at the opposite of the assumptions of our theoretical model.

(iii) $\alpha_2 < 0$ and $\alpha_3 > 0$: all other things being equal, any increase in the education to social expenditures ratio will first (for the low value of the ratio) be efficient to decrease child labor (left side of the curve) but beyond a certain threshold it will become increasingly inefficient. This would correspond to the U-curve following our theoretical model. It means that beyond a certain threshold, the education investment has to be accompanied by health investments in order to benefit from the complementarities of these two public goods.

(iv) α_2 and α_3 both positive: all other things being equal, any increase in the public education expenditures is always inefficient to reduce child labor. This corresponds to the right side of

the curve (Fig. 2) where education expenditures should be accompanied by massive investment in health: decreasing the investment education level of risk, health investments would ensure a context more favorable to education investment.

Insert Table 4 here

Estimate of equation (16) results in α_2 and α_3 both positive and significant. This implies that our developing countries sample is on average on the right side of the curve. We are then able to provide an explanation to the ineffectiveness of public education expenditures with regard to the child labor decrease: it is not only the level of education expenditures that matters, but also the share of education expenditures in social spending. Beyond a certain threshold, it is useless to increase education expenditures when this is not accompanied by health expenditures that will ensure a decrease in the risk of the investment in education, implying a context more favorable to education investments (from the parents).

4.3 Econometric discussion

4.3.1 Fixed effect estimate and serial correlation

The use of panel data econometrics with the introduction of country specific effects (η_i) allows us to control for unobservable constant heterogeneity between these countries. Moreover, while it is often assumed that most of the observed serial correlation is dominated by the presence of this country specific effect in the composite errors $u_{it} = \eta_i + \varepsilon_{it}$, (the potential serial correlation being then eliminated by the within transformation), Wooldridge (2002) highlights that there can be serial dependence in the residual term ε_{it}, the fixed effect standard errors being in that case very misleading. Following Drukker (2003), we specify Newey-West standard errors for fixed effect model to face any potential problem of serial correlation that would bias the inference: it corrects both the heteroskedastic and the autocorrelated structure of the error.

4.3.2 Reverse causality

One could argue that explaining child labor by education expenditures may induce a reverse causality leading to an endogeneity bias since the level of education expenditures is likely to be all the higher (lower) as child labor is rare (important). However it seems obvious that in the context of developing countries, *i.e.* in scarcity economies, and moreover on social questions as education and health are, the causality goes from the supply side and not from the demand one.

5 Political implications and concluding remarks

This paper analyses the effects of education and health expenditures on child labor. The household's choice to have their child(ren) working or schooling can be viewed as a risky choice, education being in that case a risky investment. In this framework, each type of public spending influes on the individual trade-off through a particular way: the education spending increases the return of education, while the health spending reduces the risk of education investment. Our theoretical model emphasizes that these expenditures can not be considered systematically as substitute, what is validated by the empirical findings. This is all the more crucial as following the MDGs governments aim at achieving shooling for all by 2015.

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A Appendix:

A.1 Proof of Proposition 2

The programm is

$$\alpha^* \equiv \underset{\alpha\in[0,1]}{\arg\max}\gamma^{T*}(\alpha, T). \tag{17}$$

where is solution of (9). By applying the envelop theorem to (9) with respect to α, it yields:

$$\frac{\partial\gamma^{T*}(\alpha, T)}{\partial\alpha} = 0$$

$$\Leftrightarrow -\frac{\begin{array}{c} T\delta\phi'(\alpha T)\left(e\left((1-\alpha)T\right)-1\right)W_c'(c_c^*)-T\delta\phi(\alpha T)e'\left((1-\alpha)T\right)W_c'(c_c^*) \\ -\gamma^{T*}T\delta\phi(\alpha T)e'\left((1-\alpha)T\right)\left(e\left((1-\alpha)T\right)-1\right)W_c''(c_c^*) \end{array}}{SOC}=0, \qquad (18)$$

where SOC is the denominator corresponds to the Second Order Condition of (8). The solution (α^*) is implicitly given by:

$$\Leftrightarrow \frac{\phi'(\alpha^*T)}{\phi(\alpha^*T)}+\frac{e'\left((1-\alpha^*)T\right)}{e\left((1-\alpha^*)T\right)-1}\left[\gamma^{T*}\left(e\left((1-\alpha^*)T\right)-1\right)A(c_c^*)-1\right]=0, \qquad (19)$$

where $A(.)$ denotes the Arrow-Pratt abolute risk aversion measure.[18] We denote $Q(\alpha)$ the numerator of the expression in equation (18).

The SOC of (17) is given by:

$$\frac{\partial^2\gamma^{T*}(\alpha,T)}{\partial\alpha^2}=-\frac{\frac{\partial P(\alpha)}{\partial\alpha}SOC-Q(\alpha)\frac{\partial SOC}{\partial\alpha}}{SOC^2}.$$

At α^*, we have: $Q(\alpha)=0$, thus it yields:

$$sign\left(\frac{\partial^2\gamma^{T*}(\alpha,T)}{\partial\alpha^2}\right)=sign\left(\frac{\partial Q(\alpha)}{\partial\alpha}\right).$$

We have:

$$\frac{\partial Q(\alpha)}{\partial\alpha}=T\delta\left[\begin{array}{c} T\phi''(.)\left(e(.)-1\right)W_c'(c_c^*)-T\phi'(.)e'(.)W_c'(c_c^*)+\phi'(.)\left(e(.)-1\right)\frac{\partial c_c^*}{\partial\alpha}W_c''(c_c^*) \\ -T\phi'(.)e'(.)W_c'(c_c^*)+T\phi(.)e''(.)W_c'(c_c^*)-\phi(.)e'(.)\frac{\partial c_c^*}{\partial\alpha}W_c''(c_c^*) \\ -T\gamma^{T*}\phi'(.)e'(.)\left(e(.)-1\right)W_c''(c_c^*)+T\gamma^{T*}\phi(.)e''(.)\left(e(.)-1\right)W_c''(c_c^*) \\ +T\gamma^{T*}\phi(.)e'(.)^2W_c''(c_c^*)-\gamma^{T*}\phi(.)e'(.)\left(e(.)-1\right)\frac{\partial c_c^*}{\partial\alpha}W_c'''(c_c^*) \end{array}\right]$$

where $\frac{\partial c_c^*}{\partial\alpha}=-Tw\gamma^{T*}e'\left((1-\alpha)T\right)$ given that $\frac{\partial\gamma^{T*}}{\partial\alpha}=0$ at α^*. Dividing by $W_c'(c_c^*)$, substituting by the absolute risk aversion measure, $A(c_c^*)$, and after some manipulations, it yields:

$$sign\left(\frac{\partial Q(\alpha)}{\partial\alpha}\right)=sign\left[\begin{array}{c} \phi''(.)\left(e(.)-1\right)-2\phi'(.)e'(.)+\phi(.)e''(.) \\ +(1+w)\gamma^{T*}e'(.)\left[\phi'(.)\left(e(.)-1\right)-\phi(.)e'(.)\right]A(c_c^*) \\ -\gamma^{T*}\phi(.)e''(.)\left(e(.)-1\right)A(c_c^*) \\ +w\gamma^{T*2}\phi(.)e'(.)^2\left(e(.)-1\right)\frac{W_c'''(c_c^*)}{W_c''(c_c^*)}A(c_c^*) \end{array}\right]$$

From (19), we know that:

$$A(c_c^*)=\frac{1}{\gamma^{T*}e'(.)}\left(\frac{e'(.)}{e(.)-1}-\frac{\phi'(.)}{\phi(.)}\right)$$

[18] Indeed, since the child is not a decision maker (he is considered as too young to choose to invest in schooling), we express our conditions in term of parental risk aversion with respect to the children consumption at the second period, denoted $A(c_c^*)$. We have:

$$\frac{\partial W\left(c_p^1,c_p^2,W_c(c_c)\right)}{\partial c_c}=\delta\phi(H)W'(c_c), \quad \frac{\partial^2W\left(c_p^1,c_p^2,W_c(c_c)\right)}{\partial c_c^2}=\delta\phi(H)W''(c_c),$$

$$A_c(c_c)=A(c_c), \quad \text{where} \quad A(c_c)\equiv-\frac{\frac{\partial^2W\left(c_p^1,c_p^2,W_c(c_c)\right)}{\partial c_c^2}}{\frac{\partial W\left(c_p^1,c_p^2,W_c(c_c)\right)}{\partial c_c}}.$$

We deduce that

$$sign\left(\frac{\partial Q(\alpha)}{\partial \alpha}\right) = sign\left[\begin{array}{c} \phi''(.)\left(e(.)-1\right) - 2\phi'(.)\,e'(.) + \phi(.)\,e''(.) \\ -\left(1+w\right)\left[\phi(.)\,e'(.) - \phi'(.)\left(e(.)-1\right)\right]\left(\frac{e'(.)}{e(.)-1} - \frac{\phi'(.)}{\phi(.)}\right) \\ -\frac{e''(.)}{e'(.)}\left[e'(.)\,\phi(.) - \phi'(.)\left(e(.)-1\right)\right] \\ +w\gamma^{T*}e'(.)\,\frac{W_c'''(c_c^*)}{W_c''(c_c^*)}\left[e'(.)\,\phi(.) - \phi'(.)\left(e(.)-1\right)\right] \end{array}\right]$$

Since by definition $A(c_c^*) > 0$, it is immediate that $e'(.)\,\phi(.) - \phi'(.)\,(e(.)-1) > 0$. Moreover,we denote $P(c_c^*)$, the coefficient of absolute prudence, $P(c_c^*) = -\frac{W_c'''(c_c^*)}{W_c''(c_c^*)}$. The SOC of (17) is then respected if and only the following condition on the household's prudence is valid:

$$P(c_c^*) > \frac{1}{w\gamma^{T*}e'(.)}\left[\begin{array}{c} \frac{\phi''(.)(e(.)-1)-2\phi'(.)e'(.)+\phi(.)e''(.)}{e'(.)\phi(.)-\phi'(.)(e(.)-1)} \\ -\left(1+w\right)\frac{e'(.)\phi(.)-\phi'(.)(e(.)-1)}{\phi(.)(e(.)-1)} - \frac{e''(.)}{e'(.)} \end{array}\right].$$

A.2 Country list

Algeria; Argentina; Bahrain; Bangladesh; Barbados; Belize; Benin; Bolivia; Botswana; Brazil; Burkina Faso; Cambodia; Cameroon; Chad; Chile; China; Colombia; Comoros; Cote d'Ivoire; Dominican Republic; Ecuador; Egypt; Arab Rep.; El Salvador; Ethiopia; Guatemala; Honduras; India; Iran Islamic Rep.; Jamaica; Jordan; Kenya; Kuwait; Lesotho; Malaysia; Maldives; Mali; Mauritania; Mauritius; Mexico; Mongolia; Morocco; Mozambique; Namibia; Nepal; Nicaragua; Niger; Nigeria; Oman; Panama; Paraguay; Peru; Philippines; Saudi Arabia; Senegal; South Africa; Sri Lanka; Swaziland; Syrian Arab Republic; Thailand; Trinidad and Tobago; Tunisia; Turkey; United Arab Emirates; Venezuela RB; Zambia; Zimbabwe.

B Figures and tables

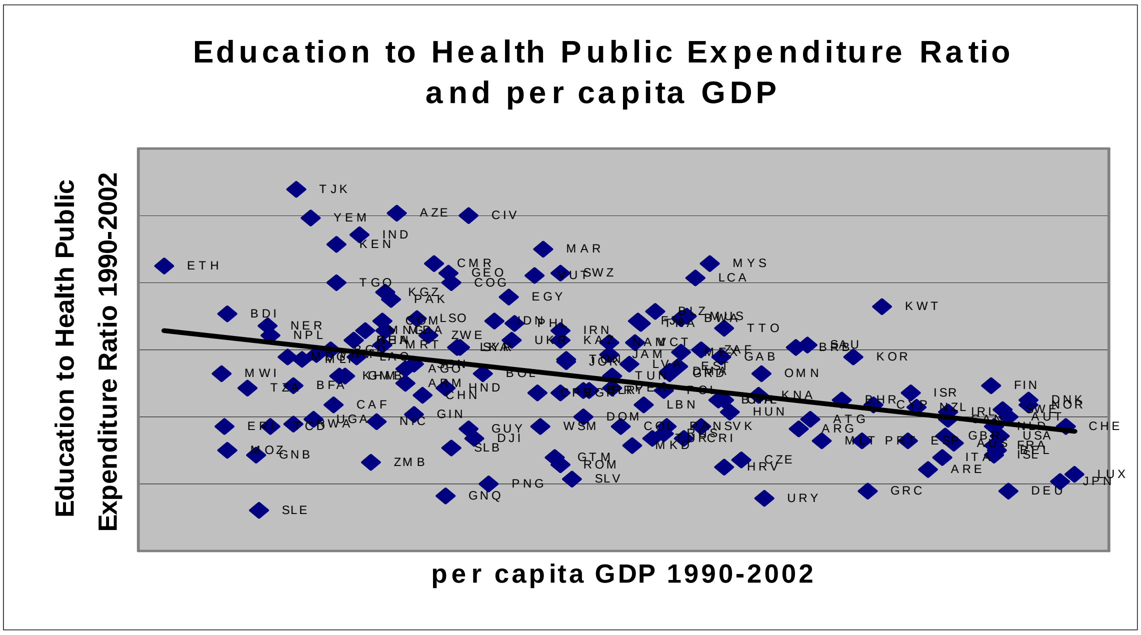

Figure 1: Data come from the World Bank (2004), the variables are expressed in logs

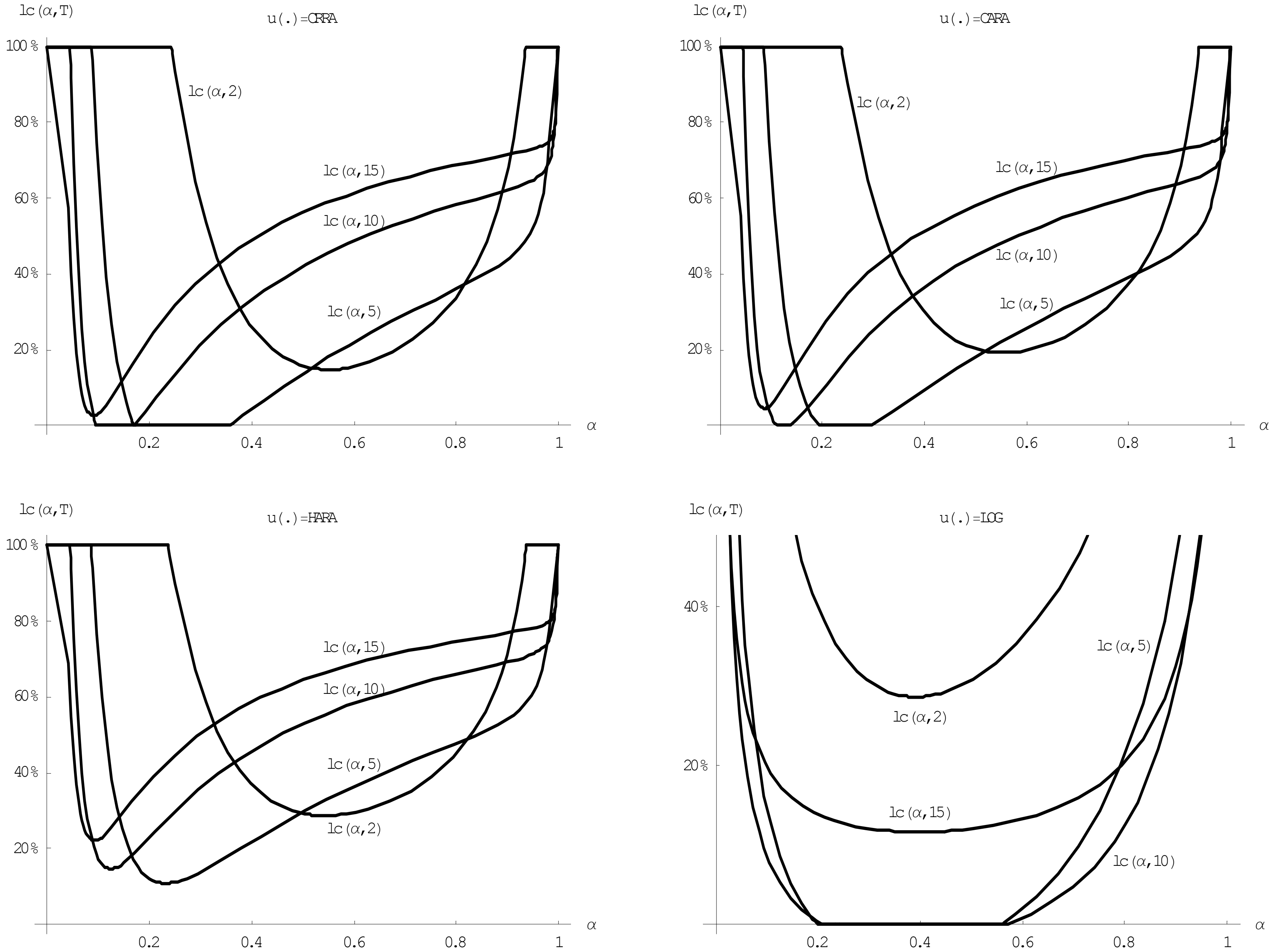

Figure 2: Optimal level of education investment $(\gamma(\alpha, T))$ with the following specifications: $\delta = 0.6$, $d = 0.3$, $w = 30$, $\phi(H) = 1 - \frac{1}{1+3H}$, $e(E) = 1 + E^{0.8}$, $U(.) = W(.)$, and CARA: $U(x) = -\frac{e^{-\sigma x}}{\sigma}$ with $\sigma = 0.014$, CRRA: $U(x) = \frac{x^{1-R}}{1-R}$ with $R = 0.4$, HARA: $U(x) = \frac{1-k}{A(2-k)}(Ax + B)^{\frac{2-k}{1-k}} + C$ with $A = 2$, $B = 1$, $k = 3$.

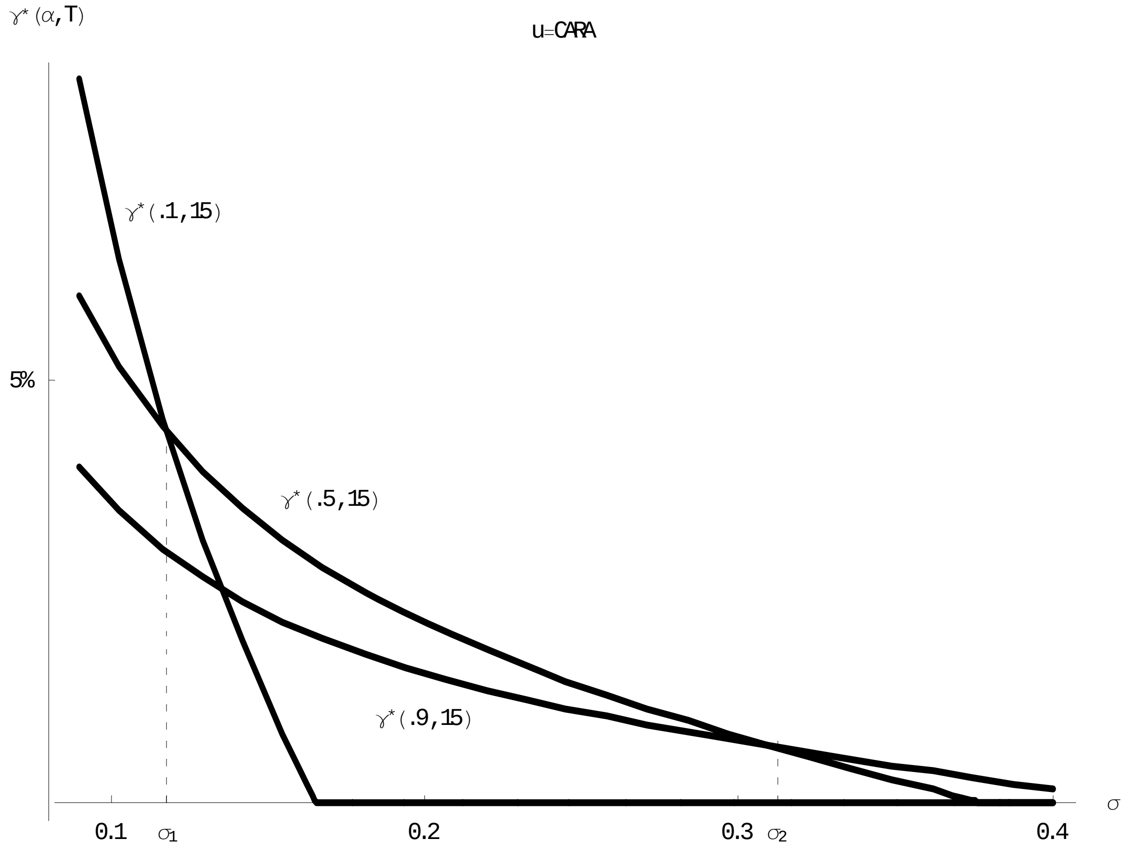

Figure 3: Optimal level of education investment $(\gamma(\alpha, T))$ depending on the coefficient of absolute risk aversion (σ) in case of CARA utility function, with the following specifications: $U(.) = W(.)$, $U(x) = -\frac{e^{-\sigma x}}{\sigma}$, $\delta = 0.6$, $d = 0.3$, $w = 30$, $\phi(H) = 1 - \frac{1}{1+3H}$, $e(E) = 1 + E^{0.8}$,

Theoretical Variables	**Corresponding Empirical Variables**	**Definition**
$1-\gamma$	lc	Child Labor
w	y	Income
ϕ	csr	Child Survival Rate
H	he	Health Public Expenditures
E	ee	School Public Expenditures
α	$share$	Share of Education in Social Expenditures
T	T	Social Expenditures

Table 1: Corresponding Symbols of the Variables

Dependant variable is labor child rate (in logs)	
	(14)
y_{it}	-0.03^{***}
	(0.00)
csr_{it}	-0.03^{***}
	(0.00)
$Constant$	-0.44^{***}
	(0.00)
R^2-Within	0.32
Obs.	212
Countries	81
p-values are indicated under the coefficients	

Table 2: Child Labor, Child Survival and Preference for Present (Within Estimator with Newey-West Robust Standard Errors)

Dependant variable is labor child rate (in logs)	
	(15)
y_{it}	-0.02^{***}
	(0.01)
csr_{it}	-0.04^{***}
	(0.00)
he_{it}	-1.72^{*}
	(0.06)
$csr_{it}.he_{it}$	0.47^{**}
	(0.05)
ee_{it}	-1.22
	(0.55)
$Constant$	0.41^{***}
	(0.00)
R^2-Within	0.36
Obs.	212
Countries	81
p-values are indicated under the coefficients	

Table 3: Child Labor, Child Survival and Social Expenditure (Within Estimator with Newey-West robust standard errors)

Dependant variable is labor child rate (in logs)	
	(16)
y_{it}	-0.05^{***}
	(0.00)
$share_{it}$	0.10^{**}
	(0.03)
$sqshare_{it}$	0.08^{**}
	(0.03)
T_{it}	-0.02^{**}
	(0.05)
$Constant$	0.49^{***}
	(0.00)
R^2-Within	$0,25$
Obs.	212
Countries	81
p-values are indicated under the coefficients	

Table 4: Child Labor, Health and Education Expenditures, the Share Matters (Within Estimator with Newey-West Robust Standard Errors)

Variable	**Definition**	**Source of the data**
lc_{it}	Part of the children aged 10-14 in the active population (expressed in logarithms)	World Development Indicator (2004)
y_{it}	GDP per capita in dollars of 1995 (expressed in logarithms)	World Development Indicator (2004)
csr_{it}	Logit transformation of child survival $(=ln\left(\frac{childsurvival}{1-childsurvival}\right))$	Bulletin of World Health Organisation(2000)
he_{it}	Public Health expenditures in percent of GDP (expressed in logarithms)	Fiscal affairs department, IMF
ee_{it}	Public Education expenditures in percent of GDP (expressed in logarithms)	Fiscal affairs department, IMF
$literacy_{it}$	Logit transformation of literacy rate $(=\ln(\frac{literacyrate}{1-literacyrate}))$	World Development Indicator (2004)

Table 5: Definition and Source of the Data