Health and the intergenerational persistence of inequality and child labour

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The paper focuses on the phenomenon of intergenerational persistence of child labour that saddles many poor societies. Using an overlapping generations model with heterogeneous agents, we highlight the interaction between inequalities in human capital, health and child labour. The model is based on a broad idea of human capital in which 'health' and 'skill' are complimentary factors. While health is augmented through nutritional intake, skill is accumulated *via* schooling. However, access to these inputs is determined by one's relative position in the distribution of human capital. The model generates endogenous evolution of human capital distribution and child labour across generations. We show that along a balanced growth path, differential access to schooling and health inputs interact to generate multiple equilibria and lead to polarisation of human capital. Furthermore, the results suggest that public provision of education can lead to perfect equality in the long run, but a *ceteris paribus* ban on child labour is likely to exacerbate both health and schooling outcomes for the poor.

Key words: Child labour, Health, Human capital, Inequality, Multiple equilibria, Polarisation.
JEL classification: I1, J2, O1.

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1. Introduction

According to recent global estimates published by the International Labour Office (2010) the progress to eliminate child labour has been uneven, and despite a modest decline since 2004 about 215 million children were still engaged in child labour. Worse still, there has been an alarming 20% increase in global child labour in the 15-17 age group from 52 to 62 million. It appears that *persistence* has become a disturbing phenomenon in addition to the high incidence of child labour in many societies. This is despite a steady decline in the global Poverty Headcount Rate, including the poorest regions of sub-Saharan Africa and South Asia.[1] Why then has child labour been persistent? One possible explanation is that families living in poverty face different costs and benefits of schooling and therefore have different incentives for engaging their children at work. These differences, to a large extent, arise due to differences in socio-economic characteristics, such as, access to education and health. The objective of this paper is to show that such differences in *relative* access to education and health are passed on from one generation to the next, creating persistence of morbidity and child labour.

Our story of inter-dynastic persistence of child labour is thus inextricably related to the phenomenon of persistence of income inequality analysed by Galor and Zeira (1993), Galor and Tsiddon (1997), among others.[2] Poor families are unable to catch up with the rest of the population in skill accumulation because the rich enjoy relatively higher net marginal returns from investment in skill than the poor. Credit market imperfection and fixed cost of education put the poor at a disadvantage relative to the rich in Galor and Zeira (1993). Galor and Tsiddon (1997) introduce intra-family external effects that generate non-convexities in the production of skill which propel the rich-poor differences over time. However, capital market imperfections do not matter much in demand for education as the latter is mostly self-financed in most poor societies. This is due to the fact that future earning of the skilled is generally not accepted as collateral, and children cannot be legally forced to assume parental debt. Furthermore, empirical evidence on the existence of non-convexities in individual skill production is far from conclusive (see Altonji and Dunn, 1996). Additionally, Loury (1981) demonstrates higher marginal returns may accrue to (poor) parents investing in smaller amounts when education is self-financed and

[1] This is according to World Bank's poverty estimates, using the 'poverty-line' definition of $1.25/day.

[2] Other significant contributions in this area include Becker and Tomes (1979), Loury (1981), Esteban and Ray (1994) and Durlauf (1996).

skill formation exhibits convexity. This will generate forces of convergence rather than divergence in skill accumulation across dynasties.

Prominent contributions in the literature on child labour focus on capital market failure in conjunction with poverty (Basu and Van, 1998, Basu, 1999), segmented labour markets (Behrman, 1999), breakdown of intergenerational contract (Baland and Robinson, 2000), and endogenous evolution of preference structure (Chakraborty and Das, 2005a, b). However, the role of income inequality in explaining the intergenerational persistence of child labour has attracted little attention. Most notable exceptions are Rogers and Swinnerton (2001) and Ranjan (2001). The former study extends the Basu and Van (1998) model and argues that child labour arises when non-labour income is unequally distributed among households and finds equality breeds child labour in poor countries. Ranjan (2001), on the other hand, postulates a positive relationship between income inequality and child labour in the presence of credit constraints.

While our theory of child labour is motivated by the body of work mentioned above, we differ in three critical aspects. First, we introduce 'health' and 'skill' as two distinct components of human capital, each of which can be accumulated through parental investments. While health is a *necessary* component, skill is not. Educational investment entails higher cost at the margin for poorer parents – not only because they face higher direct cost of schooling, but more importantly because of foregone child income and future health. Second, we obtain non-convergence in human capital distribution even though aggregate human capital and each of its components – health and skill – exhibit convexity. Third, we propose a persistence mechanism where both the level and the dispersion of income play important roles – the former characterises the steady state equilibrium of the model, while the latter drives the transition to the steady states. Therefore, our model extends the well-studied poverty-based notion of child labour by adding the less-studied income inequality dimension.

We develop a simple two-period overlapping generations model where parents care about the future human capital of their children. Heterogeneity of human capital causes income stratification of parents who invest differently in their child's schooling and health. This alters the distribution of human capital and income in the next period. The resulting co-evolution of income inequality, morbidity and child labour, and the interactions among them generate potential multiple steady states. Using a numerical example, we demonstrate that human capital across different socioeconomic groups may diverge during the transition leading to "polarisation" in the long run. The low level equilibrium represents a "poverty-trap", where successive generations find themselves in a vicious circle of full-time child labour, accompanied by high morbidity.

Before introducing the formal model, we take a brief look at simple intra and inter-country comparisons from a motivational perspective. Using data from the Young Lives Survey (2006) on children aged 5 to 15 we compare the extent of child labour, and levels of schooling and health across wealth percentiles in three countries –India, Peru and Ethiopia–in Table 1.[3] Child work is measured by the reported hours of work per day in (a) all activities (column 1) – unpaid (domestic chores, family farm or business) and paid, and (b) paid work only (column 2). The share of family expenditure spent on the child (Med. exp.) is used to capture parental investment in health. Hours spent at school seem to decrease with decreasing rank in the wealth distribution within each country. Shorter schooling time translates into longer time in paid work

Table 1: Child work, health investment and schooling across wealth groups

	Peru (Gini = 0.25)				India (Gini = 0.32)				Ethiopia (Gini = 0.43)			
	Total work	Paid work	Med. exp.	School	Total work	Paid work	Med. exp.	School	Total work	Paid work	Med. exp.	School
Bottom 10%	1.81	0.07	1.17	4.96	2.33**	0.96***	0.84*	4.91	4.05***	0.25	0.30***	4.12***
Middle 80%	1.491	0.12	0.61	5.34	1.37	0.38***	0.88	5.96	3.69***	0.15	0.61***	4.78***
Top 10%	0.70	0.00	1.04	5.72	0.62	0.04	0.86	7.06	1.91***	0.00	0.90	6.25***

Source: Authors' calculation using survey data for India, Peru and Ethiopia (2006).
Note: ***/**/* denotes p-value <0.01/0.05/0.1 from the test of equality of means in the same wealth class between two adjacent countries. The alternative hypothesis assumes a higher mean in a higher inequality country when testing for mean difference in Total work and Paid work, and a lower mean in a higher inequality country when testing for differences in Medical Expenditure and Schooling hours.

for lower ranked families in Ethiopia and India, and longer total (paid and unpaid) work hours in all countries. The evidence is less clear on child's health investment with a clear decline for the bottom 10% visible only for Ethiopia, the country with the highest wealth inequality. Additionally, these basic comparisons suggest lower schooling and health investments, and higher incidence of child labour are likely to be prevalent in societies with higher levels of

[3] The Young Lives Survey is an International Study of Childhood Poverty conducted by the University of Oxford. We use data from the latest available round when the survey child is 12 years old.

inequality, as measured by the Gini coefficient.[4] These cross-country differences are statistically significant in most comparisons, but particularly so for the bottom 10%.[5]

The rest of the paper is organised as follows. Section 2 presents the theoretical model, while section 3 discusses the results along with a numerical analysis. Section 4 discusses two policy options to reduce eradicate child labour – the effect of free public provision of education and an explicit ban on child labour. Section 5 concludes.

2. The Model

Consider a discrete time, infinite horizon overlapping generations economy populated with a continuum of individuals who live for three periods – childhood, adulthood and old age. Individuals are heterogeneous with respect to their embodied human capital. A household is a family unit consisting of a child, an adult (parent) and an old (grandparent), and headed by the altruistic parent who cares about the future human capital of her child. Each individual is endowed with a unit of time in the first two periods of life, implying that all individuals retire at the end of adulthood. Children use part of their time attending school, and/or participating in the labour market, and adults use their time at work and leisure. The adult parent takes all economic decisions and optimally chooses the amount of consumption, c_t, the time her child would spend in school, e_t, at work, l_t , and spending on child's nutritional and medical needs to augment her health, n_t. For simplicity, we assume away old-age consumption.[6]

Given the evidence on *idleness* being an important part of a child's time allocation, we extend the standard binary choice (schooling versus work) framework to include the possibility that children may neither attend school, nor participate in labour market, and instead remain idle.[7] In the child labour literature idleness among children has been ascribed to factors such as labour market frictions, low ability, poor health, importance of household work, etc. We

[4] Other measures, such as the Theil entropy, the Kakawani, and Atkinson index, yield identical result.

[5] The *p*-values to test the difference in means are not reported in Table 1 but are available upon request. Instead, indicators for significance at conventional levels are provided to avoid clutter.

[6] Incorporating old-age consumption will only add complexity without altering the basic conclusions.

[7] A number of studies find evidence of child idleness. Ravallion and Wodon (2000) find 54% of children in Bangladesh while Rosati and Tzannatos (2000) report 2.2 %– 3% children in Vietnam neither work nor attend school. Deb and Rosati (2002) estimate that idle children constitute 14% in Ghana and 23% in India.

interpret child idleness as conferring a positive non-economic benefit to parents as it involves time spent with the family, helping with unpaid household work, and being available to care for the younger, ill and infirm family members. Therefore idleness is akin to leisure as long as the time spent involves both children and parents.[8] Denoting leisure time by ls_t, the time available for work is $(1 - ls_t)$ for adults and $(1 - e_t - ls_t)$ for a child. The utility function of an adult parent is given by:

$$\ln c_t + \beta[\nu \ln(\delta + ls_t) + \ln\left(H_{t+1}\right)] \tag{1}$$

The parameter $\beta > 0$ represents the psychological discount factor and H_{t+1} denotes the *effective* human capital (henceforth, human capital) of her child upon reaching adulthood. The parameter $\nu > 0$ represents the weight parents put on child leisure relative to their human capital and $\delta > 0$ is a constant.

Departing from the existing literature we conceptualise ‘health’ and ‘skill’ as two endogenous and complementary components of human capital. Adult health can be improved by undertaking ‘health investments’ in childhood. We think of health investments as consisting of expenditure on nutritional food, safe drinking water and sanitation, vaccination against preventive diseases, medical care, healthy activities, etc. The timing of these investments is crucial for the formation of human capital for two reasons. First, there is ample evidence of a profound effect of malnutrition and poor health in early childhood on human capital formation and future earnings.[9] Second, recent research suggests that adult health and morbidity, to a large extent, is determined early in life.[10] Therefore investment in health early in life may raise the returns to education simply by lowering morbidity in adulthood.

Following Dasgupta and Ray (1986), we emphasise the fact that at low nutrition levels, food intake and work capacity are positively related. We argue that while education raises the

[8] Inclusion of adult leisure is not necessary for obtaining the qualitative results. However, it allows for closed form corner solutions.

[9] In the medical literature, the adverse effects of protein, mineral and vitamin malnutrition on cognitive development, educational achievement, and productivity is well documented (see for example, Basta *et al*., 1979, Levinger, 1996).

[10] For example, Blackwell *et al*. (2001) report significant negative effects of childhood health on adult morbidity, while Case *et al*. (2005) find prenatal health matters as well in additionally determining earnings. Hass (2007) finds poor childhood health to be a good predictor of the risk of work-limiting disability in adulthood.

skill-level embodied in an individual, thus raising the productivity of *labour-time*, health of a worker raises her capacity to work, raising her *labour-power*. The two are often complementary. Health status positively affects returns to skill by reducing morbidity and increasing the productivity of labour time. Higher skill, on the other hand, raises the effectiveness of labour power. We assume a simple multiplicative form to capture the complementary between health and skill 'inputs' in the production of human capital:

$$H_{t+1} = h_{t+1} s_{t+1} \tag{2}$$

where h_{t+1} denotes the health-status of an adult with skill level s_{t+1}.[11]

Health-status depends on "health investment" (n_t) as defined previously, and the quality of health infrastructure of the economy. Following Schultz (2009) we assume that the marginal effect of private health expenditure hinges critically on environmental disease conditions, which can be changed by cooperative or public health investments and health infrastructure such as water, sanitation, community disease control programs, etc. These provisions reflect the overall quality of health institutions in society which is considered exogenous by individuals. Quality of health institutions in period $t+1$ is assumed to depend on the level of government health spending in the previous period (G_t).[12] Apart from direct spending, the child's future health also depends on her 'initial endowment' derived from the parent's health and education levels. Not only does a child genetically inherit her parent's health, the empirical literature almost unanimously suggests that parental education directly or indirectly influences child's health (see Charmarbagwala *et al*., 2004 for an excellent survey). Parental human capital, H_t, is therefore a determinant of h_{t+1}. We assume a simple Cobb-Douglas technology for h_{t+1}:

$$h_{t+1} = B n_t^{\psi} G_t^{\mu} H_t^{1-\mu-\psi}, \; B > 0, \; 0 < \psi, \mu < 1 \tag{3}$$

The health production function in (3) exhibits constant returns to scale, while each input is subject to diminishing returns.[13]

[11] The increasing returns to scale property of the human capital production function is purely for simplicity. Our analytical results are robust to alternative specifications, such as constant returns to scale. See section 3.2.

[12] Complementarity between private and public health inputs have been used in Bhattacharya and Qiao (2007).

[13] See Schultz (2009) for supporting evidence. The constant returns to scale property ensures a balanced growth equilibrium.

The skill level of an adult at time t+1 increases with the time spent in school as a child, e_t, but at a diminishing rate:

$$s_{t+1} = E(\gamma + e_t)^{\eta}\,,\ \ E > 0,\ 0 \le e_t \le 1,\ \ \gamma > 0,\ 0 < \eta < 1 \qquad (4)$$

Note that an adult possesses a minimum level of skill irrespective of time spent in school. This can be interpreted as the ‘autonomous’ level of skill resulting from positive interactions at the household and social levels. B and E represent total productivity parameters in the accumulation of health and skill, respectively.

The budget constraint for an adult with human capital H_t is:

$$c_t + n_t + e_t w_t \bar{H}_t = (1-\tau)(1-ls_t)w_t H_t + (1-e_t - ls_t)\alpha w_t H_t \qquad (5)$$

where w_t is the wage per unit of human capital and $\tau \in (0,1)$ is the proportional income tax rate. A child is assumed to possess a fraction α of the adult human capital, so the second term on the right hand side of (5) denotes earning from child work. Work-time is net of leisure for the parent, and additionally of schooling-time for the child. Following de La Croix and Doepke (2003), teachers are assumed to possess the average human capital in the population $\bar{H}_t$, which implies education cost per child is $e_t w_t \bar{H}_t$. This fixed cost makes education relatively expensive for the poor.[14] The nutritional goods, n_t, are assumed to share the same technology and inputs, and therefore price, as the final consumption good.

A representative firm produces the consumption (and nutrition) goods using a production process with labour as the only input:

$$Y_t = AL_t\,,\ \ A > 0 \qquad (6)$$

where L_t is the aggregate labour supply. The firm chooses inputs by maximizing profits $Y_t - w_t L_t$. Therefore, the competitive wage rate per efficiency unit of labour is given by $w_t = A$.

Individuals are assumed to be homogenous with respect to innate health, but heterogeneous with respect to skill. Skill is distributed over the adult population according to the distribution function $M_t(s_t)$. The average skill level $\bar{s}_t$ is given by $\bar{s}_t = \int_0^{\infty} s_t dM_t(s_t)$. The stock of

[14] Momota (2008) argues that the private costs of schooling, such as outlays for school materials, transportation, etc, are often indivisible and form a substantial part of schooling costs and impose a large burden on the poor even in a ‘free’ education system.

human capital H_t ($\equiv h_t s_t$) has the distribution function $F_t(H_t) \equiv M_t\left(H_t/h_t\right)$, where h_t is presumably a function of individual state s_t. The average human capital $\bar{H}_t$ is:

$$\bar{H}_t = \int_0^\infty H_t dF_t(H_t) \tag{7}$$

Assuming total population is constant and normalised to unity, the stock of human capital evolves according to:

$$F_{t+1}(H) = \int_0^\infty I(H_{t+1} < H)\, dF_t(H_t) \tag{8}$$

where $I(\cdot)$ is an indicator function. The market clearing condition for labour is:

$$L_t = \int_0^\infty (1-ls_t)H_t dF_t(H_t) - \int_0^\infty e_t \bar{H}_t dF_t(H_t) + \int_0^\infty (1-e_t-ls_t)\alpha H_t dF_t(H_t) \tag{9}$$

While the time devoted to leisure and teaching is not available for production of the consumption good, child labour does add to the total supply of labour. We define an equilibrium for our economy as follows:

Definition 1: Given an initial distribution of skill $M_0(s_0)$ an equilibrium consists of sequences of aggregate quantities $\{L_t, \bar{H}_t\}$, distributions $F_{t+1}(H_{t+1})$, and decision rules $\{c_t, n_t, ls_t, l_t, h_{t+1}, s_{t+1}\}$ such that:

1. the households' decision rules $c_t, n_t, ls_t, l_t, h_{t+1}, s_{t+1}$ maximise utility (1) subject to budget constraint (5);
2. the firm's choice of L_t maximises profits;
3. the price w_t is such that the labour market clears;
4. the distribution of human capital evolves according to (8)
5. aggregate variables $\{\bar{H}_t, L_t\}$ are given by (7) and (9).

3. Theoretical Results

We begin the analysis of the model by characterising the household choice of schooling, child labour, and health investment at different levels of income. We find both schooling and health investment increases, and idleness decreases with income. Families below a threshold level of income choose zero schooling and full time child labour. Child labour is found to have a non-linear relationship with income: it increases with income so long as schooling is zero, and falls thereafter. Using interior decision rules we derive the dynamic path of individual human capital along a balanced growth path. Finally, we examine its long run properties using a calibrated version of the model.

3.1. *Education, Child Labour and Private Health Investment*

We find that individual household decisions depend on the dispersion of human capital. The household decisions are obtained by maximizing (1) subject to (2) – (5). We express the optimal household decisions in terms of a key variable $z_t \equiv H_t / \bar{H}_t \equiv h_t s_t / \overline{h_t s_t}$ to denote the human capital H_t of a household relative to the average human capital $\bar{H}_t$ of the society. For households who meet the conditions for interior solutions, the first order conditions imply:

$$e_t = \frac{\kappa_1 z_t - \kappa_2}{\kappa_3 (1+\alpha z_t)}, \tag{10}$$

$$n_t = \bar{H}_t \left(\theta_1 z_t + \theta_2 \right) \tag{11}$$

$$ls_t = \frac{m_1}{z_t} + m_2 \tag{12}$$

where, $\kappa_1 \equiv \beta\eta(1+\delta)(1+\alpha-\tau) - \gamma\alpha(1+\beta(\psi+\nu))$, $\kappa_2 \equiv \gamma\left\{1+\beta(\psi+\nu)\right\}$, $\kappa_3 \equiv 1+\beta(\psi+\eta+\nu)$,[15] $\theta_1 \equiv A\beta\psi\left\{(1+\delta)(1+\alpha-\tau)+\alpha\gamma\right\}/\kappa_3$, $\theta_2 \equiv A\gamma\beta\psi/\kappa_3$, $m_1 \equiv \beta\nu\gamma / \left\{(1+\alpha-\tau)\kappa_3\right\}$, $m_2 \equiv \left\{\beta\nu(1+\alpha(1+\gamma)-\tau) - \delta(1+\alpha-\tau)(1+\beta(\eta+\psi))\right\} / \left\{(1+\alpha-\tau)\kappa_3\right\}$.

Given (10) and (12), a child's time at work is given by

$$l_t = 1 - \frac{\kappa_1 z_t - \kappa_2}{\kappa_3(1+\alpha z_t)} - \frac{m_1}{z_t} - m_2 \tag{13}$$

[15] We need a large enough value of returns to schooling, η, for $\kappa_1 > 0$. In particular, $\kappa_1 > 0$ if $\eta > \alpha\gamma(1+\beta(\psi+\nu)) / \left(\beta(1+\delta)(1+\alpha-\tau)\right)$

It is clear from (13) that we need to have $m_2 < 0$ in order to allow for full time schooling.[16] Note that, $ls \to 0$, as $z \to \left|m_1/m_2\right|$. Given the decision rules in (10) and (11), the human capital of a child in period $t+1$ is given by:

$$H_{t+1} = h_{t+1}s_{t+1} \; = BE\left(\theta_1 z_t + \theta_2\right)^{\psi} (\bar{H}_t)^{\psi} \left(\gamma + \frac{\kappa_1 z_t - \kappa_2}{\kappa_3(1+\alpha z_t)}\right)^{\eta} G_t^{\mu} (H_t)^{1-\psi-\mu}.$$

The individual decision rules in (10) – (13) merit some discussion. Equation (10) suggests that optimal choice of schooling time positively depends on parental human capital relative to the society's average ($de_t/dz_t > 0$). This result is a direct outcome of the poor facing a relatively higher cost of education as teachers are paid according to the *average* human capital level. Education also has an opportunity cost – that of foregone income from child labour. The two together makes education more expensive for the poor. Note that opportunity cost of schooling is lower for the poorer parents because earning from child labour is proportional to parental human capital.

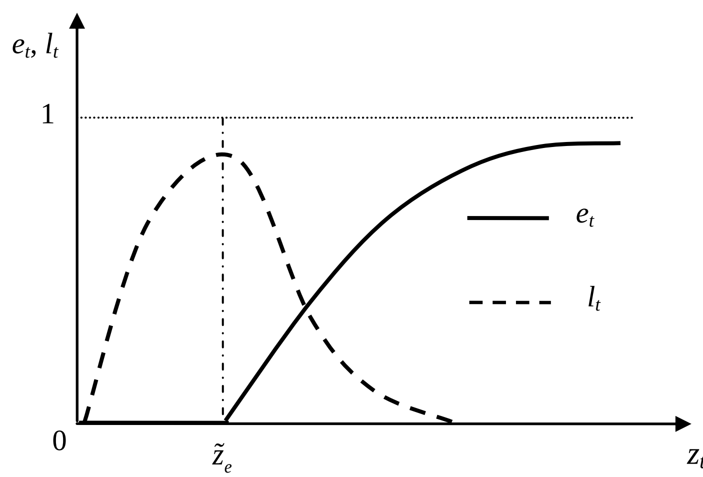

Figure 1: Child's time allocation between schooling and work

From (10) we note that schooling is zero if the relative human capital is below a critical level $\tilde{z}_e (\equiv \kappa_2/\kappa_1)$. This implies, children from families with relative human capital $z_t \le \tilde{z}_e$, will be fully engaged in child labour ($l_t = 1 - ls_t$ in (13)). Differentiation of l_t with respect to z_t shows

[16] If $e_t = 1$ and $m_2 \geq 0$, $l_t < 0$, which violates the non-negativity constraint $l_t \geq 0$. Therefore $m_2 < 0$ (that is, ν is small enough and/or if η or ψ is large enough).

that hours worked by a child rises for low values of z_t, reaches a peak and then falls as z_t rises. Figure 1 plots children's time spent in school and work as a function of relative human capital of their parents.

The fact that schooling is a concave function of relative human capital has important implications. It implies that the average quantity of schooling in the society depends upon the dispersion in the distribution of skill. In particular, if the dispersion of skill increases for a given average skill level, the concavity in the schooling function implies that the average schooling in the society will decrease.[17] Therefore, higher inequality in skill distribution would lead to a lower future average skill level, $\bar{s}_{t+1}$ and a higher future average quantity of child labour. This holds even when we hold private health spending constant across families. The fact that health status itself is a concave function of relative human capital amplifies the negative effect of inequality on child labour.

Note that demand for nutrition or health inputs (n_t) is at a positive subsistence level even when parental relative human capital is zero. Nutrition acts an *essential* input in the health production function. Like education, health investments rise with relative human capital of the parents, since $dn_t/dz_t > 0$. But unlike education, health investment rises with the average level of human capital in the economy. This result follows from the substitution effect – as $\bar{H}$ rises, relative price of education rises, inducing poor families to substitute education for health. In fact, health investment is an increasing function of the average human capital for all households irrespective of their positions in the human capital distribution. In other words, given everything else, health status of all individuals improves with economic growth.[18]

Since most child labour coexists with some amount of schooling, it is instructive to examine the role of productivity of child labour in schooling. Differentiating (10) with respect to the child productivity parameter, α , shows that schooling rises (at a decreasing rate) with child productivity for $z_t < 1/(1-\tau)$, and decreases thereafter. At low (high) levels of α , the opportunity cost of schooling is low (high) relative to the income effect of higher child productivity. Hence the inverted-U shaped relationship. As seen in (11), the impact of child productivity on health spending is unambiguously positive.

[17] This is due to Jensen's Inequality, which, for a concave function $f(X)$, implies $E[f(X)] \leq f(E[X])$.

[18] This is consistent with the empirical findings that link measures of health with economic growth.

A key feature of this model is the corner solution. As mentioned earlier, health-skill complementarity in utility and production functions, and the fixed direct cost of education generate a possibility that some households are unable to access education for their children. As suggested by (10), if parental relative human capital is not above a critical level $\tilde{z}_e\,(\equiv \kappa_2/\kappa_1)$, it is optimal to send the child to full time work. The first order conditions imply:

$$e_t = 0, \tag{14}$$

$$n_t = \theta_3 H_t\,, \text{ where } \theta_3 \equiv \frac{A\beta\psi(1+\delta)(1+\alpha-\tau)}{\alpha+\beta(\psi+\nu)} \tag{15}$$

$$ls_t = \frac{\beta(\nu-\delta\psi)-\delta}{1+\beta(\psi+\nu)} \tag{16}$$

Given that investment is made in health only, the human capital of a child in period t+1 is:

$H_{t+1} = h_{t+1}s_{t+1} = BE\gamma^{\eta}\theta_3^{\psi}G_t^{\mu}(H_t)^{1-\mu}$.

Absence of schooling cost makes the demand for health inputs independent of $\bar{H}$, and leisure-time constant. Parents spend a fraction of their income on child health even though schooling is unaffordable. As in the interior case, private health spending depends on child income and rises with child productivity, α.

Given that schooling is an increasing function of z and that it is bounded above by the unit time endowment, raises the possibility of yet another corner case where $e = 1$. In (10), $e_t = 1$ for $z_t \geq (\kappa_2+\kappa_3)/(\kappa_1-\alpha\kappa_3) \equiv \hat{z}_e$. Therefore, for $z_t \geq \hat{z}_e$, $ls = 0$ and $l = 0$. Maximisation problem at this corner implies the following decision rules:

$$e_t = 1 \tag{17}$$

$$n_t = (\theta_4 z_t + \theta_5)\bar{H}_t, \tag{18}$$

where $\theta_4 \equiv A\beta\psi(1-\tau)/(1+\beta\psi)$, and $\theta_5 \equiv \theta_4/(1-\tau)$. At this corner, the human capital of a child in period t+1 is: $H_{t+1} = h_{t+1}s_{t+1} = BE(1+\gamma)^{\eta}\left(\theta_4 z_t + \theta_5\right)^{\psi}(\bar{H}_t)^{\psi}G_t^{\mu}(H_t)^{1-\psi-\mu}$.

3.2. *The Dynamics of Individual Human capital*

Given that the stock of human capital is distributed as $F_t(H_t)$, the distribution of relative human capital levels can be expressed as $\Pi_t(z_t) \equiv F_t(z_t\bar{H}_t)$. Give constant population, the evolution of $\Pi_t(z_t)$ occurs according to:

$$\Pi_{t+1}(z) = \int_0^{\infty} I(z_{t+1} \le z)\ d\Pi_t(z_t) \tag{19}$$

Given the definition of *z*, it must be that

$$1 = \int_0^{\infty} z_t\ d\Pi_t(z_t) \tag{20}$$

Decisions on child's schooling and health are given by (14) and (15) if $0 < z_t < \tilde{z}_e$, by (10) and (11) if $\hat{z}_e > z_t > \tilde{z}_e$, and by (17) and (18) if $z_t > \hat{z}_e$. Skill level of children is given by:

$$s_{t+1} = \left(\gamma + \max\left[0,\ \min\left\{ \frac{\kappa_1 z_t - \kappa_2}{\kappa_3(1+\alpha z_t)}, 1 \right\} \right] \right)^{\eta} \tag{21}$$

From (9), equilibrium labour input is given by:

$$L_t = \bar{H}_t \left[\int_0^{\infty} \left(1 - ls(z_t)\right) z_t d\Pi_t(z_t) - \int_{\tilde{z}_e}^{\infty} e(z_t)\ d\Pi_t(z_t) + \alpha \int_0^{\hat{z}_e} \left(1 - e(z_t) - ls(z_t)\right) z_t d\Pi_t(z_t) \right]$$ which leads

to
$$\frac{L_t}{\bar{H}_t} = (1+\alpha)(1-m_1-m_2) + \frac{1}{\kappa_3}(\kappa_2 - \kappa_1) \tag{22}$$

Using (6) and (22), income per unit of labour hour in equilibrium is:

$$\frac{Y_t}{L_t} = A\bar{H}_t \left((1+\alpha)(1-m_1-m_2) + \frac{1}{\kappa_3}(\kappa_2 - \kappa_1) \right) \tag{23}$$

Public provision of health infrastructure is funded by income tax. Assuming the government maintains a balanced budget every period:

$$G_t = \int_0^{\infty} \tau\left((1 - ls(z_t)\right) w_t H_t\ dF_t(H_t)\ = \tau A\bar{H}_t(1-m_1-m_2) \tag{24}$$

Given the level of initial human capital, H_0, the evolution of human capital for an adult is represented by the difference equation:

$$H_{t+1} = \begin{cases} \chi_1 (z_t)^{1-\mu} \bar{H}_t, & \text{if } z_t \le \tilde{z}_e \\ \chi_2 \left(\theta_1 z_t + \theta_2\right)^{\psi} \left(\gamma + \dfrac{\kappa_1 z_t - \kappa_2}{\kappa_3(1+\alpha z_t)} \right)^{\eta} (z_t)^{1-\psi-\mu} \bar{H}_t, & \text{if } \tilde{z}_e < z_t < \hat{z}_e \\ \chi_3 \left(\theta_4 z_t + \theta_5\right)^{\psi} (z_t)^{1-\psi-\mu} \bar{H}_t, & \text{otherwise} \end{cases} \tag{25}$$

where, $\chi_1 \equiv BE\left((\tau A)(1-m_1-m_2)\right)^{\mu}$, $\chi_2 \equiv \chi_1 \gamma^{\eta} \theta_3^{\psi}$, and $\chi_3 \equiv \chi_1 (1+\gamma)^{\eta}$. In what follows, we assume interior solution for schooling and health investments, i.e. $\tilde{z}_e < z_t < \hat{z}_e$. Using the definition of z and (25) the relative human capital for an individual in $t+1$ is given by:

$$z_{t+1} = \frac{\chi_2}{g_{t+1}} \left(\theta_1 z_t + \theta_2\right)^{\psi} \left(\gamma + \frac{\kappa_1 z_t - \kappa_2}{\kappa_3 (1+\alpha z_t)}\right)^{\eta} (z_t)^{1-\psi-\mu} \tag{26}$$

where $g_{t+1} = \bar{H}_{t+1} / \bar{H}_t$.

We analyse the evolution of relative human capital assuming a balanced growth path (BGP) for the economy, along which the growth rate of output (and that of H) is constant. This implies $g_t = g*$. The BGP assumption helps us analyse dynamics of inequality in individual human capital without getting deviated to growth issues. Along a BGP the economy is characterised by a long run scenario where everybody has the same human capital.

For $z_t > 0$, there is a balanced growth path characterised by $d\Pi(1) = 1$ (i.e. the limiting distribution is degenerate). The growth factor of output and human capital is given by:

$$g* = \chi_2 \left(\theta_1 + \theta_2\right)^{\psi} \left(\gamma + \frac{\kappa_1 - \kappa_2}{\kappa_3 (1+\alpha)}\right)^{\eta} \tag{27}$$

The constant value $g* = \chi_2 \left(\theta_1 + \theta_2\right)^{\psi} \left(\gamma + \frac{\kappa_1 - \kappa_2}{\kappa_3 (1+\alpha)}\right)^{\eta}$ and $z_{t+1} = z_t = 1$ solve (10), (11), and (26). It immediately follows that along this BGP, $e_t = e^*$, $n_t = n^*$, and so on. Since households are assumed to differ only in their initial level of skill, along the long-run BGP, inequality among the households should no longer exist.[19] We now consider the dynamics of the human capital of an individual dynasty (of mass zero) along the BGP given in (26).

The dynamic system described above is block recursive. Given the initial conditions, we first use (10) and (11) to solve for e_t and n_t. Then using (16) and (26) we determine z_{t+1} and g_{t+1}. Leading (20) one period ahead and substituting z_{t+1} by its value from (26) yields an expression where g_{t+1} can be computed as a function of current variable z_t. The new distribution of relative human capital is given by (19). H_{t+1} is non-negative, which ensures that an equilibrium exists

[19] Inequality along a BGP would also persist if there were additional exogenous differences among household such as genetic or ability shocks, which are intentionally left out to simplify exposition.

for any given initial conditions. Uniqueness of equilibria, however, cannot be guaranteed due to the non-convexity in H_{t+1}, which arises endogenously in the model.

Using (27), the evolution of the relative human capital in (26) can now be written as:

$$z_{t+1} = z_t^{1-\psi-\mu}\left(\frac{(\theta_1 z_t + \theta_2)^{\psi}\left(\gamma + \frac{\kappa_1 z_t - \kappa_2}{\kappa_3(1+\alpha z_t)}\right)^{\eta}}{(\theta_1 + \theta_2)^{\psi}\left(\gamma + \frac{\kappa_1 - \kappa_2}{\kappa_3(1+\alpha)}\right)^{\eta}}\right) \tag{28}$$

It is easily verified that $z^* = 0$ and $z^* = 1$ are solutions to the difference equation given in (28). The solution $z^* = 0$ is trivial, but the steady state at $z^* = 1$ corresponds to a degenerate distribution whereby individual differences in human capital cease to exist and the economy attains perfect equality. However, a close inspection of (28) reveals that for steady states all we need is $z^{*(\psi+\mu)} = \frac{1}{g^*}(\theta_1 z^* + \theta_2)^{\psi}\left(\gamma + \frac{\kappa_1 z^* - \kappa_2}{\kappa_3(1+\alpha z^*)}\right)^{\eta}$, and depending on the parameter values, solutions in other ranges such as $0 < z^* < 1$ and $1 < z^*$ are also plausible. The possibility of steady state occurring at multiple ranges suggests that the equilibrium at the balanced growth path may or may not be stable, and individual human capital could evolve into a bimodal distribution in the long run. This means some households may find themselves trapped in a vicious cycle of high morbidity and high child labour.

Remark 1: The complementarity between health status and skill, in combination with the fixed cost of schooling, gives rise to non-convexity in the human capital production function in (2). It is a linear function of H_t for children with zero schooling ($n_t > 0$ and $e_t = 0$ for $H_t \leq \tilde{z}_e \bar{H}_t$), and strictly convex above the threshold ($n_t, e_t > 0$ for $H_t > \tilde{z}_e \bar{H}_t$). This non-convexity is manifested in (28), an examination of which readily reveals that the possibility of multiple steady-states and the "poverty-trap" phenomenon results from the presence of the factor $(\theta_1 z_t + \theta_2)$, that is, due to the health component of human capital. Without this component the long-run distribution of relative human capital would be degenerate.

Remark 2: The multiplicity of steady-states is not due to the increasing returns to scale assumption in human capital production function in (2). The results are valid with a more general specification of H_{t+1}. Let $H_{t+1} = h_{t+1}^{\varepsilon} s_{t+1}^{\xi}$ $(0 < \varepsilon, \xi < 1)$. In addition, let the total productivity of time spent in school depend on the existing quality of schools, which is approximated by the level of average human capital of the society. Using a simple linear form for the productivity variable, (4) is rewritten as: $s_{t+1} = E(\bar{H}_t)(\gamma + e_t)^{\eta} = \omega \bar{H}_t (\gamma + e_t)^{\eta}$, $\omega > 0$. Using decision rules (10) and (11), which remain unaffected, the period *t+1* human capital is given by:

$$H_{t+1} = h_{t+1}^{\varepsilon} s_{t+1}^{\xi} = B^{\varepsilon} \left(\theta_1 z_t + \theta_2\right)^{\psi} (\bar{H}_t)^{\psi+\xi} \left(\gamma + \frac{\kappa_1 z_t - \kappa_2}{\kappa_3 (1 + \alpha z_t)}\right)^{\xi\eta} G_t^{\varepsilon\mu} (H_t)^{\varepsilon(1-\psi-\mu)}.$$

Balanced growth equilibrium requires $\varepsilon + \xi = 1$, which leads to a modified version of (26):

$$z_{t+1} = \frac{B^{\varepsilon} (\tau A)^{\varepsilon\mu}}{g_{t+1}} \left(\theta_1 z_t + \theta_2\right)^{\varepsilon\psi} \left(\gamma + \frac{\kappa_1 z_t - \kappa_2}{\kappa_3 (1 + \alpha z_t)}\right)^{(1-\varepsilon)\eta} (z_t)^{\varepsilon(1-\psi-\mu)}. \tag{26a}$$

It is readily seen that the dynamic properties of (26) and (26a) are identical. We prefer the simpler, more parsimonious specification.

An analytical investigation is cumbersome due to the complex non-linear nature of z_{t+1} in (28). Therefore, we resort to numerical methods. In the next section we analyse a parameterised version of the dynamic path of relative human capital to examine the possibility of multiple steady states.

3.3. *Computational Exercise*

The purpose of this exercise is to gain a better perspective of the dynamic evolution of income inequality and study the possibility and nature of the steady state equilibria. By simulating the model with meaningful parameter values we will be able to quantify the degree of polarisation of income distribution, and find the values of child labour, morbidity and other variables for different income groups at the steady states.

3.3.1. *Parameter values*

Non-availability of adequate data on developing countries makes parameterisation of the model a difficult exercise. Therefore, wherever available, the parameter values are selected to match the values for a typical developing country, and some are borrowed from the existing literature. The results of this computational exercise therefore should only be taken as qualitative description of a developing economy.

As is standard in the literature, we assume that one model period (or generation) corresponds to a 30-year period. The wage of a child in efficiency units is assumed to vary in proportion to her parent's wage. The parameter α, representing the fraction of her parent's efficiency wage a child worker earns, is assigned a value of 0.19. This implies a child earns about one-fifth of her parent in real terms. In the literature, the value of the altruism parameter is commonly chosen to lie between 0.6 and 0.8 (Raut, 2003). We choose β = 0.75 – a value in the higher side of the range, to ensure that equilibrium value of schooling is not too low among the rich. The returns to schooling, η is given a value 0.67, high enough to ensure $\kappa_1 > 0$. This value of η, together with the value of total productivity parameter in skill function, E = 1.99, imply H = $\bar{H}$ =1 in the degenerate equilibrium. The literature provides no guidance for the value of elasticity of health with respect to private health investment (ψ) in the model. We choose ψ = 0.3 which ensures that about 20% of household income is spent on health and nutritional goods at the lower steady state – a value that falls in the range found in the literature (Fabricant *et al*., 1999). The total productivity parameters in output and health productions, such that g^* =1 when H = $\bar{H}$ =1. This is satisfied when A =10 and B = 1.4. Following de La Croix and Doepke (2003) we choose γ = 0.01. The value of the elasticity of leisure, ν and the shift factor, δ are chosen to ensure that the marginal benefit from leisure does not go to zero too quickly (or, $m_2 < 0$). Specifically, we choose ν = 0.22 and δ = 0.01. In the model, individuals do not internalise the income tax, and a higher tax rate reduces schooling and health spending. Since, most of the population pays minimal taxes (if any), the average tax rate is assumed to be 5%, a conservative value. The value of the elasticity of health with respect to public health spending, μ, is a key parameter in the model and it is chosen to be 0.43 in the baseline case. We further analyse scenarios to test the sensitivity of the model to changes in these parameters.

Table 2: Parameter values

A	B	E	α	β	γ	η	μ	ψ	ν	δ	τ
10	1.40	1.99	0.19	0.75	0.01	0.67	0.43	0.30	0.22	0.01	0.05

In addition to choosing parameters, we also need to set the initial conditions for income distribution. As mentioned in section 2, the overall size of the population is set to one, a scale parameter which does not affect the results. The initial distribution of human capital follows a standard log-normal distribution $F(\rho,\sigma^2)$, where the mean (ρ) equals 0 and variance (σ^2) equals 1.

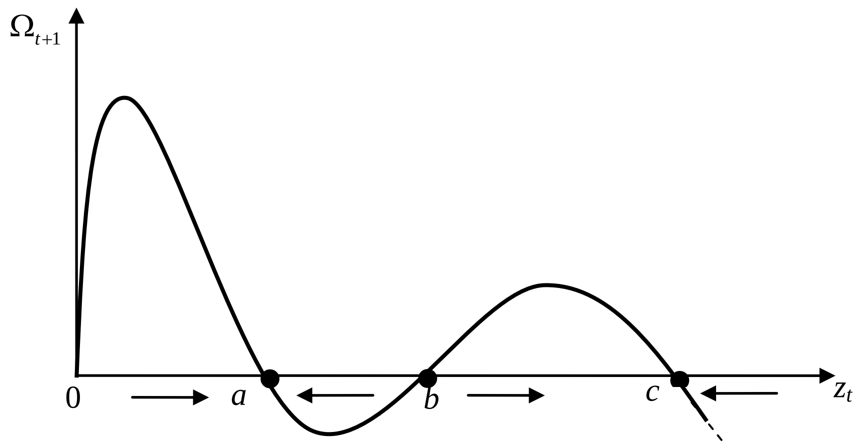

Figure 2: Transition path of relative human capital

Given (28), such parameterisation produces a transition path as shown in Figure 2. For ease of graphical exposition, we construct a variable $\Omega_{t+1} = z_{t+1} - z_t$. Figure 2 depicts a typical curvature for the function Ω_{t+1}. It intersects the z_t axis thrice, where each intersection point represents a steady state equilibrium for the economy. However, stability of a steady state requires that the trajectory intersect the horizontal axis from above, implying that the equilibria at points '*a*' and '*c*' are stable, while the one at point '*b*' is unstable. The curvature of the trajectory as depicted in Figure 2 is retained for a wide range of parameter values. Interestingly, in many such instances, the unstable equilibrium at point '*b*' corresponds to the BGP equilibrium at $z^* = 1$. Therefore the dynamic path of income inequality allows for an unstable steady state where the distribution of human capital is degenerate. Note that with this set of parameters, the threshold below which no schooling is undertaken is $\tilde{z}_e = 0.02$.

Table 3 provides the values of the key variables along the balanced growth path. The households on either side of z* = 1 diverge in the long run. The poorer households converge to the lower extreme where individual human capital is about 0.3% of the mean level. At this equilibrium there is no schooling and 97% of a child's time is spent at work and 3% at leisure.[20]

Table 3: The steady state values of key variables

	z*	Child labour time	Schooling time	Skill level	Education spending*	Health spending*	Health Status	Consumption*	Child income*
Lower Steady State	0.003	0.97	0	0.09	0	0.18	0.04	0.82	0.17
At z*=1	1	0.73	0.27	0.85	0.02	0.14	1.18	0.61	0.17
Upper Steady State	5.44	0	1	2.00	0.14	0.21	4.02	0.65	0

* denotes values expressed as a proportion of total income.

The health status of 0.04 reflects that health of a person at this equilibrium is about 3.4% of the average person in the society who has a health status of unity (alternatively, a person has a 96% higher morbidity than the average person). Skill level at this steady state is 10.6% of that of the average. In terms of income and spending, health inputs account for about 18% of household income for these households. A child contributes about 17% of household income at this equilibrium. In contrast, at the higher steady state a typical individual has 7.45 times more human capital than the average person. Each individual in this group get full time schooling (no labour or leisure for child), have 3.4 times better health status, and 2.35 times higher skill level than an average individual. 21% of income is spent on health and 14% on schooling.

Absent a policy intervention, these conditions at the two steady states would perpetuate in the long run. Therefore, the economy in the long run is characterised by an inequality-trap, with simultaneous presence of high morbidity and child labour. Note that an exogenous and proportional rise in income for all (e.g. rise in the efficiency parameter, A) will keep relative incomes unchanged for everybody and leave the position of the steady states unchanged.

3.3.2. *Polarisation*

The degree of polarisation or the distance between the two steady states can be affected by changes in certain parameter values. The relationship is represented in Table 4. Notable among

[20] Since each family has one child, this can be interpreted as 97% of all children working full time, with 3% neither working nor attending school.

these relationships are those with α, η, μ and ψ. A rise in labour productivity of children lowers the degree of polarisation, as does a rise in the elasticity of health production with respect to public health spending. Higher labour productivity of children raises family income of the poor group and their relative human capital *via* improved health. The health elasticities of private spending (ψ) and government spending (μ) raise health for both rich and poor, but in the absence of schooling, the marginal benefit for the poor is larger. As expected, a higher return to education raises the benefit of schooling for the rich, and this increases the distance between the two steady states. Income tax in this model has a redistributive effect through health accumulation. Therefore, an increase in tax rate, while reducing the incentive to educate and spend on health by all individuals, reduces the degree of polarisation.

Table 4: Sensitivity to rise in parameter values

	α	β	γ	η	μ	ψ	δ	τ
Degree of Polarisation	**-**	**+**	**-**	**+**	**-**	**-**	**+**	**-**

These results suggest a key role for the public health. An efficient health infrastructure not only raises the returns to private health spending, but also plays a crucial role in reducing the rich-poor gap in societies with high income inequality. In fact, the dynamic trajectory of z_{t+1} is quite sensitive to changes in μ, and it can be shown that the economy will be able to escape the inequality-trap if μ is increased from 0.43 to 0.6.

4. Policy Options to Combat Child Labour

In most societies child labour is discouraged through a host of policy measures ranging from outright ban to incentive-based schemes, such as education subsidies, or a mix of the two. While these policies may be effective in achieving the social objective of limiting child labour, they are unlikely to raise schooling and health among the targeted children. The households that rely heavily on child income a ban on child labour may worsen poverty, while provision of free education may raise human capital and even lower income inequality. In what follows, we briefly discuss these policy options in the context of our model.

4.1. *Provision of Public Education*

A majority of developing countries have a highly subsidised public education program in place aimed at lowering the direct cost of education, making it more affordable to the poor. Our model suggests that even with free public education, the society may find some child labour to be optimal. In the modified model with free public education households maximise (1) subject to the budget constraint:

$$c_t + n_t = (1-\tau)(1-ls_t)w_t H_t + (1-e_t - ls_t)\alpha w_t H_t$$

For households who meet the conditions for interior solution, the first order conditions imply:

$$e_t = \bar{e} \equiv \frac{\beta\left(\eta(1+\alpha-\tau)(1+\delta)-\alpha\gamma(\psi+\nu)\right)-\alpha\gamma}{\alpha\left(1+\beta(\psi+\eta+\nu)\right)}, \tag{29}$$

$$n_t = \theta_6 H_t, \text{ where, } \theta_6 = \frac{A\beta\psi\left(\alpha(1+\delta+\gamma)+(1+\delta)(1-\tau)\right)}{1+\beta(\psi+\eta+\nu)} \tag{30}$$

$$ls_t = \overline{ls} \equiv \frac{\beta\nu\left(\alpha(1+\gamma)+1-\tau\right)-\delta(1+\alpha-\tau)\left(1+\beta(\eta+\psi)\right)}{(1+\alpha-\tau)\left(1+\beta(\psi+\eta+\nu)\right)} \tag{31}$$

where $w_t = A$. The second order conditions for a maximum are satisfied. Note that each parent will be identically inclined to send their children to work if $0 < \bar{e} + \overline{ls} < 1$. The children, in turn, will possess identical amounts of gross human capital.

Now that the government has the twin responsibility of financing education as well as public health, operating under a balanced budget condition entails:

Total tax revenue = Salary of teachers (G_t^e *) + spending on health infrastructure (* G_t^h *)*

$$\text{or, } \tau(1-\overline{ls})w_t H_t \equiv \underbrace{\bar{e} w_t \bar{H}_t}_{G_t^e} + \underbrace{(\tau(1-\overline{ls})-\bar{e})w_t \bar{H}_t}_{G_t^h}$$

The accumulation function for human capital is now given by:

$$H_{t+1} = ((\tau(1-\overline{ls})-\bar{e})A)^{\mu}\theta_6^{\psi} H_t^{1-\mu}\bar{H}_t^{\mu}\left(\gamma+\bar{e}\right)^{\eta}$$

The dynamic of inequality in this regime will be governed entirely by the evolution of health status of agents. The relative human capital of children can therefore be written as:

$$z_{t+1} = \frac{1}{\bar{g}}((\tau(1-\overline{ls})-\bar{e})A)^{\mu}\theta_6^{\psi} z_t^{1-\mu}\left(\gamma+\bar{e}\right)^{\eta} \tag{32}$$

where $\bar{g} = ((\tau(1-l\bar{s}) - \bar{e})A)^{\mu} \theta_6^{\psi} \left(\gamma + \bar{e}\right)^{\eta}$ is the implied balanced growth rate. Note that under this policy regime, public health infrastructure is absent and $H_{t+1} = 0$, unless $\bar{e} < \tau(1-l\bar{s})$. There is a clear trade-off between public investment in health and education. Under this regime, the government has to raise the tax rate enough to finance both education and health.[21] However a higher τ makes the inequality $0 < \bar{e} < \tau(1-l\bar{s}) < 1$ more likely to hold, implying an interior equilibrium child labour will always exist in all households. As shown in Figure 3, the transition path of income inequality takes a smooth concave shape with Ω_{t+1} intersecting the horizontal axis from above. Hence, the steady state corresponds to perfect equality in the long run.

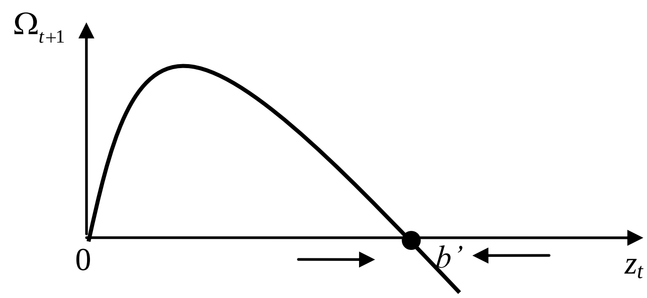

Figure 3: Transition path of relative human capital under public provision of education

4.2. *Ban on Child Labour*

We show that in a society where a large segment of population does not have much access to education and health inputs, a ban would be undesirable. Given everything else, a ban on child labour would further reduce household earnings and end up hurting the poor instead.

In our model, a ban on child labour can be interpreted as forcing the child wage to zero. Under the ban, parents maximise utility function (1) subject to the budget constraint $c_t + n_t = (1-\tau)(1-ls_t)w_t H_t - e_t w_t \bar{H}_t$, along with the time restriction $e_t + ls_t = 1$. The first order conditions for this problem are:

$$\frac{w_t((1-\tau)H_t - \bar{H}_t)}{c_t} + \frac{\beta\eta}{\gamma + e_t} = \frac{\beta\nu}{\delta + ls_t} \qquad (33)$$

[21] See Sarkar and Osang (2008) for a similar analysis.

$$\frac{1}{c_t} = \frac{\beta\psi}{n_t} \tag{34}$$

In equilibrium, the net marginal benefit for one hour of schooling (left hand side of (33)) should be equal to the marginal cost of foregone leisure (right hand side of (33)). The ban eliminates the opportunity cost of schooling, but distorts the choice of leisure time. From (33) it is evident that for parents with $H_t < \bar{H}_t/(1-\tau)$, marginal cost of foregone leisure is lower than the marginal return from future human capital. Therefore the ban will generate more incentive for poorer parents to increase schooling.

The health investment decision in (34) yields $n_t = \left(1/1+\beta\psi\right)e_t w_t\left((1-\tau)H_t - \bar{H}_t\right)$, which implies that health inputs are unaffordable for parents with $H_t \leq \bar{H}_t/(1-\tau)$, and hence future human capital of children is zero.

A ban on child labour thus reduces family income and optimal health investment. This implies reduction in optimal schooling in general, and drives schooling to zero for the households who cannot afford any health inputs. Thus the low income households are worse off under the ban. For parents with $H_t > \bar{H}_t/(1-\tau)$, schooling is replaced by more leisure.

5. Concluding Remarks

Health of an individual is determined early and often plays a vital role in separating success from failure in educational attainment as well as earnings. Despite its perceived importance, health status as a channel of persistence of income inequality and child labour has not been analysed so far. In this paper we highlight the complementarity between health and education that makes investing in education harder (easier) for individuals in the lower (upper) half of the income distribution. In the absence of credit markets the health-education interaction generates a non-linear relationship between the degree of human capital inequality and incidence of child labour. In more unequal societies, families with low human capital may choose to send their children to full time work due to low net returns from schooling. But when inequality is low, returns from education becomes positive, thereby lowering the incentives for child labour. The nonlinearity of the income inequality dynamic may generate a "poverty trap" characterised by high incidence of child labour, low nutrition, and low health.

Our analysis has important policy implications. The results suggest that a ban on child labour could be counterproductive as a policy to improve child education and welfare. It only distorts the labour-leisure choice and results in lower schooling and increased idleness among children in poverty. On the other hand, free public education is a well-understood redistributive policy that encourages schooling, and in our model it plays the expected role – it raises schooling, lowers morbidity and reduces income inequality in the long run. Yet it is ineffective in eliminating the incidence of child labour. Public provision of health has not attracted much attention in the literature as a redistributive tool. Our calibration results indicate that public provision of health could confer similar benefits as public education, and additionally may even eliminate child labour.

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