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Debt Relief, Demand for Education, and Poverty

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Abstract

The objective of this paper is to arrive at a better understanding of the implications of debt relief savings for poverty reduction in HIPC countries by focusing on one important channel of impact—human capital accumulation. Our simulation results suggest that poverty and growth objectives would be mainly enhanced if resources are targeted at the primary and secondary level of education. In addition, targeting education spending to households below the poverty line can potentially have most significant impact on reducing poverty in the economy.

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1   Introduction

It has been well recognized that despite the use of traditional mechanisms for rescheduling and debt reduction, along with the continued provision of concessional financing and the pursuit of sound economic policies, debt service obligations for heavily-indebted poor (HIPC) countries remain high compared to social spending on health and education (Table 1). In this context it has been asserted that debt relief could create and sustain a virtuous circle of poverty reduction and growth, primarily by providing additional fiscal resources for poverty alleviation. Debt relief targeted for human capital accumulation through increased public spending on education is viewed as a critical component of this link.[1]

Low overall educational attainment and school enrolment rates along with high estimated returns to schooling in many HIPC countries are often cited as justification for increased public investment in education (Table 2). As a result, explicit targets for expanding school enrolment rates and other performance criteria for education expenditures have been set in HIPC programmes. However, recent studies suggest that it is not the overall education outlay but the allocation of investment in education that matters for growth.[2] Hence, a key element in the policy discussion involves the allocation of external debt savings across different levels of schooling to meet the country's growth and poverty reduction objectives.

Using a lifecycle perspective, this paper develops a general equilibrium framework to examine the differential impact on household schooling decisions and human capital accumulation of utilizing debt relief savings for augmenting government spending on different levels of education—primary, secondary and tertiary—and of spending targeted by income groups. Government investment in education affects an individual's time profile of consumption and his lifetime asset accumulation decisions by influencing the marginal costs and benefits from human capital accumulation (Glomm and Ravikumar 1998). However, in contrast to much of the literature on human capital accumulation through formal schooling where each individual makes his own educational decisions, we explicitly model the intertemporal trade-off in the contribution of the child to household income and the parental choice of schooling involved as in Glomm (1997).

Our theoretical framework is a dynamic general equilibrium model of overlapping generations of long-lived and heterogeneous agents in the spirit of Auerbach and Kotlikoff (1987). Agents in the model are differentiated by their age-earning profiles. We assume that parents make schooling decisions for children and there are fixed and varied costs to different levels of schooling which are partially financed by parents. In many HIPC countries, despite basic education being obligatory and free, in practice, schools collect contributions from students to supplement government subsidies and

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[1]   For cross-country studies that emphasize the importance of schooling for economic growth see Barro (1991), Hanushek (1996), Collins and Bosworth (1996), and Judson (1998). Some examples of studies that focus on connection between schooling and labour market outcomes include Card and Krueger (1992) for the US and Behrman and Birdsall (1983) for Brazil, and Duflo (2002) for Indonesia. Other studies focus on the relationship between schooling and income distribution (Psacharopolous *et al.* 1992).

[2]   In a cross country study Judson (1998) finds that countries whose allocations are inefficient gain little in output and growth from their investments in education.

Table 1
Government spending on external debt service, education and health:
Select HIPC countries, 1998-2000 [a]
(in % of GDP unless otherwise noted)

	Debt service [b]			Education			Health		
	1998	1999	2000 (est.)	1998	1999	2000 (est.)	1998	1999	2000 (est.)
Benin	2.6	2.9	2.9	3.0	3.2	3.6	1.3	1.8	1.9
Bolivia	4.8	4.0	4.8	5.7	6.1	6.1	2.8	2.7	2.8
Burkina Faso	2.0		2.2	2.2	2.7	2.3	2.0	2.7	2.3
Gambia, The	6.2		4.0	2.9	3.0	3.0	1.8	1.8	1.9
Madagascar	3.4		2.9	2.5	3.0	3.0	1.0	1.2	1.9
Mali	3.1	3.2	3.5	3.2	3.2	3.2	2.4	2.4	2.4
Mauritania [c]	7.9	14.0	9.4	5.0	5.3	5.3	1.7	1.7	1.7
Niger	3.0		3.2	2.2	2.7	2.5	1.3	2.2	2.0
Sao Tome & Principe	9.1		12.5		4.9	7.2		9.6	8.9
Senegal	3.7	4.8	3.9	3.8	4.0	3.7	1.1	1.3	1.2
Group average [d]	3.8	4.4	3.9	3.8	4.2	4.1	1.9	2.1	2.1
Debt service/health and education spending	66.8	70.9	62.9						

Notes: [a] Data for 2000 are from IMF's HIPC databank.

[b] Debt service after traditional debt relief; not including HIPC or Enhanced HIPC debt relief.

[c] Data for 1999 are for debt service before debt relief.

[d] Group average is calculated by weighting by each country's nominal GDP in dollars.

Sources: IMF Board documents (IMF); World Development Indicators (World Bank).

parents bear costs for uniforms and books. For instance, Canagarajah and Coulombe (1997) find that per capita costs of publicly provided primary education in Ghana accounted for more than 15 per cent of household mean per capita expenditures in 1994. For Uganda, Mackinnon and Reinikka (2000) note that parents on average contributed 60 per cent of total primary education spending.

Our model—calibrated to Ghana—yields important insights into the qualitative and quantitative effects of utilizing debt relief savings for targeting 'broad' and 'narrow' expenditures.[3, 4] Specifically, the government in our model utilizes debt relief savings to provide transfer payments and public investment for different levels of education.[5] Our simulation results suggest that a country's poverty and growth objectives would be mainly enhanced if resources are targeted at the primary and secondary level of education. This result follows because the fixed costs to schooling introduce increasing returns to scale in human capital accumulation. As a result, in the absence of the higher public subsidy for primary or secondary schooling, lower income households invest in

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[3] In this paper we abstract from expenditures on health and focus on education spending although there clearly are complementarities between the two.

[4] Most of the recent contributions to the analysis of targeted expenditures has been limited to a static framework (van de Walle 1995), ignoring the long run effects of such expenditures, in part, due to the unavailability of panel household surveys for most developing countries.

[5] Ghana is used as an illustrative case and similar results can be derived by applying the model to other HIPC countries with less than universal basic education.

child human capital at the expense of physical asset accumulation. A higher subsidy for basic education allows lower income households to forego child earnings and increase investment in child human capital while accumulating more assets for future consumption over their lifecycle. For households in the higher income classes, a reduction in schooling costs simply serves to increase their asset accumulation profiles over their lifetime, resulting in a higher aggregate physical capital stock in the economy. Therefore, both aggregate human and physical capital accumulation increase.

The growth and poverty effects of an increase in the subsidy for tertiary education are not as substantial for several reasons. First, such policies do not affect the asset accumulation decisions of households earlier in their working lives, and, hence, result in lower lifecycle asset accumulation. In addition, this policy has little impact on the marginal schooling decisions of low income households as their optimal schooling choices typically involve lower levels of schooling. We also find that the impact of a targeted transfer on the lifecycle behaviour of households depends on the magnitude of the transfer. With a sufficiently large transfer, a significant improvement in growth and poverty reduction can obtain.

The paper proceeds as follows: Section 2 describes the analytical framework. Section 3 describes the calibration and parameterization of the model economy. Section 4 presents the policy experiments and the results of the sensitivity analysis. Section 5 concludes.

Table 2
Countries with primary gross school enrolment ratios below 90%, 1996

Enrolment between 50-90%			Enrolment below 50%		
Region and country	Gross enrolment rate	HIPC	Region and country	Gross enrolment rate	HIPC
Sub-Saharan Africa			Sub-Saharan Africa		
Benin	78	yes	Burkina Faso	40	yes
Burundi	51	yes	Djibouti	39	
Chad	57	yes	Ethiopia	43	yes
Gambia, The	77	yes	Mali	49	yes
Ghana	79	yes	Niger	29	yes
Guinea-Bissau	62	yes			
Kenya	85	yes	South Asia		
Mauritania	79	yes	Afghanistan	49	
Mozambique	60	yes			
Senegal	71	yes			
Tanzania	66	yes			
Uganda	74	yes			
Middle East and North Africa					
Morocco	86				
Oman	76				
Qatar	62				
Yemen	79	yes			
Latin America and Caribbean					
Guatemala	88				
East Asia and Pacific					
Papua New Guinea	80				
South Asia					
Pakistan	82				

Source: UNESCO.

2   Theoretical framework

2.1   Demographic structure

The model economy population consists of two broad groups—parents and their children. Each group consists of sequences of distinct cohorts that are distinguished by their dates of birth and their cumulative schooling, distinguishing between 17 levels. The first level refers to individuals with no schooling (unskilled). Primary education levels range from 1 to 6 years of education attainment, for secondary skills range from 7 to 12 years and tertiary education ranges from 13 to 16 years. Each parent cohort is distinguished by their own level of schooling while each child cohort is distinguished by the parent's level of schooling in addition to his own cumulative schooling.[6] Individuals are children up to 22 years of age (the end of the schooling phase) when they consume as part of their parent's households. At age 23, they enter the formal work force and also become parents when they give birth to one child each. Between the following ages, the child is expected to be at the following schooling levels:

Age		
Child	Parent	Level of schooling
7-12	30-35	Primary education
13-18	36-41	Secondary education
19-22	42-45	Tertiary education

Individuals in the model work through age 50 and live until they reach 55 years. We assume stationary population growth with the number of births per period equalling the number of deaths.

2.2   Schooling attainment

Each household decides the fraction of time its child will spend in school each period, $s_{i,t}^{j} \in [0,1]$. For analytic tractability, we assume that once a child leaves school, he cannot return. To derive the aggregate educational attainment, that is the total number of years spent in school, we sum over the per-period optimal schooling time obtained from the household optimization decision. The total schooling attainment of a child of household j as of time t can then simply be written as

$$S_{i,t}^{j} = \sum_{k=0}^{t} s_{i,k}^{j} \ .$$

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[6]   Years of schooling attainment of adults in Ghana were obtained from Barro and Lee (1997). Enrollment rates for children at different levels of education were taken from Blunch and Verner (2000).

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2.3 Preferences and household budget constraints

Each j-type agent beginning its economic life at calendar date t chooses a perfect-foresight consumption path $c_{i,t}$ and child time in school $s_{i,t}^j \in [0,1]$ to maximize a time-separable utility function of the form

$$U_t^j = \sum_{i=23}^{55} \beta^{i-23} u(c_{i,t+i-23}^j) + \beta^{21} \mu(h_{45,t+21}^j) \tag{0.1}$$

where U is strictly concave and increasing and β is the subjective discount rate. At the end of the schooling phase, households leave a child human capital stock $h_{45,t+45}^j [t+21]$, the value of which is given by an increasing concave function μ.[7] Note that $s_{i,t}^j = 0$ for $i = 23, \dots 29$ and $i = 45, \dots 50$. We ignore leisure, both of the child and of the parent.

Define $a_{i,t}^j$ as the stock of physical capital held by an agent with schooling j, of age i, at time t. If children are not in the schooling phase, maximization of (0.1) is subject to a sequence of budget constraints given by[8]

$$a_{i+1,t+1}^j = (1 + r_t - \delta)a_{i,t}^j + w_t^j H_i^j - (1 - \tau_t^c)c_{i,t}^j + z_{i,t}^j \quad \text{for } s_{i,t}^j = 0 \tag{0.2}$$

If children are in the schooling phase, the relevant budget constraint is

$$a_{i+1,t+1}^j = (1 + r_t - \delta)a_{i,t}^j + w_t^j H_i^{jP} - (1 - \tau_t^c)c_{i,t}^j + [\overline{w}h_{i,t}^j(1 - s_{i,t}^j) - s_{i,t}^j(1 - \phi_{i,t})e_i] + z_{i,t}^j \quad \text{for } 0 < s_{i,t}^j \leq 1 \tag{0.3}$$

where r_t is the pre-tax returns to savings, δ is the rate of depreciation of physical capital, $z_{i,t}^j$ are direct transfers received from government, and τ_t^c is the tax rate on consumption. Household income has two components, parental income and child earnings. We assume that the labour income of a parent is the wage payment received, distributed according to the human capital efficiency levels of the parent (captured by his human capital stock, H_i^{jP}). Thus, $w_t^j H_i^{jP} + r_t a_{i,t}^j$ is total parental income at time t, where w_t^j is the rate of return for effective labour differentiated by skill level of the parent at time t.

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7   For simplicity the value of the child's final human capital enters into the parent's utility function at the parent's age 45 when the child completes tertiary education and enters the workforce. In cases where children drop out of school, this assumption tends to underestimate the value of the child's primary and secondary education in the parent's utility function.

8   Note that this is the budget constraint faced by households for $i = 23, \dots 29$ and $i = 45, \dots 50$. The relevant schooling decisions are made between the ages of 30 and 44, the time at which the child first starts school to the point when the child can quit school permanently.

The cost of attending school is foregone production or earnings and school fees, $s_{i,t}^{j}(1-\phi_{i,t})e_{i}$.[9] The price of child time is assumed to be equivalent to the unskilled wage in the labour market, $\overline{w}$, multiplied by child human capital.[10] Schooling costs are given by e_{i}, where e_{i} includes school fees, books and other related education materials such as school uniforms. Education costs are exogenously fixed for each level of schooling (primary, secondary and tertiary) and the government subsidizes schooling costs at the rate $\phi_{i,t}$.[11] We assume that

$$e_{t}^{primary} < e_{t}^{secondary} < e_{t}^{tertiary}$$

that is, costs of schooling are increasing across levels of education.

Schooling time $s_{i,t}^{j}$ augments the child's beginning of period stock of human capital $h_{i,t}^{j}$, where the superscript j denotes the schooling level of a child of a household of age i. Human capital of the child evolves according to

$$h_{i+1,t+1}^{j} = \gamma_{0}h_{i,t}^{\gamma_{1}}s_{i,t}^{\gamma_{2}} + (1-\delta_{h})h_{i,t}^{j} \qquad (0.4)$$

where δ_{h} is the rate of depreciation of human capital, $0 \leq \gamma_{1} \leq 1$, $0 < \gamma_{2} < 1$, and γ_{0} captures the innate ability of the child or school quality. This functional form is used widely both in the empirical literature and the literature on human capital accumulation.[12] However, this specification ignores the productivity of government education spending and its implications for human capital accumulation. In reality, the productivity of government education spending in many developing countries can have an important bearing for household demand for education.

The optimal consumption, schooling time and assets profile of individuals at different ages can be derived by reformulating the problem as a recursive structure via the value function

$$V_{i,t}^{j}(a_{i,t}^{j}, h_{i,t}^{j}) = \max_{a_{i+1,t+1}, a_{i,t}, s_{i,t}} U(c_{i,t}^{j}) + \beta V_{i+1,t+1}^{j}(a_{i+1,t+1}^{j}, h_{i+1,t+1}^{j}) \qquad (0.5)$$

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[9] While it may be more realistic to assume that the same school fees are paid for full-time and part time schooling, for analytical tractability, we assume that overall schooling costs are lower with part time schooling.

[10] Canagarajah and Coulombe (2001) note that, on average, children in Ghana earn one-sixth of what adults earn.

[11] Note that the level of subsidy provided can vary with the age of the parent and the commensurate level of education of the child. Since schooling costs net of the subsidy therefore vary across education levels, different cohorts face different environments.

[12] See Ben-Porath (1967) and Heckman (1999). New human capital can also be produced through formal or informal job training or as a product of experience (learning by doing). We abstract from these considerations by focusing on human capital accumulation through schooling.

subject to the constraints (0.3) and (0.4) when children are in the schooling phase and subject to (0.2) before children start schooling ($i = 23,...29$) and when children quit schooling permanently ($i = 45,...55$). The agent solves a lifecycle optimization problem given initial stocks of human and physical capital. At the end of the terminal period, we assume that the household's assets are zero.

The solution to the dynamic schooling problem is as follows. Working backward from T, the end of the schooling phase, the value of going to school for an additional year and the value of stopping schooling and entering the informal labour market can be characterized using backward recursions. The value function associated with the decision to remain in school, $V_{i,t}^S(a_{i,t}, h_{i,t})$ (dropping cohort-specific superscripts j) given that an individual was in school the previous period is given by

$$V_{i,t}^S(a_{i,t}, h_{i,t}) = \max_{a_{i,t}} U(c_{i,t}) + \beta V_{i+1,t+1}\big|_{s_t=1} \tag{0.6}$$

where $V_{i+1,t+1}^j\big|_{s_t=1}$ denotes the value of following the optimal policy next period (either to obtain schooling or enter the informal labour market). The relevant constraints for the household are:

$$a_{i+1,t+1} = (1+r_t-\delta)a_{i,t} + w_t H_i^P - (1-\tau_t^c)c_{i,t} - (1-\phi_{i,t})e_i + z_{i,t}$$
$$h_{i+1,t+1}^S = \gamma_0 h_{i,t}^{\gamma_1} + (1-\delta_h)h_{i,t} \tag{0.7}$$

Notice that by choosing $s_{i,t} = 1$, the household reduces its current disposable income (by $\overline{w}h_{i,t} + (1-\phi_{i,t})e$) but increases labour income of the child and future household consumption if the child leaves school in subsequent periods as well as child human capital at the end of the schooling phase.

The value of stopping schooling in period t, $V_{i,t}^{NS}(a_{i,t}, h_{i,t})$, is the value of entering the informal labour market this period and not accumulating any additional human capital in the future. That is,

$$V_{i,t}^{NS}(a_{i,t}, h_{i,t}) = \max_{a_{i,t}} U(c_{i,t}) + \beta V_{i+1,t+1}\big|_{s_t=0} \tag{0.8}$$

The household now faces the constraints:

$$a_{i+1,t+1} = (1+r_t-\delta)a_{i,t} + w_t H_i^P - (1-\tau_t^c)c_{i,t} + \overline{w}h_{i,t} + z_{i,t} \quad h_{i+1,t+1}^{NS} = (1-\delta_h)h_{i,t} \tag{0.9}$$

A household, therefore, chooses $s_{i,t} = 1$ when $V_{i,t}^S(a_{i,t}, h_{i,t}) > V_{i,t}^{NS}(a_{i,t}, h_{i,t})$ and zero otherwise.

Given that the schooling decision is independent of the asset accumulation decision, the Euler equation for assets still holds, such that

$$\frac{U'(c_{i+1,t+1})}{U'(c_{i,t})} = \beta(1 + r_{t+1} - \delta) \qquad (0.10)$$

2.3.1 Firms

Output in the model economy is produced by identical competitive firms using a neoclassical, constant returns to scale production technology. Letting λ^j be the fraction of j-type agents in each generation, aggregate capital K_t is obtained from household asset accumulation decisions as

$$K_t = \sum_{j=1}^{17} \lambda^j \sum_{i=23}^{55} a_{i,t}^j \qquad (0.11)$$

Labour types are differentiated by their years of schooling attained. For simplicity, we assume that the labour stock is composed of four education levels: unskilled, primary-educated, secondary-educated and higher-educated (or tertiary), where

$$
\begin{aligned}
L_t^U &= \sum_{j=1}^{} \lambda^j \sum_{i=23}^{50} H_{i,t}^{jP} + \sum_{j=1}^{17} \lambda^j \sum_{i=7}^{22} h_{i,t}^j \Bigg|_{s_{i,t}=0} \\
L_t^P &= \sum_{j=2}^{8} \lambda^j \sum_{i=23}^{50} H_{i,t}^{jP} \\
L_t^S &= \sum_{j=9}^{14} \lambda^j \sum_{i=23}^{50} H_{i,t}^{jP} \\
L_t^T &= \sum_{j=15}^{17} \lambda^j \sum_{i=23}^{50} H_{i,t}^{jP}
\end{aligned}
\qquad (0.12)
$$

Note that the unskilled labour demanded, L_t^U, is simply the summation of the individual human capital stocks of unskilled parents and children who have dropped out of school as of period t.[13]

The technology of the firm producing output y_t is

$$y_t = F(K_t, L_t^U, L_t^P, L_t^S, L_t^T) \qquad (0.13)$$

where $F(.)$ is a neoclassical production function exhibiting positive but diminishing marginal productivity in its arguments. Since households make the investment choices,

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[13] The present model implicitly assumes that the labour markets for the four types of labour are segmented. That is, the higher-educated workers cannot enter the market for primary-educated or non-educated workers and vice versa. In many developing countries, it is not unusual to find underemployment, whereby more educated workers decide to enter the market for less skilled activities. While this would result in a greater 'crowding out' of unskilled workers and, hence a larger differential between skilled and unskilled wages, the basic thrust of our results will continue to hold.

the firm's problem is static and it chooses capital and effective labour to maximize profits. Physical capital evolves over time according to

$$K_{t+1} = (1 - \delta_k)K_t + I_t \tag{0.14}$$

where δ_k is the depreciation rate.

2.3.2 Government

The role of government in the model is to collect taxes and spend revenues on transfers, government consumption and education. We assume that in some periods the government runs unbalanced budgets and borrows. Total government expenditure (excluding interest costs on government debt) in period t is given by

$$G_t = \sum_{j=1}^{17} \lambda^j \sum_{i=23}^{45} \phi_{i,t}^j e_{i,t} + \sum_{j=1}^{17} \lambda^j \sum_{i=23}^{55} z_{i,t}^j + \Gamma_t \tag{0.15}$$

where Γ_t is other government consumption.

The evolution of public debt b_t is given by the following

$$b_{t+1} = (1 + r_t)b_t + \sum_{j=1}^{17} \lambda^j \sum_{i=23}^{55} \tau_t^c c_{i,t}^j - G_t \tag{0.16}$$

We assume that all public debt is foreign owned and the government does not borrow from the domestic market since capital markets are typically not well developed in HIPC countries. The government is subject to the following intertemporal budget constraint, which imposes the condition that at the terminal date, the discounted value of government debt is zero.

$$b(0) + \int_0^\infty G e^{-rt} dt = \int_0^\infty T e^{-rt} dt \tag{0.17}$$

where $T = \sum_{j=1}^{17} \lambda^j \sum_{i=23}^{55} \tau_t^c c_{i,t}^j$

2.3.3 Equilibrium

A competitive equilibrium is a set of processes for individual allocations, $\{a_{i,t}^j, c_{i,t}^j, s_{i,t}^j\}$, aggregate inputs, $\{K_t, L_t^U, L_t^P, L_t^S, L_t^T\}$, prices for the factors of production, $\{w_t^j, r_t\}$ such that:

(i) $\{a_{i,t}^j, c_{i,t}^j, s_{i,t}^j\}$ solves the representative household's problem,

(ii) $\{K_t, L_t^U, L_t^P, L_t^S, L_t^T\}$ solves the firm's problem,

(iii) $H_t = \sum_{j=1}^{17} \lambda^i \sum_{i=7}^{22} h_{i,t}^j + \sum_{j=1}^{17} \lambda^i \sum_{i=23}^{50} H_{i,t}^{jP}$

(iv) $K_t = \sum_{j=1}^{17} \lambda^j \sum_{i=23}^{55} a_{i,t}^j$

(v) $a_{i+1,t+1}^j = (1 + r_t - \delta)a_{i,t}^j + w_{i,t}^j H_i^{jP} - (1 - \tau_t^c)c_{i,t}^j - (1 - \phi_{i,t})e_{i,t} + z_{i,t}^j$ for $s = 1$

(vi) $a_{i+1,t+1}^j = (1 + r_t - \delta)a_{i,t}^j + w_t H_i^{jP} - (1 - \tau_t^c)c_{i,t}^j + \overline{w}h_{i,t}^j + z_{i,t}^j$ for $s = 0$

(vii) $b_{t+1} = (1 + r_t)b_t + \sum_{j=1}^{17} \lambda^j \sum_{i=23}^{55} \tau_t^c c_{i,t}^j - G_t$

2.3.4 Poverty

We extend the above model to consider poverty issues by adopting the Foster, Greer and Thorbecke poverty (1984) measures. We assume that $m = (m_1, m_2, \ldots \ldots m_n)$ is a vector of agents' incomes in increasing order, and assume that the poverty line given by $\Phi > 0$ is predetermined. If $g_i = \Phi - m_i$ is the income shortfall of the ith household, q is number of households having income less than the poverty line, and the total number of households is N, the poverty measure used is given by

$$P_\alpha = \frac{1}{N} \sum_{i=1}^{q} \left[\frac{g_i}{\Phi} \right]^\alpha$$
(0.18)

where P_0 is the headcount ratio while P_1 is the renormalization of the income-gap measure. The value of α is a measure of poverty aversion and a higher value gives greater emphasis to the poor.

3   Calibration and parameters

The experiments reported in the next section share a common set of parameters and an initial steady state equilibrium in Table 3. We choose all the parameters for both the consumers and producers so that our model economy mimics as closely as possible the main Ghana economic statistics.

(i)   Factor shares and production efficiency parameter: Both the factor share α and the efficiency parameters α_0 are derived from a cross section study by Senhadji (2000). These parameters are derived using a human capital index which is derived by weighting education levels attained using relative earnings of different groups.

(ii)   Real rate of return: A value of 10 per cent is assumed. In an overlapping generations setting, economic theory does not impose any restriction on the size

of the discount factor.[14] The value of the households' discount factor that implements the targeted rate of return is $\beta = 0.95$.[15]

(iii)   Human capital depreciation rate is assumed to be 0.025. Driffill and Rosen (1983) use a value of 0.01; while Lord (1989) employs values of 0.08 and 0.12; some empirical studies report values as high as 0.10 for certain categories of labour.

(iv)   For the parameter γ_1 and γ_2 which are in the investment function of human capital, values of 0.67 and 0.33 are used. Previous estimates of the parameter γ_1 in the literature lie in the range of 0.5-0.8. See Heckman (1999).

(v)   Human capital efficiency profiles: The earnings ability profiles H_i^j are estimated using the following functional form:

$$H_i^{jP} = f(age, education, family, region) \qquad (0.19)$$

Values for the parameters are based on regressions fitted to the Ghanaian Living Standard Measure Survey (1999). Using these estimates, we simulate earnings ability profiles for agents that vary by age, education background, and family characteristics.[16]

Table 3
Parameters

α_0	Production efficiency parameter	1.01
α	Capital factor share	0.31
α_U	Unskilled labour factor share	0.20
α_P	Primary labour factor share	0.25
α_S	Secondary skilled labour factor share	0.15
α_T	Tertiary skilled labour factor share	0.09
δ_K	Physical capital depreciation	0.05
β	Discount factor	0.95
σ	Elasticity of substitution	0.25
δ_h	Human capital depreciation	0.03
γ_0	Human capital investment parameter	0.67
γ_1	Parameter on human capital accumulation	0.15

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[14] See Deaton (1991) for a discussion of restrictions on the subjective discount factor in economies with infinitely lived agents.

[15] Recent empirical evidence on the value of β suggests that a subjective discount factor greater than unity is plausible (Hurd 1989).

[16] Results of the estimation are available upon request.

3.1 The benchmark equilibrium

The benchmark steady state is calibrated to the 1999 Ghanaian National accounts, distribution and poverty data. Government expenditure on education is set at 4 per cent of national output, while education expenditures as share of total government expenditure are set at 11.4 per cent. The shares of education expenditures across education categories are set at 41 per cent for primary education, 38 per cent for secondary education, and 21 per cent for tertiary education. The out of pocket primary education expenditures by the parents are assumed to be 15 per cent of total household expenditures, 60 per cent for secondary education, and 90 per cent for tertiary education.

Given our parameter choices, the model generates consumption and investment output ratios, wage rates and poverty indices described in Table 4. The wage rate for labour with tertiary education is normalized to one and wages for other education categories are obtained relative to the tertiary wage.

Figure 1 in the appendix shows the optimal lifecycle profiles of the selected variables for the benchmark case for different generations by lifetime-income groups. Given fixed costs for different levels of schooling, asset accumulation decisions of households vary with the parents' level of schooling attainment (and, therefore, their corresponding income profiles). The desire to smooth lifecycle consumption entails a de-accumulation of assets at the beginning of each level of schooling for those households with sufficiently low initial incomes. As can be seen from Figure 1A, the rate of asset accumulation declines for most households during the schooling phase of the child. This decline is particularly marked for households in the lowest income class. At the end of the schooling phase, asset profiles for all agents decline as all agents de-accumulate their assets.

Given the higher opportunity costs of schooling, parents with lower skill levels demand less schooling for their child than more educated parents. In the steady state, given the choice of parameter values, all households choose at least primary education for the child. However, households in higher income classes choose some secondary as well as tertiary education.

Table 4
Baseline

Capital	5.6430
Output	1.5970
Consumption	1.1230
Aggregate human capital	1.3240
Return on capital	0.0460
Unskilled wage rate	0.3650
Primary wage rate	0.7610
Secondary wage rate	0.9690
Tertiary wage rate	1.0000
Poverty (headcount ratio)	0.5350
Poverty (P_1)	0.2431
Poverty (P_2)	0.0832

4 Policy experiments

The policy experiments described in this section examine how the government should allocate its debt relief savings so as to achieve both growth and poverty objectives. In all simulations, additional fiscal resources available from debt relief are used to increase education expenditures on primary, secondary and tertiary education. Table 5 provides a comparison of the various steady state macroeconomic aggregates and poverty levels relative to the benchmark case.

4.1 Increase in government subsidy for primary, secondary and tertiary education

The first policy experiment examines the intertemporal effects on growth and poverty when debt relief savings are used to further subsidize primary, secondary or tertiary education.[17] In contrast to the baseline steady state, Table 5 indicates that output is higher if resources are devoted to primary and secondary education due to higher aggregate physical and human capital accumulation.

The increase in primary education spending results in the most significant increase in the physical and human capital stock and, hence, output. Two reasons account for this. First, a reduction in the costs for primary education affects households' marginal schooling decisions by lowering their opportunity costs of schooling. As a result, lower income households that previously had optimally chosen very little schooling for their child now increase their investment in child human capital. Given the sequencing of schooling decisions, this enables households to choose higher levels of secondary and tertiary schooling in subsequent periods, leading to a higher accumulation of human capital in the steady state.

Second, higher primary education spending serves to smoothen household lifetime asset accumulation profiles. Figures 3 A-D illustrate the effects of such a policy on household asset accumulation decisions. Note that for all households, a reduction in primary schooling costs results in higher asset accumulation over their lifetime. Lower schooling costs during the beginning of the schooling phase (the early working years) enables low income (unskilled) households to forego child earnings and increase investment in child human capital while accumulating more assets in subsequent periods for future consumption.[18] For skilled households (with higher lifecycle earnings), a reduction in primary schooling costs also allows for a larger accumulation of assets earlier in life. Therefore, increasing primary education spending shifts the household lifecycle asset accumulation curve upwards for all skill types. This increase is more significant for primary education spending than for secondary and tertiary spending as in the latter cases, parents are already in their prime working years (between ages 36 to 45) when these policies comes into effect. The higher asset accumulation profiles translate into a larger aggregate capital stock and to higher levels of output.

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17 Since education costs are fixed, we assume that when government increases its contribution to education parents pay less in form of education expenses.

18 In contrast with the baseline, unskilled parents do not have to deaccumulate assets (borrow) earlier in life to finance schooling for their child.

With a higher capital stock, the return to labour of all skill-types increases. The price of unskilled labour exhibits a significant increase relative to the baseline, by over 2.2 per cent, as more parents choose to keep their children in school, thereby reducing the pool of unskilled labour in the economy. The large increase in the primary wage rate, of 2.5 per cent, results from older cohorts (with higher age-earning profiles) demanding higher levels of secondary schooling for their children. Figures 4 A-D illustrate the demand for schooling by households of different ages. As a result, the supply of primary educated labour in the economy declines, which increases the price of such labour. The skilled-unskilled wage differential is reduced relative to the baseline as the supply of skilled human capital in the economy increases while the number of unskilled and primary-educated workers falls.

As discussed above, the growth effects of an increase in secondary education spending are reduced as households benefit from such a policy only in the middle of their working life. Moreover, as shown in Figure 3A, unskilled households increase investment in child human capital at the expense of asset accumulation, leading to lower lifetime asset accumulation profiles relative to the baseline. Therefore, aggregate physical and human capital stock are lower than in the previous case. Given the sequencing of schooling decisions, an increase in government subsidy on tertiary education only benefits those households which demanded secondary education in the baseline (the high income, skilled groups). This policy stance has no impact on the marginal schooling decisions of low income households as their optimal schooling choices typically involve much lower levels of schooling. As a result, an increase in the government subsidy for tertiary education leads to lower physical and human capital accumulation, and, hence, output relative to increases in primary or secondary education spending.

Table 5 also reports the impact on poverty of alternative education policies. The decline in the head count ratio is most marked when primary education spending is increased relative to secondary or tertiary spending. Two reasons account for this: first is the higher household disposable at the beginning of the schooling phase. Second, there is an increase in lifetime asset accumulation profiles of low income households in response to the policy change. As discussed above, the increase in aggregate human and physical capital accumulation is most significant for an increase in primary education spending, resulting in the sharpest reduction in the head count ratio. The severity of poverty is also shown to decline as indicated by the lower poverty indices, P_1 and P_2.

The transition effects of the policy changes on macroeconomic aggregates are illustrated in Figures 5 A-D. Notice that the growth effects of higher primary and secondary education spending are more important in the short run. However, in the long run, an increase in tertiary education results in the largest aggregate capital stock, and, hence, output, due to the higher productivity of such labour. This result suggests that the policy currently advocated in developing countries of increasing primary and secondary education spending at the expense of tertiary education may be detrimental to the long term growth prospects of these countries. It suggests that countries should not ignore tertiary education given its importance for long run growth.

4.2 Targeting transfers

Two types of targeting of public resources are typically advocated in the literature. The first, broad targeting, involves an allocation of debt relief savings on social services which are directly beneficial both to the rich and the poor, with no attempt made to identify individuals who are most needy. The simulations in the previous section fit this description. The second approach, known as narrow targeting, requires identifying groups according to their income levels or geographical location. In the latter case, the government supplements household income with directed transfers or subsidies.[19]

The policy experiments reported in this section examine the implications of narrow targeting of government expenditures on household demand for schooling, growth and poverty reduction (columns 4 and 5 in Table 5). Households below the poverty line are assumed to be targeted through two types of transfers: a low type, equivalent to the costs of primary education, and a high type, equivalent to the costs of secondary education.[20] As expected, the actual impact of the transfers on the lifecycle behaviour of households depends upon the relative size of the transfer. The 'low' transfer lowers the opportunity cost of schooling and results in a higher demand for primary schooling by low income (unskilled) households as households forego child earnings to increase investment in child human capital. In addition, this policy results in a higher lifecycle asset profile (Figure 6A). However, household's lifetime asset accumulation profile is not smoothened as parents are forced to substitute physical assets for investment in human capital at higher levels of schooling.

Table 5
Steady state results

Simulation	1	2	3	4	5
Capital	5.8553	3.0701	1.2567	1.8238	4.0823
Output	2.3267	1.2286	0.4910	0.7273	1.6317
Consumption	1.2435	0.8765	0.3541	0.5643	1.4220
Aggregate human capital	1.8954	1.2341	0.8932	0.5438	1.1011
Return on capital	-3.3912	-1.8149	-0.7319	-1.1010	-2.3985
Unskilled wage rate	2.1324	1.2286	0.4910	0.7273	1.6317
Primary wage rate	2.5408	0.0012	0.0018	0.7942	1.7818
Secondary wage rate	1.5634	1.5026	0.0009	0.8895	1.9956
Tertiary wage rate	1.0932	1.0452	1.4354	0.9073	2.0355
Poverty (headcount ratio)	0.4321	0.5185	0.5272	0.4537	0.4235
Poverty (P_1)	0.2212	0.2654	0.2699	0.2323	0.2168
Poverty (P_2)	0.0612	0.0734	0.0747	0.0643	0.0600

Simulation   1 ==> Increasing primary education spending.

2 ==> Increasing secondary education spending.

3 ==> Increasing tertiary education spending.

4 ==> Lower direct transfer to households.

5 ==> Higher direct transfer to households.

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[19] While, in principle, the latter approach is a more appealing and effective way of achieving equity objectives, these schemes are usually associated with high administrative costs to identify those who qualify. Narrow targeting can also distort the incentive structure facing agents as they may change their behaviours in order to qualify for these programmes.

[20] These transfers can take the form of school lunches for the poor or directed subsidies for education in the form of free textbooks or school fees.

A higher transfer allows households to increase investment in child human capital and demand more primary as well as secondary schooling, leading to an increase in the aggregate human capital stock. Aggregate physical capital is also higher in this case as households of all types increase asset accumulation over their lifecycle. The impact on poverty in the steady state also depends on the size of the transfer. If the transfer results in a substitution of human capital accumulation for asset accumulation, poverty levels may not be significantly improved relative to the baseline. With a sufficiently large transfer, however, poverty levels are significantly lower than in the baseline. As in the steady state, the transition paths of physical capital stock and output are higher the larger the transfer (Figures 7A-D).

4.3 Sensitivity analysis

In this section, we briefly summarize the sensitivity of the results of the preceding sections to the parameters employed. In particular, we experiment with different values of the elasticity of substitution, the subjective discount rate, and the elasticity of human capital accumulation with respect to an increase in human capital. As shown in Table 6, it turns out that the conclusions from the previous sections are robust to alternative parameter specifications.

Table 6
Sensitivity

	Low sigma σ-0.001	High sigma σ+0.001	Low beta β-0.001	High beta β+0.001	Low gamma $\gamma 1$-0.001	High gamma $\gamma 1$+0.001
Capital	-0.1131	0.1269	-0.1068	0.1370	-0.1194	0.1382
Output	-0.0442	0.0496	-0.0417	0.0535	-0.0466	0.0540
Consumption	-0.0319	0.0358	-0.0301	0.0386	-0.0336	0.0390
Aggregate human capital	-0.0804	0.0902	-0.0759	0.0974	-0.0849	0.0983
Return on capital	0.0659	-0.0739	0.0622	-0.0798	0.0695	-0.0805
Unskilled wage rate	-0.0442	0.0496	-0.0417	0.0535	-0.0466	0.0540
Primary wage rate	-0.0388	0.0436	-0.0367	0.0470	-0.0410	0.0474
Secondary wage rate	-0.0468	0.0525	-0.0442	0.0567	-0.0494	0.0572
Tertiary wage rate	-0.1292	0.1450	-0.1220	0.1565	-0.1364	0.1579

5 Conclusion

This paper adopts a lifecycle perspective to examine the implications of increased narrow and broad targeting of education expenditures financed by debt relief savings. In an environment in which altruistic parents make schooling decisions for their children and there are fixed costs to different levels of schooling, we find that the macroeconomic and poverty reduction benefits of increasing the subsidy for primary and secondary education in countries with less than universal basic education can be substantial. However, public spending on tertiary education has important implications for long run growth. We also find that targeting of transfers to households below the poverty line can have non-trivial growth effects. The precise quantitative impact on growth and poverty alleviation, however, depends upon the magnitude of the transfer.

This result suggests that appropriate targeting of transfers for education can serve as an important policy tool for achieving the twin objectives of growth and equity.

References

Auerbach, A., and L. Kotlikoff (1987). *Dynamic Fiscal Policy.* Cambridge: Cambridge University Press.

Barro, R. (1991). 'Economic Growth in a Cross Section of Countries'. *Quarterly Journal of Economics*, 105 (2): 407-43.

Barro, R., and J. Lee (1997). 'International Data on Educational Attainment: Updates and Implications'. NBER Working Paper Series No. 7911. Cambridge, MA: National Bureau of Economic Research.

Behrman, J., and N. Birdsall (1983). 'The Quality of Schooling: Quantity Alone Is Misleading'. *American Economic Review*, 73: 928-46.

Ben-Porath, Y. (1967). 'The Production of Human Capital and the Life Cycle of Earnings'. *Journal of Political Economy*, 84: 449-72.

Blunch, D., and N. Verner (2000). 'Revisiting the Link Between Poverty and Child Labor: The Ghanaian Experience'. World Bank Working Paper No. 2488. Washington, DC: World Bank.

Canagarajah, S., and H. Coulombe (1997). 'Child Labor and Schooling in Ghana'. World Bank Policy Research Working Paper No. 1844. Washington, DC: World Bank.

Canagarajah, S., and H. Coulombe (2001). 'Public Health and Education Spending in Ghana in 1992-98: Issues of Equity and Efficiency'. World Bank Working Paper No. 2579. Washington, DC: World Bank.

Card, D., and A. Krueger (1992). 'Does School Quality Matter? Returns to Education and the Characteristics of Public Schools in the United States'. *Journal of Political Economy*, 100: 1-40.

Collings, S., and B. Bosworth (1996). 'Economic Growth in East Asia: Accumulation versus Assimilation'. *Brookings Papers on Economic Activity*, 2: 135-203.

Deaton, A. (1991). *Understanding Consumption.* Oxford: Clarendon Press.

Driffill, E., and H. S. Rosen (1983). 'Taxation and Excess Burden: A Life-Cycle Perspective'. *International Economic Review*, 24: 671-83.

Duflo, E. (2002). 'The Medium Run Effects of Educational Expansion: Evidence from a Large School Construction Program in Indonesia'. NBER Working Paper Series, No. 8710. Cambridge, MA: National Bureau of Economic Research.

Foster J., J. Greer, and E. Thorbecke (1984). 'A Class of Decomposable Poverty Measures'. *Econometrica*, 52 (3): 761-6.

Glomm, G. (1997). 'Parental Choice of Human Capital Investment'. *Journal of Development Economics*, 53: 99-114.

Glomm, G., and B. Ravikumar (1998). 'Flat-rate Taxes, Government Spending on Education, and Growth'. *Review of Economic Dynamics*, 1: 306-25.

Hanushek, E. (1996). 'Schooling, Labor Force Quality and Economic Growth'. NBER Working Paper Series No.5399. Cambridge, MA: National Bureau of Economic Research.

Heckman, J. (1999). 'Accounting for Heterogeneity, Diversity and General Equilibrium in Evaluating Social Programs'. NBER Working Paper Series No. 6230. Cambridge, MA: National Bureau of Economic Research.

Hurd, R. (1989). 'Issues and Results from Research on the Elderly'. NBER Working Paper Series No. 3018 (1-3). Cambridge, MA: National Bureau of Economic Research.

International Monetary Fund (1999). 'HIPC Initiative—Progress Report', by the Staffs of the IMF and World Bank. September.

Judson, R. (1998). 'Economic Growth and Investment in Education: How Allocation Matters'. *Journal of Economic Growth*, 3: 337-59.

Lord, W. (1989). 'Transitional from Payroll to Consumption Receipts with Endogenous Human Capital'. *Journal of Public Economics (Netherlands),* 38: 53-73.

Mackinnon, J., and R. Reinikka (2000). 'Lessons from Uganda on Strategies to Fight Poverty'. World Bank Working No. 2440. Washington, DC: World Bank.

Psacharopoulos, G., S. Morly, A. Fiszbein, L. Haeduck, and B. Wood (1992). *Poverty and Income Distribution in Latin America: The Story of the 1980s.* Washington, DC: World Bank.

Senhadji, A. (2000). *IMF Staff Papers*, 47 (1): 129-57. Washington, DC: IMF.

Van de Walle, D. (1995). 'Public Spending and the Poor: What We Know, What We Need to Know'. World Bank Working Paper No. 1476. Washington, DC: World Bank.
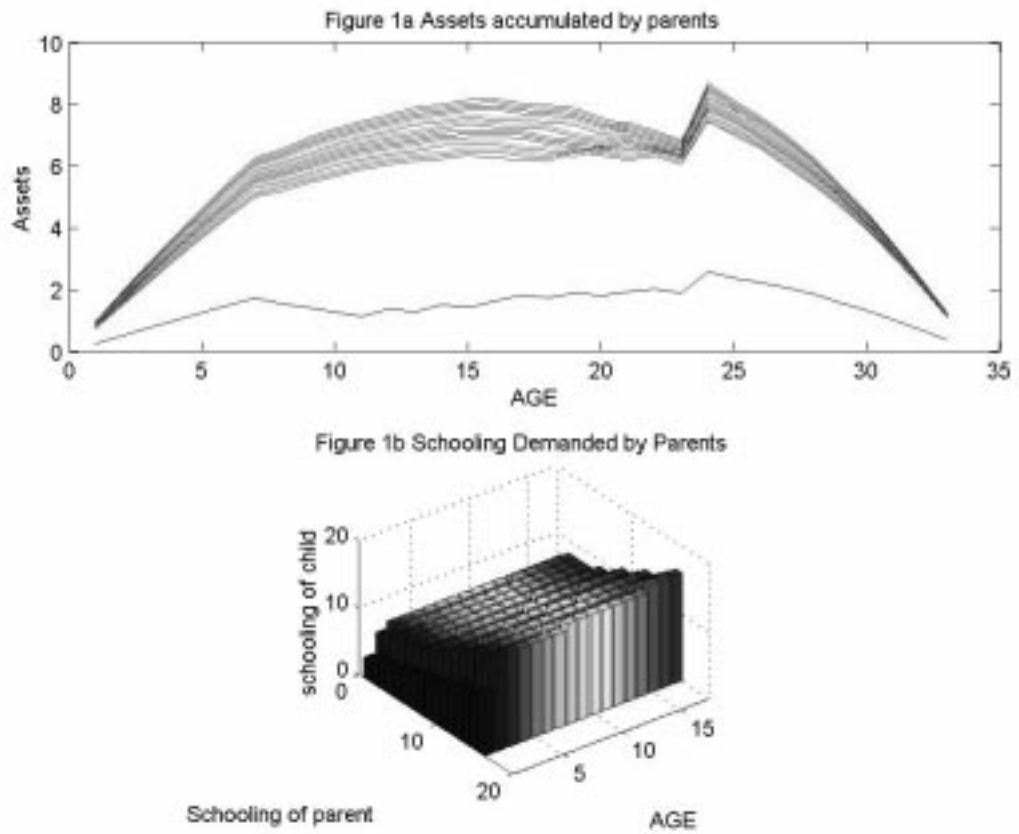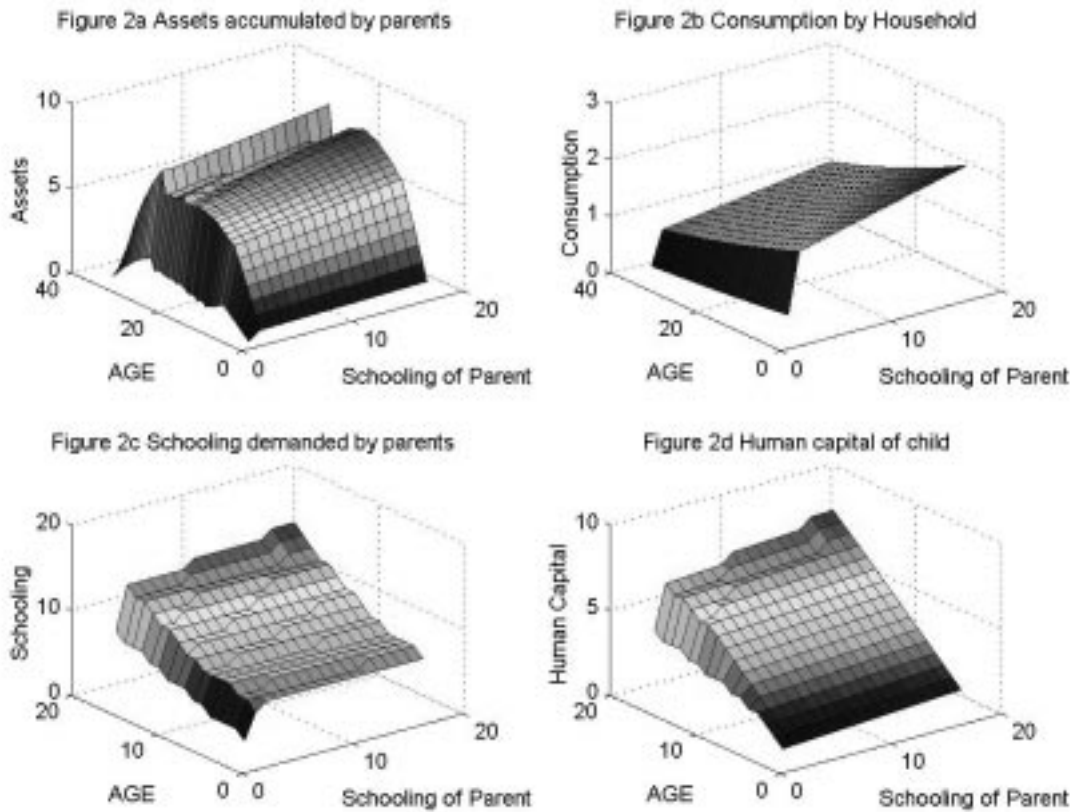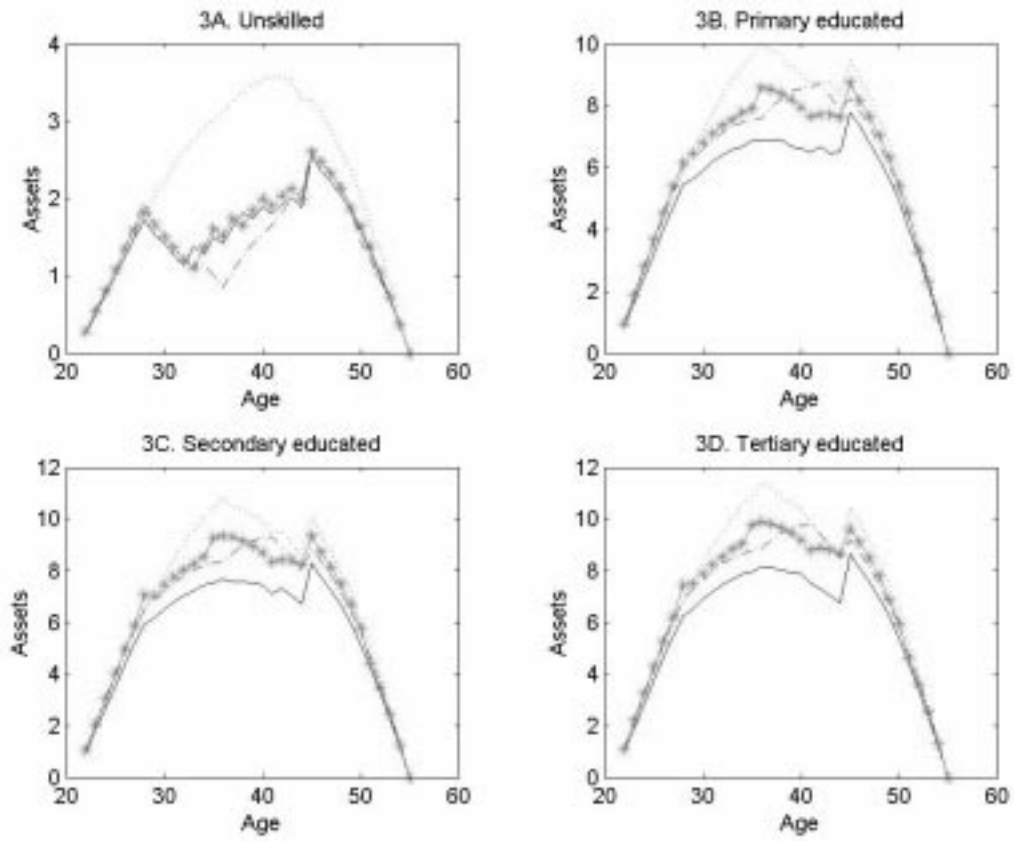
Figure 1

Figure 1a Assets accumulated by parents

Figure 1b Schooling Demanded by Parents

Figure 2
Baseline scenario

Figure 2a Assets accumulated by parents

Figure 2b Consumption by Household

Figure 2c Schooling demanded by parents

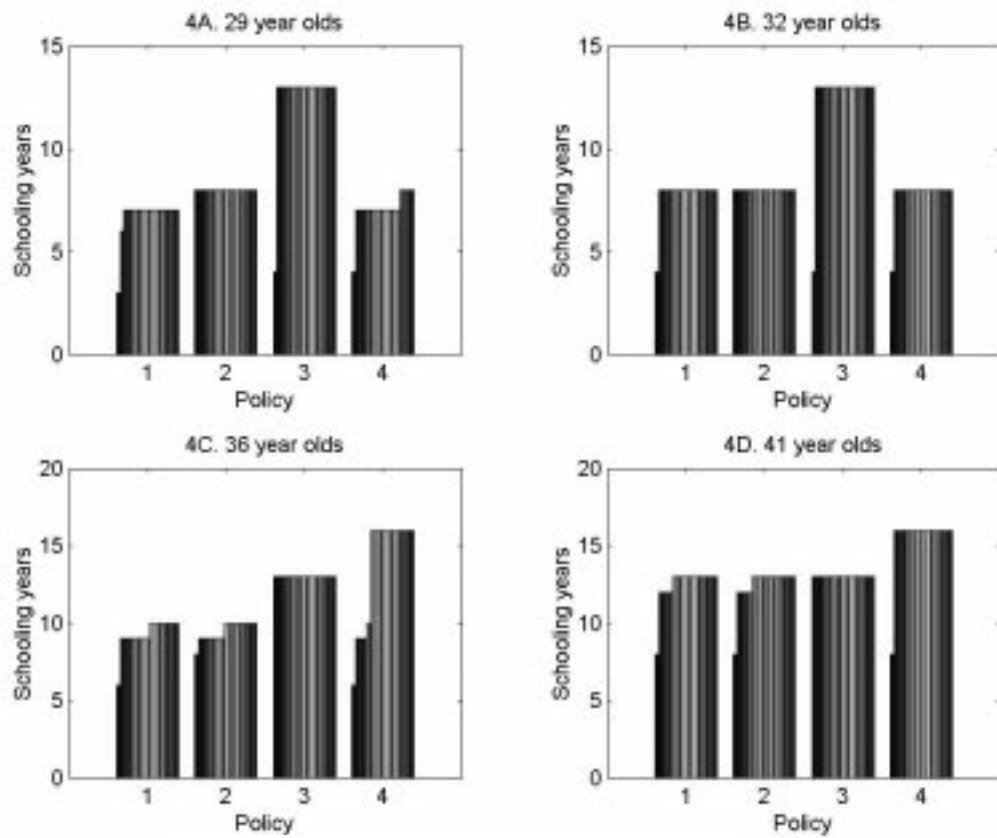Figure 2d Human capital of child

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Figures 3 A-D
Impact of increasing education spending on asset accumulation by skill types in the steady state
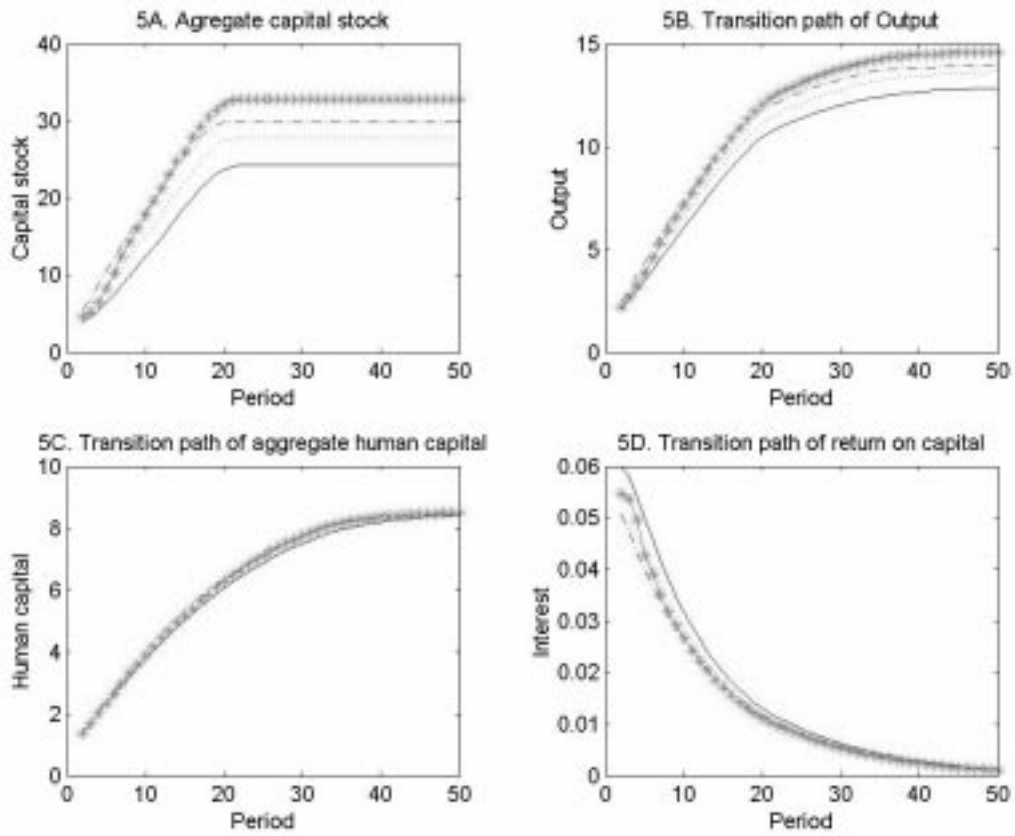

Legend:
—————— Baseline
………….. Increase in primary spending
— - — - Increase in secondary spending
- * - * - * Increase in tertiary spending.

Figures 4 A-D
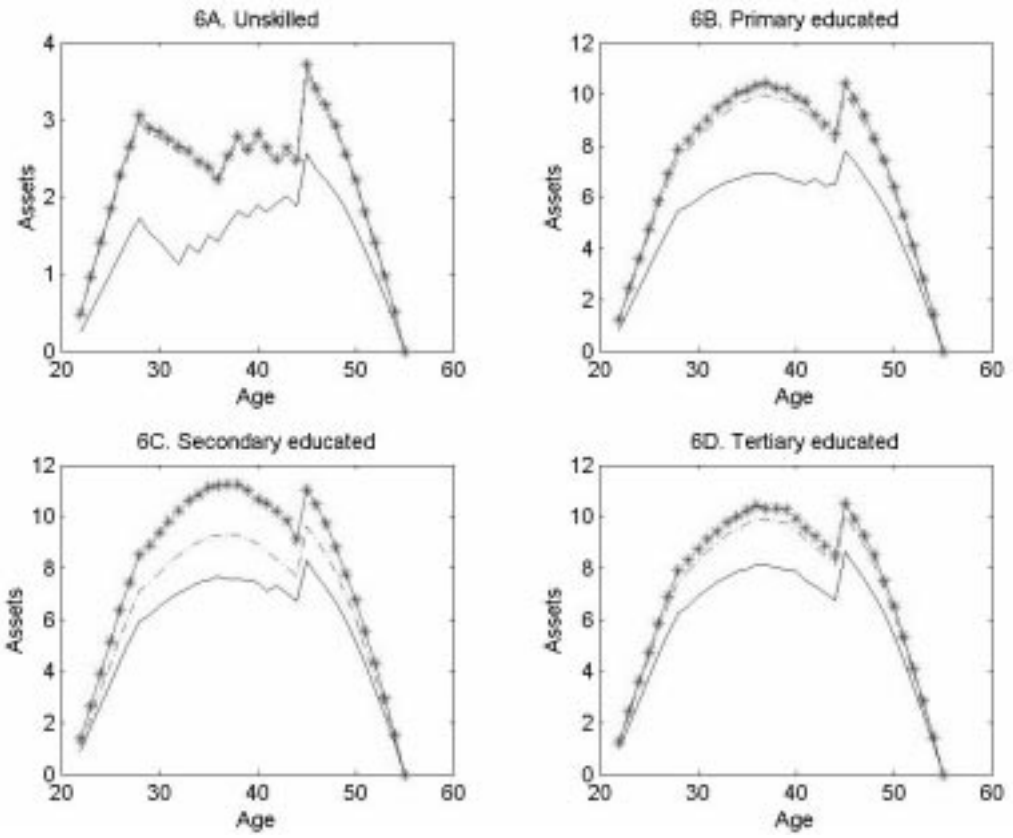Demand for schooling by age and skills of households in the steady state

Legend:
1   Baseline
2   Increase in primary spending
3   Increase in secondary spending
4   Increase in tertiary spending.
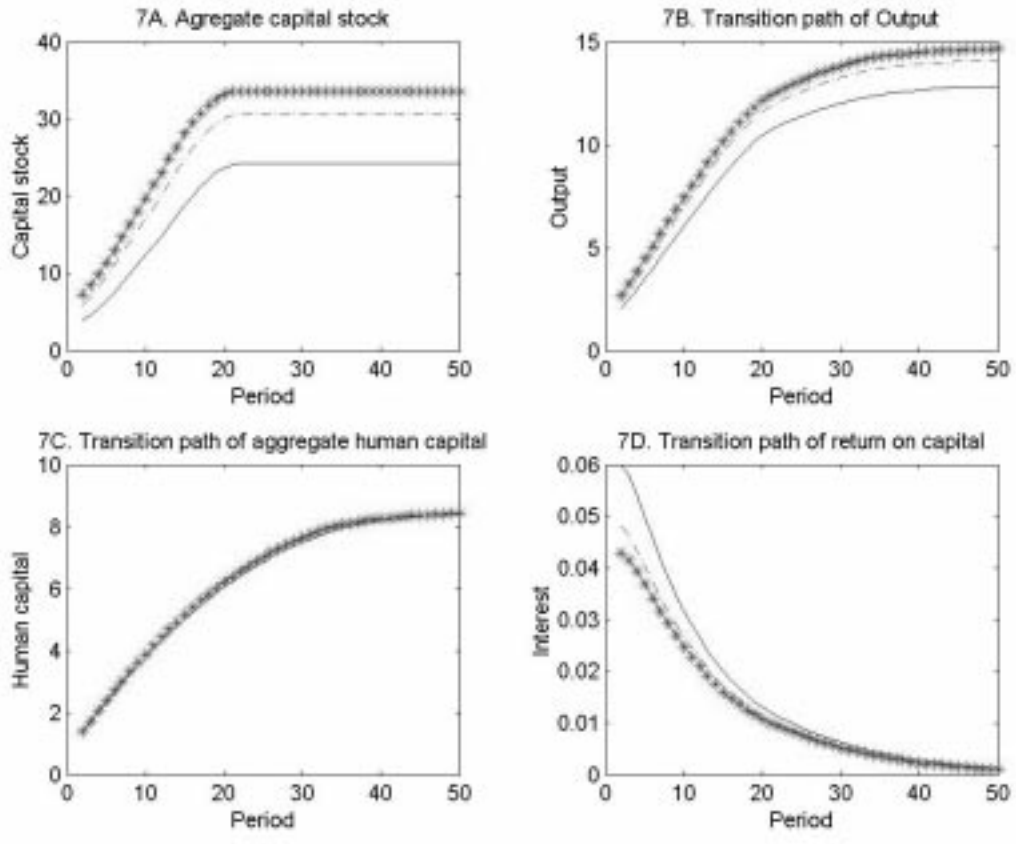
21

Figures 5 A-D
Transition effects

Legend:
——————   Baseline
....   Increase in primary spending
— · — ·   Increase in secondary spending
- * - * - *   Increase in tertiary spending.

Figures 6 A-D
Impact of transfers on asset accumulation by skill type in the steady state

Legend:
——————   Baseline
— - — -   Low transfer
- * - * - *   High transfer.

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Figures 7A-D
Transition effects of transfers

7A. Agregate capital stock

7B. Transition path of Output

7C. Transition path of aggregate human capital

7D. Transition path of return on capital

Legend:
——————— Baseline
— - — - Low transfer
- * - * - * High transfer.

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