Financing human capital development via government debt: a small country case using overlapping generations framework

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Abstract:
Using an over-lapping generations (OLG) model, we show how small open economies can enhance their growth through educational subsidies financed via government debt. In our model, we endogenize human capital and fertility without the strong assumptions of altruism or positive spill over effects from human capital accumulation. We show that subsidizing education through government debt leads to a Pareto improvement of all generations. Even if a country is a net borrower in the international capital market, we show that this subsidy-policy can help, under certain conditions, to improve its net borrowing position. Especially, our analysis can be applied to less developed countries, which are locked in a low development trap. A further desirable outcome of our analysis is that fertility rates decline for the small and less developed countries.

Keywords: Keywords: OLG; fertility; human capital; education subsidy; government debt.

JEL: E60, H63, O41

1 Introduction

After the Korean War in 1953, South Korea was one of the poorest countries in the world. However, over the succeeding five decades, the country has made immense progress and now stands as an impressing example of a fast growing economy. South Korea in retrospect has experienced an increase in per capita income from US$1,571 (constant) in 1960 to US$15,881 (USD) in 2000. Over these periods, the average years of schooling also increased from 4.3 years to 11.1 years on the back of a decline of total fertility rate from 5.2 children per female to 1.2 children per female (Hanushek and Woessmann, 2010; and World Bank, 2013) and a comfortable ratio of education expenditure of 7.6% of the GDP (OECD, 2011) necessary for triggering growth in human capital accumulation. On the other hand, Mexico which was twice as rich as Korea in 1960 with a per capita income of US$3,970 (constant) experienced an increase of per capita income to US$8766 (constant) in 2000. The years of schooling over these periods increased from 2.8 years in 1960 to 7.6 years in 2000 while the fertility rate declined from 6.8 children per female (in 1960) to 2.5 children (in 2000) and the relative expenditure on education was 5.8% of GDP (OECD, 2011), which was significantly lower than South Korea.[1] Against these backdrops, we argue that high education expenditure and low fertility rates have influenced the per capita growth rates of these two economies. More specifically, we assert that high education and low fertility rate has supported the momentous growth of South Korea and that the converse held for Mexico.[2]

In regards to developing counties, most if not all of them are characterized by low productivity, high population growth, and low human capital that constraint their growth potential. In this paper, we highlight the importance of education and human capital accumulation for such an economy. Inevitably, education expenditure is a significant portion of budget for both households and the economy, particularly for countries where population growth is high. The cost is both in terms of raising children and providing quality education at all levels. Subsequently, there is a trade-off between

[1] It should be noted that the private willingness to pay for education is relatively high in Korea.
[2] Although the argument is a necessary condition, it may not be sufficient in aggregate. We accept that other intuitional and structural factors have influenced the growth path of these two countries.

quantity and quality of human capital in an economy. Our premise is based on the notion that that human capital accumulation is the engine of growth.[3]

Nevertheless, our argument is different from Lucas (1988), who assumed increasing returns to scale caused by positive externalities and also from Barro (1974) and Zhang (2003, 2006) who impressed the importance of intergenerational altruism. In our analysis, we argue that even when we relax the assumptions of strong altruism and the existence of externalities, human capital accumulation can be shown to play a vital role in enhancing economic growth. More specifically, we show that a government subsidy for education is welfare and growth enhancing in a small open economy under certain conditions. The rest of the paper is outlined as follows. In section 2, we provide a brief literature review.[4] In section 3, the method, model and arguments are presented. Section 4 concludes with some policy implications.

2 Literature Review

The literature on endogenizing fertility and human capital in growth model goes back to Becker et al. (1990) and Becker and Barro (1988). Using an intertemporal utility function, they assume that that a higher fertility rate of the present generation raises the discount factor on per capita future consumption. Consequently, a higher fertility rate discourages investments in human and physical capital. On the other hand, higher stocks of physical and human capital (education) reduce the number of children because of the high cost of raising and caring for children.

One strand of the literature is based on the work of Kolmar (1997), which includes only endogenous fertility behaviour in a standard OLG framework. His idea was further extended by Fenge and Meier (2005, 2009) and Groezen et al. (2003). However, these scholars did not concentrate on government debts but on pay-as-you-go pension systems, which are in economic sense, a form of government debt.[5] They show that for a small country under certain conditions, it is possible to increase the fertility rate and the welfare simultaneously. They assumed that pension is dependent on the

[3] In retrospect, the Asian success story since the last 50 years was in large part due the substantial drive to promote education and human development.

[4] We do not insist that our literature review is exhaustive or unmitigated, because of space restrictions.

[5] A pay-as-you-go pension system is a form of a government debt caused by government bond issuance because both are characterized by a government's promise to pay a pension respectively, that is, to pay back the debt plus interest.

number of children and that the growth in population attracts higher capital inflows so that all individuals are better off. These results hold only for small open economies. On the contrary, Stauvermann et al. (2013) argues that, except for increase in fertility rates, these results do not hold in an OLG-model with endogenous growth because reduced savings tend to reduce the per-capita growth rates and hence the welfare of future generation. Furthermore, the authors show that increase in fertility is accompanied by high costs for the future generations, which further decrease the rate of capital accumulation, per capita growth and capital, and hence the labour income.

Another strand of literature goes back to Bental (1989), Raut (1992), Cigno (1993), and Zhang and Nishimura (1993), Zhang and Zhang (1995) and Zhang (1995). These authors interpret children as an insurance good for old age. In their models, the introduction of a pay-as-you-go pension scheme decreases the importance of children and therefore the number of them declines. As a consequence, the per capita income growth rises and the fertility reducing effect of a pension system offsets the saving reducing effect, which is usually the outcome of the introduction of a pay-as-you-go pension system.

Moreover, Zhang (1997, 2003, 2006) and Li and Zhang (2008) provides another dimension on fertility and human capital accumulation. Their main assumptions are that individuals are altruistic with respect to their offspring and that the human capital accumulation is associated with positive externalities (similar to Lucas, 1988). Subsequently, (and not surprisingly), a government debt is able to internalize the externality, which leads to a welfare gain.

In contrast to these approaches, our approach relaxes the assumption of altruism and externalities derived from human capital accumulation. We argue that the generation who gain from human capital investment should pay partly for it, instead of the entire burden of responsibility being put on the current generation. Moreover, we assume that parents (the current generation) can derive part of their utility from the number of children and their investment in human capital (education) of their children. Therefore, under these conditions, we show that it is possible to increase growth of the economy by decreasing the number of children. Our results are in contrast to Fanti and Gori (2008a, 2008b). In summary, their study show that a general subsidy for children raises the fertility rate in the long run and lowers it in the short run provided the preference for the quality of children exceeds the preference for the number of children. In our model, this is not the case. We argue that by subsidizing education of children and not the number of them will have a welfare enhancing effect and a negative effect on fertility, independently of the preferences for the quality or quantity for children.

3 The model

To model the production side in a small open economy, we convene with production function of Lucas (1988) and Uzawa (1965). The production depends on physical and human capital and has the following form:

$$Y_t = F(K_t, H_t) = F(K_t, L_t h_t) \quad (1)$$

Here Y_t is the production, K_t is the capital stock, and $H_t = h_t L_t$, is the human capital stock which results from the product of the average human capital per head (h_t) times the number of workers (L_t). The production function exhibits the usual diminishing marginal productivities in each input factor, fulfils the Inada conditions and is linear homogenous.[6] The subscript t indicates period. Furthermore, we assume that the creation of human capital depends on the age of an individual (degree of 'youngness'), the investments in education of the current generation, and the average human capital of the current generation. Our human capital function is similar to Lucas (1988) and de la Croix and Roepke (2003). The efforts are represented by u_t, which is measured in time. The total available time is normalized to one. Then the human capital of a worker in period *t* is given by:

$$h_t = \bar{h}_{t-1}^{\varepsilon} h_{t-1}^{\eta} (\Lambda + \varphi u_t - m). \quad (2)$$

The parameter $\varphi > 0$ measures the effectiveness of learning and the parameter $1 \geq m \geq 0$ represents the depreciation rate of human capital. We assume a positive depreciation rate, because it is not unknown in human history that human knowledge vanishes rarely because of different reasons. Here the parameter Λ satisfies $\Lambda > m$. This assumption guarantees that the human capital stock will not totally degrade, if the effort u_t is zero. As in de la Croix and Roepke (2003) we assume $\eta \epsilon [0,1]$ and $\varepsilon \ \epsilon [0, 1-\eta]$. The variable $\bar{h}_t$ represents the average human capital stock per capita, which creates spillovers. To simplify the analysis, we assume that $\eta + \varepsilon = 1$ and $\Lambda = 1$. Then we get for the resulting growth factor of human capital:

[6] In capital per capita human capital unit, the production function is transformed to $f(\tilde{k}_t) = F\left(\frac{K_t}{H_t}, 1\right)$. Hence the the Inada conditions: $f(0) = 0$; $f(\infty) = \infty$; $f'(\infty) = 0$; and $f'(0) = \infty$ holds.

$$1 + g_t^h = (1 + \varphi u_t - m)\left(\frac{\bar{h}_{t-1}}{h_{t-1}}\right)^{\varepsilon} \tag{3}$$

Assuming that all individuals are identical, the resulting growth rate of human capital per capita results in $g_t^h = \varphi u_t - m$. Therefore the human capital per capita can decrease, remain constant or increase.

Because of the assumption of a small open economy, the wage rate per human capital unit $\tilde{w}_t$, and the interest factor R_t is determined on the world capital market. The capital stock used in this economy adjusts according to the factor prices. Assuming that the physical capital is totally depreciated within one period, we get the following equations:

$$\tilde{w}_t = f(\tilde{k}_t) - f'(\tilde{k}_t)\tilde{k}_t \tag{4}$$

$$R_t = f'(\tilde{k}_t) \tag{5}$$

The function $f(\tilde{k}_t) = F\left(\frac{K_t}{H_t}, 1\right)$ represents the production function per human capital unit. Then the resulting wage rate per capita is given by $w_t = \tilde{w}_t h_t$.

We use a three period overlapping generation (OLG) model similar to Allais (1947), Samuelson (1958) and Diamond (1965). According to their model, in the first period of life, an individual is relatively young, not yet prepared to work, and/or participate in economic decision making, and hence undergoes education funded by her parents. In the second period of life, the individual supplies labour which is considered to be offered inelastically; gives birth to N_t children, rears and educates her offspring and consumes c_t^1 and saves s_t amounts respectively. In the third period of life the individual is unable to work and lives from her savings and interest income, that is, $c_{t+1}^2 = R_t s_t$. Subsequently, the utility function of the individual over the three periods is defined as the following log-linear equation. This form of the utility function is a variation of those used by Fanti and Gori (2008a, 2008b), and de la Croix and Roepke (2003). Subsequently:

$$U(c_t^1, c_{t+1}^2, N_t, u_t N_t) = \ln c_t^1 + q \ln c_{t+1}^2 + \mu \ln N_t + \beta \ln(u_t N_t). \tag{6}$$

The parameter q reflects the subjective discount factor. The last two terms in equation (6) expresses the relationship between the quality and quantity of children (Becker, 1960; 1991; Becker and Lewis, 1973; Becker and Tomes, 1976). Both summands can be rewritten as $ln\left(N_t^{\beta+\mu}u_t^{\beta}\right)$.[7] We assume that both preference parameters μ and β lie in the range of zero and one. The last summand, $\beta\ln(u_tN_t)$, reflects the desire of the parent to educate her child which depends on her efforts per child u_t times the number of children N_t. Alternatively, the term u_tN_t can be also interpreted as expenditures for education, which have to be paid in the form of tuition fees and the parents have to work u_t time units to finance the fees of one child. This amount is multiplied by the number of children to derive the expenditure on education. This last part represents a form of altruism towards raising the offspring. However, this form of altruism is different from the approach used by Barro (1974) which was based on the future utility of the children. In our case, a parent is only interested to guarantee her children a specific amount of education and therefore is constrained by the following budget defined as:

$$c_t^1 \leq w_t(1-(1-\tau)u_tN_t - bN_t) - s_t - T_t \tag{7}$$

$$c_{t+1}^2 \leq R_{t+1}s_t \tag{8}$$

Combining (7) and (8) gives us a single budget constraint:

$$w_t(1-(1-\tau)u_tN_t - bN_t) - T_t - c_t^1 - \frac{c_{t+1}^2}{R_{t+1}} = 0 \tag{9}$$

We assume that the government can decrease the costs of education by giving a subsidy τ for education, where the government finances this subsidy by issuing government bonds B_t with a term of one period. The parameter b represents the constant consumption expenditures per child. Additionally the government collects a tax of T_t per capita to finance its debt and interest payments. This means that the government debt per worker at the beginning of the current period D_t equals the subsidies per child of the previous period times the interest factor, R_t. This means implicitly, that a worker pays back the subsidies to market conditions she received as she was young. That is:

$$D_t = R_tB_{t-1} = R_t\tau u_{t-1}w_{t-1}N_{t-1}. \tag{10}$$

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[7] The quality-quantity trade-off means that given a budget, parents can either invest in the number of children or in the quality of children (education). Of course, parents would like to do both, to increase the number of children and the quality, however, there will always be a trade-off. Liu, Zhang, and Yi (2008), Rosenzweig and Wolpin (1980) and Rosenzweig and Zhang (2009) confirm the existence of the quality-quantity tradeoff of children econometrically.

It should be noted that parents are unable to get an analogous loan contract on the capital market, because of the moral hazard problem. To guarantee a balanced government budget, the lump sum tax of an individual working in period t has to be:

$$T_t = R_t B_{t-1} = R_t \tau u_{t-1} w_{t-1} = R_t \tau d \widetilde{w}_{t-1} h_{t-1} u_{t-1}. \tag{11}$$

The government is financing the educational subsidies by a government debt, which will be covered by the tax revenue in the future. We maximize (6) subject to (9) by constructing the following Lagrange function:

$$L(c_t^1, c_{t+1}^2, \lambda) = \ln c_t^1 + q \ln c_{t+1}^2 + \mu \ln N_t + \beta \ln(u_t N_t)$$
$$-\lambda \left(w_t (1 - d(1-\tau) u_t N_t - b N_t) - T_t - c_t^1 - \frac{c_{t+1}^2}{R_{t+1}} \right). \tag{12}$$

Accordingly, the first order conditions are:

$$\frac{1}{c_t^1} + \lambda = 0, \tag{13}$$

$$\frac{q}{c_{t+1}^2} + \frac{\lambda}{R_{t+1}} = 0, \tag{14}$$

$$\frac{\mu+\beta}{N_t} + \lambda w_t [(1-\tau) u_t + b] = 0, \tag{15}$$

$$\frac{\beta}{u_t} + \lambda w_t (1-\tau) N_t = 0, \tag{16}$$

$$w_t (1 - (1-\tau) u_t N_t - b N_t) - T_t - c_t^1 - \frac{c_{t+1}^2}{R_{t+1}} = 0. \tag{17}$$

Substituting (15) into (16) and solving for the investment in education gives us:

$$u^* = \frac{\beta b}{(1-\tau)\mu}. \tag{18}$$

By assuming tax rate to be zero, equation (18) gives us the relationship between the preference to spend time (money) for educating children and the preference to spend time (money) for the number of children β/μ times the inverse relationship between the associated marginal costs of these activities $b/1$. Because of the subsidy τ the marginal costs of educating a child decreases and hence the investments in the education of children increases. However, to guarantee an interior solution, we assume that $(1-\tau)\mu > \beta b$. In the corner solution the parent would have only one child.[8] Subsequently**,** the growth rate of human capital is given by:

[8] For convenience, we restrict the analysis to interior solutions.

$$g^{h*} = \frac{\varphi\beta b}{(1-\tau)\mu} - m. \tag{19}$$

In summary, the growth rate of human capital stock depends positively on the pure child raising costs b, the preference parameter for the quality of children β, the subsidy rate for education τ, and negatively on the depreciation rate m and the preference parameter for the number of children μ. It should be noted that the depreciation rate can also be a variable determined by culture or politics.[9] Because of the fact that the per capita growth is driven by the human capital accumulation, different types of equilibria are possible:

Equilibria: The economy grows if $\frac{\varphi\beta b}{(1-\tau)\mu} > m$. If equality holds, steady-state or no-growth equilibrium is realized and if the relation is reverted the economy shrinks. However, the growth rate of human capital can be positive, constant or negative, even if education is taking place. Solving for the remaining variables, we get the following quantities:

$$c_t^{1*} = \frac{h_{t-1}(1+g^{h*})\widetilde{w}_t - T_t}{1+q+\mu+\beta}, \tag{20}$$

$$c_{t+1}^{2*} = R_{t+1}q\left(\frac{h_{t-1}(1+g^{h*})\widetilde{w}_t - T_t}{1+q+\mu+\beta}\right), \tag{21}$$

$$N_t^* = \frac{\mu\left(h_{t-1}(1+g^{h*})\widetilde{w}_t - T_t\right)}{h_{t-1}(1+g^{h*})\widetilde{w}_t(1+q+\mu+\beta)}. \tag{22}$$

Because of our small country assumption, the capital intensity per human capital unit is determined on the international capital market. We define the equilibrium wage rate per unit of human capital as $\widetilde{w}$ and the worldwide interest rate as R. If we now substitute (11) into (20) to (22) and using (18) and (19), we get the following equilibrium quantities:

$$c_t^{1*} = \frac{\widetilde{w}h_t\left(\mu(1-\tau)(1-m)+\beta b(\varphi-R\tau)\right)}{\mu(1+q+\mu+\beta)(1-\tau)}, \tag{23}$$

$$c_{t+1}^{2*} = \frac{qR\widetilde{w}h_t\left(\mu(1-\tau)(1-m)+\beta b(\varphi-R\tau)\right)}{\mu(1+q+\mu+\beta)(1-\tau)}, \tag{24}$$

$$N_t^* = \frac{\mu\left(\mu(1-\tau)(1-m)+\beta b(\varphi-R\tau)\right)}{b(1+q+\mu+\beta)(\mu(1-\tau)(1-m)+\varphi\beta b)}, \tag{25}$$

and the net savings per capita, which is the private savings less the government bonds per capita to finance the subsidy gives us:

[9] For example Pol Pot and his Khmer Rouge government has increased the depreciation rate in Cambodia dramatically by killing mostly all Cambodian intellectuals, even that the Khmer Rouge were only 3 years in power, or the Taliban government also increased the depreciation rate of the human capital by prohibiting female work and schooling of girls. Or alternatively, HIV is reducing the human capital in African countries.

$$s_t^{N*} = s_t(\widetilde{w}h_t, \tau, R) - B_t = \frac{\widetilde{w}h_t[(1-\tau)(1-m)\mu+\beta b(\varphi-R\tau)][q\varphi\beta b+\mu(q(1-\tau)(1-m)-\beta\tau)]}{(1+q+\mu+\beta)\mu(1-\tau)[(1-\tau)(1-m)\mu+\varphi\beta b]} \lesseqgtr 0 \quad (26)$$

It should be noted, that the net savings per capita is negative, if the individual savings per capita is lower than the value of the issued bonds per capita. In such a case, part of the bonds is purchased by foreigners. However, if the country is a net borrower on the international capital market depends on the current aggregate net savings and the equilibrium capital stock of the following period. Now we can analyze the effect of an increasing subsidy rate τ on the equilibrium values of this economy. By differentiating (17) with respect to τ, yields the effect on the human capital accumulation:

$$\frac{\partial g_t^{h*}}{\partial \tau} = \frac{\beta b}{(1-\tau)^2\mu} > 0 \quad (27)$$

Not surprisingly, the subsidy will increase the investments in human capital. This means the subsidy can turn a shrinking or stagnant economy into a growing one. Subsequently, subsidy can be considered as a policy measure for an economy to come out of a low equilibrium trap. The effect of the fertility equals to:

$$\frac{\partial N_t^*}{\partial \tau} = -\frac{\mu R\beta(\mu(1-m)+\varphi\beta b)}{b(1+q+\mu+\beta)(\mu d(1-\tau)+\beta b)^2} < 0. \quad (28)$$

Obviously, the fertility rate will decrease, if the subsidy increases to reduce the cost of education. This effect is caused by the fact that the pure child raising costs increases relative to the costs of education.

Proposition 1: *Undoubtedly, a human capital subsidy financed via a government debt, will decrease the fertility rate.*

Next, we derive the effect of an increasing subsidy and the coinciding tax on the current and future consumption:

$$\frac{\partial c_t^{1*}}{\partial \tau} = \frac{\widetilde{w}h_{t-1}\beta b(\varphi-R)}{\mu(1+q+\mu+\beta)(1-\tau)^2} > 0, \text{ if } \varphi > R \quad (29)$$

$$\frac{\partial c_{t+1}^{2*}}{\partial \tau} = \frac{qR\widetilde{w}h_{t-1}\beta b(\varphi-R)}{\mu(1+q+\mu+\beta)(1-\tau)^2} > 0, \text{ if } \varphi > R \quad (30)$$

Both, the current and future consumption increases, if the productivity parameter of human capital building φ exceeds the interest factor *R*. Intuitively, the result is obvious, because if the rate of return of a time unit invested in human capital exceeds the international capital market interest rate of an implicitly invested time unit, the consumption possibilities increase. If the opposite holds, the consumption declines in both periods. Subsequently, we derive the effect on the net savings, where $\tau = 0$:

$$\left.\frac{\partial s_t^N}{\partial \tau}\right|_{\tau=0} = \frac{\widetilde{w} h_t \beta[bq(\varphi - R) - \mu]}{\mu(1+q+\mu+\beta)} \lesseqgtr 0. \qquad (31)$$

The effect of the subsidy with respect to net savings is ambiguous; it strongly depends on the difference of the marginal productivity of human capital building φ and the interest factor. If $R > \varphi$, the net savings declines unambiguously. However, if $bq\varphi > bqR + \mu$ holds, the net savings rises if a subsidy is introduced. This implies that in order to guarantee that the net savings increases, the difference between the marginal productivity of time with respect to human capital building and the marginal productivity of physical capital must be sufficiently large. This difference will be larger the stronger the preference for the number of children μ, the lower the costs to raise a child *b,* and the lower the discount factor q.

For a country to be a net lender or net borrower in the international capital market will depend on how huge the national savings per human capital unit are with respect to the worldwide equilibrium capital stock per human capital unit. Let us assume that the domestic country is a net borrower in the world capital market. Then we know from (27) that the increase of the subsidy can improve or worsen the net borrowing position.

Proposition 2: *If* $bq(\varphi - R) > \mu$, ($bq(\varphi - R) < \mu$) *the introduction of a debt-financed subsidy for education will enhance (retard) the savings per capita and improve (worsen) the net borrowing position of the country.*

Next, we analyze the welfare effects of an increase in the subsidy rate. If the subsidy is increased in *t-1* period, the older generation will be indifferent and the younger generation will be better off because the latter will receive subsidy without any obligation. The relevant generation is therefore the young generation in period *t*, because they have to pay the government debt. The utility function of generation *t* is therefore given by:

$$U(c_t^{1*}, c_{t+1}^{2*}, N_t^*, u^* N_t^*, \tau) = \ln c_t^{1*} + q \ln c_{t+1}^{2*} + \mu \ln N_t^* + \beta \ln(u^* N_t^*). \qquad (32)$$

If we introduce a subsidy for human capital building, the effect on the utility of this generation can be ascertained by differentiating (32) with respect to τ at the point where $\tau = 0$. Calculating this, we get:

$$\left.\frac{\partial U}{\partial \tau}\right|_{\tau=0} = \frac{\beta\left[[(1+q+\beta)\varphi - R(1+q+\beta+\mu)]b + (1-m)\mu\right]}{(\beta+\mu)d}.[10] \qquad (33)$$

[10] Even that it is beyond of the scope of the paper we should note the following. If the derivative is positive at $\tau = 0$, then there exists either an optimal subsidy rate between zero and one, or the utility function is continuously increasing in the subsidy rate until the educational time strives to its maximum.

Proposition 3: *An introduction of a human capital subsidy will always increase the utility of the representative individual of generation t, if* $(1 + q + \beta)\varphi \geq R(1 + q + \beta + \mu)$.

The condition of proposition 3, in general, is fulfilled if the interest rate is not implausibly high. The intuition behind this result is that the subsidy reduces the marginal costs of education relative to child rearing costs. This effect increases the investments in education and lowers the number of children. If the market interest rate is not too high in relation to the rate of return of human capital, a higher tax burden of the working generation is overcompensated by an increase in wage caused by a higher human capital. It should be noted that a welfare increase under certain conditions is also possible if the interest rate exceeds the productivity of human capital accumulation. Therefore, it can conclude that a Pareto improvement will always be realized if the condition of proposition 3 holds.

Further, if the interest factor is in the usual range,[11] then generation t is better-off after the introduction of a subsidy. The following generation will also realize a welfare gain because their income will be higher given a higher growth rate of human capital accumulation and wages income as a result of education support via government subsidy. Therefore, an introduction of a subsidy for education will lead to a welfare increase of all generations as long as the parameter values β, μ, b and φ are sufficiently accommodative.

4 Conclusion and policy discussion

In this paper, we showed that building human capital through government debt will provide a beneficial outcome both on the current and future generations, even in the absence of positive externality and altruism in the sense of Barro (1974). Specifically, we have shown that the proposed finance mechanism reduces the fertility rate and enhance the human capital accumulation, and hence the per capita growth rate of income. Additionally, under certain conditions, it was shown that the net borrowing

[11] The usual range for the real interest rate is 3-6 percent over a 10-15 years period. According to the OECD (2011) the (private) rate of return of human capital in OECD countries lies between 9.1-18.5% in 2007 for tertiary education and between 7.5-21.4% for secondary education.

position of the economy improves and the welfare in the sense of Pareto outcome increases.

If we take into account the recent publication of Barro and Lee (2010) on human capital, then it is obvious that there are still huge differences with respect to human capital building in developed and developing countries. For example, in 2010, the years of schooling of people older than 15 years in developed countries were 11.0 years and in developing countries, it was 7.1 years. Moreover, in regards to the completion of tertiary education, the percentages of population figures stood at 14.5 for developed countries and only 5.1 percent for developing countries. On the other hand, 17.4 percent of the population did not attend school in 2010 in developing countries. This number stood at 2.3 percent for developed countries. Considering the estimated rate of return of one more year of schooling from Barro and Lee (2010), it is obvious that a minimum of 6 percent is by far the real interest rate in the international capital market.

Even though subsidizing education via government debt may not have any short-run welfare-enhancing effect, it is likely to have a momentous long-term effect on the premise that with human capital accumulation via education for all, over time, the growth rate of the economy also increases. In a world where altruistic motivations dominates parents preferences for their children's education as future investment, the argument of subsidizing education becomes even more strong and the net savings tend to increase under certain conditions (as indicated above). Nevertheless, we have shown that when education is financed via subsidy, the outcome is unambiguously welfare enhancing. Therefore, from development aid perspective, it would make sense to give concessional loans to small and developing countries to finance education and human capital development in areas of resource deficit identified both in the developing and the developed economies.

5 References

Allais, M. 1947. *Economie et Intérêt. Imprimerie Nationale*, Paris.

Barro, R.J., 1974. Are government bonds net wealth? Journal of Political Economy 82 (6), 1095–1117.

Barro, R.J., Lee, J-W., 2010. A new Data Set of Educational Attainment in the World: 1950–2010. NBER Working paper, 15902.

Becker, G.S., Barro, R.J., 1988. A Reformulation of the Economic Theory of Fertility. Quarterly Journal of Economics 103 (1), 1–25.

Becker, G.S., 1960. An economic analysis of fertility, In: *Demographic and Economic Change in Developed Countries*, A conference of the universities and the National Bureau Committee for Economic Research, pp. 209-231, Columbia University Press, New York.

Becker, G.S., Lewis, G.H., 1973. On the interaction between the quantity and the quality of children. Journal of Political Economy 81 (2), S279-S288.

Becker, G.S., Tomes, N., 1976. Child endowments and the quantity and quality of children. Journal of Political Economy 84 (4), S143-S162.

Becker, G.S., 1991. *A Treatise on the Family.* Cambridge: Harvard University Press

Becker, G.S., Murphy, K.M., Tamura, R., 1990. Human capital, fertility, and economic growth. Journal of Political Economy 98 (5), S12–S37

Bental, B., 1989. The Old Age Security Hypothesis and Optimal Population Growth. Journal of Population Economics 1 (4), 285–301.

Cigno, A., 1993. Intergenerational Transfers without Altruism. European Journal of Political Economy 9 (4), 505–518

de la Croix, D., Doepke, M., 2003. Inequality and Growth: Why Differential Fertility Matters. American Economic Review 93 (4), 1091-1113.

Diamond, P., 1965. National Debt in a Neoclassical Growth Model. American Economic Review 55 (5), 1126-1150

Fanti, L., Gori, L., 2008a. Child quality choice and fertility disincentives. Economics Bulletin 10 (7), 1-6

Fanti, L., Gori, L., 2008b. Human capital, income, fertility and child policy. Economics Bulletin. 9 (6), 1-7.

Fenge, R., Meier, V., 2005. *Pensions and Fertility Incentives*. Canadian

Fenge, R., Meier, V., 2009. Are Family Allowances and Fertility-Related Pensions Perfect Substitutes? International Tax and Public Finance 16 (2), 137-163.

Groezen, B., Leers, T., Meijdam, L., 2003. Social security and endogenous fertility: pensions and child allowances as siamese twins. Journal of Public Economics 87 (2), 233-251.

Hanushek, E.A., Woessmann, L. 2010. How Much Do Educational Outcomes Matter in OECD Countries? Economic Policy 26 (67), 427-491.

Kolmar, M., 1997. Intergenerational redistribution in a small open economy with endogenous fertility. Journal of Population Economics 10 (3), 335–356.

Li, B., Zhang, J., 2008. Optimal government debt in a dynastic model with endogenous fertility, human capital externalities, and a labor-leisure choice. Far East and South Asian Meeting of the Econometric Society 2008, Singapore.

Liu, H., Zhang, J., Yi, Z., 2008. The Quantity-Quality Tradeoff of Children in a Developing Country: Identification Using Chinese Twins, Demography 45 (1), 223–243.

Lucas, R.E., 1988. On the Mechanics of Economic Development. Journal of Monetary Economics 22 (1), 3-42.

OECD, 2011. Education at a Glance 2011: OECD Indicators, OECD Publishing.

http://dx.doi.org/10.1787/eag-2011-en

Raut, L.K., 1992. Effect of Social Security on Fertility and Savings: An Overlapping Generations Model, Indian Economic Review 27 (1), 25-43

Rosenzweig, M. R., Wolpin, K. I., 1980. Testing the Quantity-Quality Model of Fertility: The Use of Twins as a Natural Experiment. Econometrica. 48, 227–240.

Rosenzweig, M. R., Zhang, J., 2009. Do Population Control Policies Induce More Human Capital Investment? Twins, Birthweight, and China's 'One Child' Policy. Review of Economic Studies 76 (3), 1149–1174.

Samuelson, P.A., 1958. An Exact Consumption-Loan Model or Interest with and without the Social Contrivance of Money, Journal of Political Economy 66 (6), 467-482

Stauvermann, P.J., Ky, S., Nam, G-Y., 2013. The Cost of Increasing the Fertility Rate in an Endogeneous Growth Model. MPRA Paper No. 46381. Munich Personal RePEc Archive, Germany

Uzawa, H., 1965. Optimum Technical Change in an Aggregative Model of Economic Growth. International Economic Review 6 (1), 18-31.

World Bank, 2013, Fertility rate, total (births per woman), http://data.worldbank.org/indicator/SP.DYN.TFRT.IN

Zhang, J., 1997. Government debt, human capital, and endogenous growth. Southern Economic Journal 64 (1), 281–292.

Zhang, J., 2003. Optimal debt, endogenous fertility, and human capital externalities in a model with altruistic bequests. Journal of Public Economics 87 (7-8), 1825-1835.

Zhang, J., 2006. Second-Best Public Debt with Human Capital Externalities. Journal of Dynamics and Control 30 (2), 347-360.

Zhang, J., 1995. Social Security and Endogenous Growth. Journal of Public Economics

58 (2), 185–213.

Zhang, J., 1995. Does Unfunded Social Security also Depress Output Growth? Economics Letters 49 (3), 307–312.

Zhang J., Nishimura K., 1993. The Old-Age Security Hypothesis Revisited. Journal of Development Economics 41 (1), 191–202.

Zhang J., Zhang J. 1995. The Effects of Social Security on Population and Output Growth, Southern Economic Journal 62, 440–450