Parental Health, Education Investment and Human Capital Accumulation

Chen LU
Tan Kah Kee College, Xiamen University, Zhangzhou, 363105, China
luchen@xujc.com

Keywords: Parental Health, Human Capital, Overlapping Generations Modeled

Abstract. We extend the simple overlapping generations model with human capital formation to incorporate parental health condition determined by the health investment made by children. We model this health investment from children to parents as an upstream transfer motivated by exchanging for a higher level of human capital. We first show that the government should provide subsidies for individuals’ education and health investments. Second, the subsidy rates should be higher if the effectiveness of education investment or intergenerational transmission on human capital accumulation is higher.

Introduction

An important contribution of intergenerational transfer has been to draw the attention of economists to child-to-parent transfer, or upstream transfer. By using data from the Health and Retirement Study, Sloan et al. (2002) analyzed upstream intergenerational transfers from middle-aged children to their elderly parents. Their empirical results indicated that upstream transfers, particularly financial transfers, were motivated by altruism. Lee and Robert (1997) used data on time and money transfers between generations in Malaysia, where there is neither Social Security nor Medicare. They found evidence supporting the hypothesis that children are an important source of old age security and that old age security is, in part, children’s repayment for parental investments in their education.

Even though previous empirical studies have clarified the existence of upstream intergenerational transfer based on altruistic or exchange motives, to our knowledge, there has been no theoretical work on the effect of upstream transfer on economic growth and government policy. In this paper, we regard health investments made by children for parents as upstream intergenerational transfers. This transfer is made because young individuals foresee that their level of human capital in old age depends on the health condition of their parents. We analyze the optimal education and health policy when parental health condition plays a role in human capital accumulation.

This paper differs from previous studies in two respects. First, previous studies have paid little attention to health and its role in education. In our paper, we incorporate parental health condition determined by children’s purposeful health investment into their education, and analyze both intergenerational and intra-generational resource allocation for children’s higher levels of human capital. Second, rather than comparing the difference in the growth of human capital between public and private education systems, as in previous studies, our paper concentrates on the external effect of health investment and government policy with respect to education and health investment. Therefore, our paper can be seen as a complement rather than a substitute to previous research.

The rest of the paper is organized as follows. Section 2 presents the model. The social optimum and the optimal policy are analyzed in Section 3. Section 4 concludes.
The Model

We develop a simple overlapping-generations model in which time is discrete and indexed by $t = 1, 2, \ldots, \infty$. There is an initial generation of old individuals ($t = 1$), each of whom is endowed with an exogenously given level of human capital ($h_0$). The succeeding individuals live for two periods, young and old, and they work in both periods of life.

Preferences

The individuals born at time $t$ are called the generation $t$. After the individuals are born, they inherit their parents’ level of human capital ($h_t$) at no cost. With the inherited level of human capital, they work by inelastically supplying one unit of time and earn income that is assumed to be equal to the level of their human capital (Glomm, 1997). Income can be allocated to current consumption ($c_t$), education investment ($e_t$) and health investment for their parents ($x_t$). Specifically, the budget constraint of the generation $t$ in the young period can be written as follows:

$$ h_t - T = c_t + (1 - \tau^e_t) e_t + (1 - \tau^x_t) x_t. $$

Here, $\tau^i_t > 0$ ($i = e, x$) represents the subsidy rate, and $T$ denotes the lump-sum tax. It is worthwhile to note that the education investment and the health investment indicate intragenerational and intergenerational allocations of resources, respectively.

When old, the individuals earn income by inelastically supplying one unit of time with human capital ($h_{t+1}$), which is accumulated through education investment. In contrast to the young period, this income is not solely dependent on the level of human capital but is also dependent on health condition ($\pi_{t+1}$). This is because, given the same level of human capital, old individuals with better health work more efficiently and thus receive more income than those with poor health. Denoting the individuals’ consumption when old by $d_{t+1}$, the budget constraint of the generation $t$ in the old period can be written as follows:

$$ d_{t+1} = \pi_{t+1} h_{t+1}. $$

The preferences of the individuals are defined over their consumption bundle ($c_t, d_{t+1}$). We assume that the intertemporal utility function of the individuals is represented by

$$ u(c_t, d_{t+1}) = \ln c_t + \frac{1}{1 + \rho} \ln d_{t+1}, \quad \rho > -1, $$

where $\rho$ is the rate of time preference.

Health Production

Contrary to previous studies, in which it is assumed that individuals’ health condition is dependent on their own health investment, we assume that the health condition of the old is dependent on the health investment made by their children. In other words, health investment, in our model, is defined as upstream transfer from children to parents that improves the health condition of the parents. This health
investment includes not only medical care provided by children but also the expenditure for sports paid by children.¹

We assume that the health condition of the generation \( t \) when old, \( \pi_{t+1} \), can be represented by the following simple form:

\[
\pi_{t+1}(x_{t+1}) = x_{t+1}^\phi, \quad \phi > 0, \tag{4}
\]

where \( \phi \) measures the effectiveness of the health investment made by the young on the health condition of their parents.

**Human Capital Accumulation**

In this paper, the level of human capital that individuals acquire when old, \( h_{t+1} \), depends on the following three elements. The first element is the amount of education investment made by the individuals when young, \( e_t \). The second element is the health condition of their parents, \( \pi_t \). The incorporation of parental health condition into children’s human capital accumulation is the key element that distinguishes our paper from previous studies. As we have explained, the positive effect of parental health condition on children’s human capital accumulation can be interpreted as a non-pecuniary transfer that children obtain from their healthy parents in the form of inherited experience and guidelines. The third element is the level of human capital inherited from parents (\( h_t \)). In sum, human capital is accumulated according to the following function:

\[
h_{t+1} = A e_t^\alpha \left[ \pi(x_t) \right]^\beta h_t^\gamma, \quad A > 0, \; \alpha, \beta, \gamma \in (0,1), \tag{5}
\]

where \( A \) is a constant parameter representing the productivity of the human capital accumulation, \( \alpha \) and \( \beta \) denote the elasticity or effectiveness of education investment and of parental health condition, respectively, and \( \gamma \) captures the degree of intergenerational transmission of human capital.

**Government**

The revenue collected from a lump-sum tax is used by the government to subsidize individuals’ education and health investment. A balanced government budget requires that

\[
\tau_i e_t + \tau_i x_t = T_i. \tag{6}
\]

**Individuals’ Decisions**

The problem for the generation \( t \) is to choose their consumption when young (\( c_t \)) and old (\( d_{t+1} \)), their education (\( e_t \)) and health investments (\( x_t \)) to maximize their intertemporal utility (3) subject to budget constraints (1) and (2), health production function (4) and human capital accumulation (5). When making maximizing choices, the individuals do not perceive the positive effect of those decisions on their parents’ income. The optimal education and health investments are obtained as:

\[
e_t = \frac{\alpha h_t}{1 - \tau_i^e \mu},
\]

¹As pointed out by Bhattacharya and Qiao (2007), both public and private expenditures are important components for a health system. However, because our paper concentrates on inter- and intra-generational conflicts for individuals, we exclude public expenditure on health.
\[ x_t = \frac{\beta \phi}{1 - \tau^t} h_t, \] where \( e_t \) and \( x_t \) indicate the intragenerational and intergenerational allocation of resources when the individuals are in their young period and \( \mu = 1 + \alpha + \rho + \beta \phi + \frac{\beta \phi \tau^t}{1 - \tau^t} + \alpha \tau^t \). It is obvious that the effectiveness of education investment is increasing on human capital accumulation and is decreasing on parental health condition.

**Long-run Market Equilibrium**

The level of human capital that the generation \( t \) acquires when old, \( h_{t+1} \), can be obtained by substituting the optimal choices for education investment and health investment into health production (4) and human capital accumulation (5), as follows:

\[ h_{t+1} = A \alpha^a \left(1 - \tau^t\right)^{-\alpha} \left(\frac{\beta \phi}{1 - \tau^t}\right)^{\beta \phi} \left(\mu\right)^{-\alpha - \beta \phi} h_t^{\alpha + \beta \phi + \gamma}. \] (7)

To obtain the steady state value of \( h \), we set \( h_{t+1} = h_t = h \) in (7), where subscript “*” denotes the steady state in the market equilibrium. In addition, we assume that \( \alpha + \gamma + \beta \phi < 1 \) to obtain the unique value of \( h_* \), as

\[ h_* = \left[A \alpha^a \left(1 - \tau^t\right)^{-\alpha} \left(\frac{\beta \phi}{1 - \tau^t}\right)^{\beta \phi} \left(\mu\right)^{-\alpha - \beta \phi}\right]^{1/(1-(\alpha+\gamma+\beta \phi))}, \]

where \( \tau^t \) and \( \tau^* \) without time subscripts represent the subsidy rates of education and health investment in the steady state. It is obvious that the steady state of human capital is increasing in the effectiveness of education investment on human capital accumulation (\( \alpha \)) and is decreasing in the effectiveness of parental health condition (\( \beta \)). In addition, it is obvious that the steady state of human capital under market equilibrium depends on the subsidy rates.

The simple substitution of \( h_* \) into education and health investment yields the education and health investment in the market equilibrium, as follows:

\[ e_* = \left[A \alpha^a \left(1 - \tau^t\right)^{-\alpha} \left(\frac{\beta \phi}{1 - \tau^t}\right)^{\beta \phi} \left(\mu\right)^{-1-\alpha - \gamma}\right]^{1/1-(\alpha+\gamma+\beta \phi)} \]

\[ x_* = \left[A \alpha^a \left(1 - \tau^t\right)^{-\alpha} \left(\frac{\beta \phi}{1 - \tau^t}\right)^{\beta \phi} \left(\mu\right)^{-1-\gamma}\right]^{1/1-(\alpha+\gamma+\beta \phi)}. \]

**Social Optimum and Optimal Policy**

In this section, we focus on the optimal policy of the government with regard to the individuals’ education and health investments. To obtain the optimal policy, we consider the problem of the government maximizing social welfare or the individuals’ utility in the steady state. The individuals’ education and health investment in market equilibrium does not constitute the social optimum because of the existence of a positive external effect of health investment. Therefore, it is necessary for the government to apply policy to achieve the social optimum. We will first investigate the social optimum and then obtain the optimal policy with regard to the individuals’ education and health investment.

The problem confronted by the government is to maximize social welfare (\( W \)) by choosing a consumption bundle \((c, d)\), education investment \((e)\) and health investment \((x)\). Because the analysis focuses on the steady state, time subscripts are omitted.

\[ \max W = \ln c + \frac{1}{1 + \rho} \ln d, \quad s.t. h = c + e + x, \quad d = \pi(x) h, \quad \pi(x) = x^\rho, \quad h = A e^{a(1-\gamma) \left[ \frac{\pi(x)}{x} \right]^{\beta/(1-\gamma)}}, \] (8)
By solving the problem, the optimal education and health investments are obtained as follows:

\[ e_\infty = \left\lfloor \frac{(1 + \rho)(1 - \gamma) + \alpha + \alpha \Omega}{\alpha(2 + \rho)} \right\rfloor \Omega^\beta \alpha^{-1} \] \[ x_\infty = \left\lfloor \frac{(1 + \rho)(1 - \gamma) + \alpha + \alpha \Omega}{\alpha(2 + \rho)} \right\rfloor \Omega^{\gamma + \beta \alpha^{-1}} \alpha^{-1} , \]

where \( \Omega \equiv \frac{\phi(1 + \beta(2 + \rho) - \alpha - \gamma)}{\alpha(2 + \phi + \rho)} > 0 \), and the subscript “**” denotes the value of the steady state in the social optimum.

The comparison of these solutions with those in market equilibrium yields the optimal subsidy rates for the individuals’ education and health investment in market equilibrium to achieve the social optimum. Then, we summarize them in the following proposition.

**Proposition 1**: The optimal subsidy rates for the individuals’ education and health investment are

\[ \tau_\infty^e = \frac{1 + \rho + \alpha + \alpha \gamma + \beta \phi}{2 + \rho + \phi} \] \[ \tau_\infty^x = \frac{1 + \beta(1 + \rho + \alpha + \gamma + \beta \phi) - (\alpha + \gamma)}{1 + \beta(2 + \rho) - (\alpha + \gamma)} , \]

where \( \Omega \equiv \frac{\phi(1 + \beta(2 + \rho) - \alpha - \gamma)}{\alpha(2 + \phi + \rho)} > 0 \), and the subscript “**” denotes the value of the steady state in the social optimum.

It can be seen that both \( \tau_\infty^e \) and \( \tau_\infty^x \) are always between 0 and 1 by the assumption that \( \alpha + \gamma + \beta \phi < 1 \). This result is not surprising. In the market economy, because young individuals are unable to conceive of the positive external effect of their health investments on parental income through better health, they tend to make lower health investments than the social optimum. In other words, young individuals underestimate the effect of their health investment on the welfare of society as a whole. As a result, the government provides incentives to them through subsidies to achieve higher health investment. In addition, because health and education investments are complementary in human capital accumulation, the increased health investment will lead to a greater effectiveness of education investment. Therefore, the government will encourage individuals to make larger education investments by providing subsidies as incentives.

Next, based on the optimal subsidy rates of education and health investments, we investigate the effect of the rate of time preference, \( \rho \), and the effectiveness of education investment on human capital accumulation on these two subsidy rates. This produces the following proposition.

**Proposition 2**: When the rate of time preference or the elasticity of education investment on human capital accumulation rises, the optimal subsidy rates become higher:

\[ \frac{\partial \tau_\infty^i}{\partial j} > 0, \quad \forall i = e, x, \quad j = \rho, \alpha . \]

We can provide the intuition for the cases of increases in \( \rho \) and \( \alpha \) in turn. When the rate of the time preference increases, consumption in the young period increases. It leads to lower education and health investment when income is unchanged. Lower education and health investments in the young period decrease consumption in the old period. To achieve the social optimum, the government should increase the subsidy rate to provide incentives for individuals to make greater education investments. Similarly, when the effectiveness of education investment increases, the marginal utility of education investment increases, which leads the individuals to make smaller education investment than the optimum. Therefore, the government will also provide subsidies to increase individuals’ incentive to invest in education.

In contrast to the above results, the direction of changes in the subsidy rates of education and health investments might differ when the effect of parental health on human capital accumulation increases.

**Proposition 3**: (a) When the effectiveness of parental health on human capital accumulation increases, the optimal subsidy rate of education investment unambiguously increases: \( \frac{\partial \tau_\infty^e}{\partial \beta} > 0 \); (b) When the effectiveness of parental health on human capital accumulation increases, the optimal subsidy rate of
health investment becomes higher (lower) if the effectiveness of health investment on parental health production is sufficiently large (small): \[
\frac{\partial \tau^*_i}{\partial \beta} \begin{cases} 
\geq 0 & \text{if } \phi \geq (\leq) \frac{(\alpha + \gamma - 1)^2}{\beta[2(1-\alpha - \gamma) + \beta(2 + \rho)]}
\end{cases}
\]

The intuition of Part (a) of Proposition 3 can be given similarly to Proposition 2 and Corollary 1. When the effectiveness of parental health condition on human capital accumulation increases, the productivity of education investment increases, which leads to a higher marginal utility for education investment. Because parental health and education investment are complementary in human capital accumulation, the education investment should be higher. Therefore, the government will provide subsidies to individuals to increase their education investment.

In contrast to Part (a), in Part (b), the effect of the increase in \(\beta\) on the optimal subsidy rate of health investment is dependent on the effectiveness of health investment on parental health condition, \(\phi\). When \(\phi\) is sufficiently large (small), the government should increase (decrease) the subsidy rate of health investment when the effectiveness of parental health condition on human capital accumulation increases. It should be noted that, in our paper, the effectiveness of health investment on parental health condition can be interpreted as the degree of the positive external effect of health investment on parental health condition. When this level becomes large (small), the increase in \(\beta\) will cause young individuals’ health investment to have a strong (weak) effect on human capital accumulation. As a result, the government should increase (decrease) the subsidy rate of health investment.

Summary

This paper incorporates parental health, determined by children’s health investment, as an important element of children’s education into an overlapping-generations model with human capital. This purposeful investment, regarded as upstream transfer from children to parents, is motivated by an exchange for higher levels of human capital. Our results first suggest that the government should provide subsidies for individuals’ education and health investments when parental health condition plays a role in children’s human capital accumulation. Second, the government should increase the subsidy rates to raise incentives for individuals’ education and health investment if the effect of education investment or intergenerational transmission on human capital accumulation increases or if the preference for current consumption becomes higher. Third, if the positive external effect of health investment on parental health condition is sufficiently large, a greater effect of parental health condition on children’s human capital accumulation should lead to a higher subsidy rate.

References


