THE EFFECTS OF EDUCATION SUBSIDIES ON HUMAN CAPITAL ACCUMULATION: A NUMERICAL ANALYSIS OF MACROECONOMY IN CHINA

Yuko Shindo
Graduate School of Economics, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, Aichi 464-8601 JAPAN.

ABSTRACT: In this paper, we conduct a macroeconomic simulation in China using a six-period overlapping generations model with human capital formation consisting of quality and quantity. Two types of education subsidy are examined: that for expenditure on quality of education (SEQ) and that for opportunity cost of education in terms of foregone wage income (SOC). The effects of these two subsidies on human capital accumulation are then compared with the case of human capital accumulation depending only on the factor of education time. The results of this study show that, despite subtle differences in education time between the two types of education subsidies, individuals may neglect quality of education by introduction of the SOC. As a consequence, economic growth is expected to slow down with this subsidy. It is concluded that it may therefore be precipitous to estimate human capital without considering the quality aspect.

1. INTRODUCTION

In this paper, we conduct a macroeconomic simulation using national data from China based on the six-period overlapping generations (OLG) model of Bouzahzah et al. (2002) and human capital formation employed by Docquier and Michel (1999). Two types of education subsidy are examined: firstly, subsidy for expenditure on quality of education (SEQ), the main form of subsidy provided by the Chinese government, and secondly, subsidy for opportunity cost of education in terms of foregone wage income (SOC), which are at present not used in China. The effects of these subsidies on human capital accumulation are also compared with the case of human capital accumulation dependent only on the factor of education time as described in Bouzahzah et al. (2002).

Since its market-oriented economic reform in 1978, China has achieved outstanding economic development with an annual GDP growth rate of nearly 10 percent. This rapid development has been accompanied by an increase in the demand for post-basic education. It is a demand that has been growing sharply despite the abolishment of free higher education in 1985. Because education is regarded as a key element determining long-term economic growth, the government has also pushed to expand and improve the quality of post-basic education by providing subsidies.[1] Consequently, it is critical for policy analysis that an adequate system of assessing the subsidy policy is established. Such a system is also vital for raising the country's economic competitiveness on the

[1] China has nearly achieved universal basic education. The average school life expectancy from primary to tertiary is 11.2 years in 2006 from UNESCO (2008).

world market.

Auerbach and Kotlikoff (1987) extended Diamond's (1965) OLG model by introducing a dynamic simulation model and applied the model in the field of public finance. Auerbach and Kotlikoff's (1987) seminal paper has been followed by an extensive literature discussing various public policies, including education. Docquier and Michel (1999), for example, was one of the first studies to examine the tradeoff between education subsidies for the younger generation and pensions for the elderly in European countries with aging societies using a simple three-period OLG model. The analysis indicates that in Europe higher economic growth can be achieved with the introduction of a blended policy comprising both SEQ and SOC on an equal basis. Although Docquier and Michel's (1999) study was credited with contributing to the establishment of the dynamic endogenous growth model, the three periods of the lifecycle model was too simple a form by which the impact of education on the individual lifecycle could be examined. Other studies include those by Fougère and Mérette (1999), who conducted a simulation in seven OECD countries using a 15-period OLG model, and Sadahiro and Shimasawa (2001) who focused on Japan using a similar framework as Fougère and Mérette (1999), but incorporated the element of physical capital in human capital formation. However, the role of government in financing education, which significantly affects individual incentives to accumulate human capital, was omitted from these analyses. Bouzahzah et al. (2002) extended the model of Docquier and Michel (1999) to a more realistic six-period OLG model and specified human capital formation as a function of the time invested in education as in Fougère and Mérette (1999). Bouzahzah et al.'s (2002) study showed that an endogenous growth model can serve an important role in education policy. However, by ignoring the quality input from the human capital formation, which contradicts empirical evidence, the model may fail to measure the human capital level appropriately.[2]

Seeking to overcome the weaknesses in other models, we use the human capital formation used by Docquier and Michel (1999) based on the six-period OLG model of Bouzahzah et al. (2002) and apply the model to China. We then investigate the effects on human capital accumulation of the government's introduction of the SOC as described by Docquier and Michel (1999). The results obtained by the numerical analysis show that, while there is no obvious difference in education time per person between the two subsidies, significant difference is found in expenditure on quality of education. These results reveal that there is a strong possibility that growth will slow down with the implementation of SOC. As a consequence, it may be unwise to estimate human capital without considering the quality aspect.

The paper is organized as follows. Section 2 describes the framework of the model. Section 3 explains the process of parameter setting and calibration. Section 4 compares the impacts on economic growth between the two types of education subsidies. Section 5 concludes the paper with limitations of the model

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[2] Barro and Lee (2000) showed the importance of not only quantity of education but also quality in the human capital formation.

and implications for policy development.

2. THE MODEL

In this section, we develop a six-period OLG model of endogenous growth in discrete time with 10 years considered as one period. We assume a perfectly competitive, closed economy.[3] The economy in the model includes three kinds of economic agents: homogeneous individuals, a representative firm, and the government. The individuals conduct economic activities for six periods from 15 to 74 years of age, with the 0-14 age band being an economically non-productive one.[4] It is assumed that there is no uncertainty in the life span of the individuals. For simplicity, the population is assumed to remain unchanged; that is, the population in each age group is normalized to one (e.g., age group 1 is from 15 to 24 years old, age group 2 is from 25 to 34 years old, etc.).[5] The firm and individuals have perfect foresight regarding government policy.

2.1 Human capital formation

We define individuals who begin economic activities from period *t* as generation *t*. The individuals of generation *t* choose both their education time and expenditure for quality of education in the first age group. Thus, their human capital is formulated as:

$$h_{t+1}^2 = \left(1 + B e_t^{\varepsilon} q_t^{\theta}\right) h_t^1 \tag{1}$$

h_t^j represents the human capital level of individuals in age group *j* in period *t*. Education time and expenditure on quality of education are represented by e_t and q_t, respectively. *B* (>0) is the human capital productivity parameter. $\varepsilon (0<\varepsilon<1)$ and θ $(0<\theta<1)$ are parameters for education time investment and for quality education investment, respectively, and $\varepsilon + \theta < 1$ indicates a decreasing return to scale. The inheritance of the human capital of the previous generation in the first age group is regarded as a positive externality of education, and is expressed as h_t^1 in the following equation: $h_t^1 = \left(1 + B e_{t-1}^{\varepsilon} q_{t-1}^{\theta}\right) h_{t-2}^1$.

After individuals formulate their human capital in the first age group given as (1), their human capital is accumulated through on-the-job training. The parameters are exogenously given as φ^j (j=2, 3, 4, 5, 6), where j denotes an age group. Hence, the human capital level in each age group is obtained as follows:[6]

$$h_{t+j-1}^j \equiv \varphi^j \left(1 + B e_t^{\varepsilon} q_t^{\theta}\right) h_t^1 . \tag{2}$$

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[3] Although China is an open economy, this assumption is acceptable for our modelling purposes.

[4] This assumption is based on a life expectancy in China of 73.18 years as estimated by *The 2008 World Factbook.*

[5] Although China is an aging society, a negative population growth rate is not considered in order to avoid eventually reaching a zero population situation.

[6] Note Bouzahzah et al. (2002) assume that the human capital stock in the sixth age group is defined as 0. It is assumed that the sixth age group can hold the same human capital level as the fifth, a situation that most probably reflects reality.

2.2 Firm

A representative firm uses the constant-returns to scale technology to produce a composite good that can be either consumed or used as capital. The firm rents capital and effective labour to maximize its profit. Denoted by capital letters, the aggregate production function is given as:

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha} \tag{3}$$

where Y_t, K_t and L_t are respectively aggregate output, capital, and effective labour in period t.[7] A (>0) and α (0< α < 1) are parameters for the exogenously given technology and capital income share. The lower case letter k_t is defined as being equal to the per effective labour variable, that is: $k_t \equiv K_t / L_t$ which gives us $y_t = Ak_t^{\alpha}$.

The labour market is assumed to be perfectly competitive. The supply of labour arises from individual tradeoffs between work and study. By normalizing one period as one time unit, the time not spent on education, 1- e_t, is allocated to labour in the first age group. The second, third, and fourth age groups inelastically supply one unit of their time. The fifth age group supplies $1-\zeta_t \left(0<\zeta_t<1\right)$ of their fixed time for labour, and then retires. In sum, the aggregate effective labour time supply in period t is thus given by:

$$L_t \equiv \sum_{j=1}^{5} l_t^j h_t^j , \tag{4}$$

where l_t^j is the labour supplied by individuals in age group j in period t, and $\left(l_t^1, l_t^2, l_t^3, l_t^4, l_t^5\right) \equiv \left(1-e_t, 1,1,1, 1-\zeta_t\right)$.

Given that the profit-maximizing firm hires the factors of production until their marginal productivities are equal to their marginal costs, we can derive the following two conditions:

$$\delta + r_t = A\alpha\, k_t^{\alpha-1} \tag{5}$$

and

$$w_t = A(1-\alpha)k_t^{\alpha} \tag{6}$$

where $\delta\left(0<\delta<1\right)$ is the invariant capital depreciation rate, and r_t and w_t are the rates of return to capital and effective labour, respectively.

2.3 Individuals

The individual preferences are given by the constant elasticity of substitution (CES) utility function. The lifetime utility function is additively separable in the instantaneous utilities which are discounted by a constant rate of time preference as:

$$U_t \equiv \frac{1}{1-1/\sigma} \sum_{j=1}^{6} \gamma^{j-1} \left({c_{t+j-1}^{j}}^{\,1-1/\sigma} - 1 \right) \tag{7}$$

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[7] Because our aim is to ensure a constant long-term economic growth, we do not include an intratemporal externality where average human capital increases productivity as shown by Lucas (1988).

c_{t+j-1}^{j} is the per capita consumption level in age group j in period t and $\gamma(0<\gamma<1)$ and $\sigma \in \Re$ are the time preference rate and intertemporal elasticity of substitution, respectively.

The individual lifetime budget constraint of generation t is expressed as below:

$$\sum_{j=1}^{6} c_{t+j-1}^{j}\left(1+\tau_{c,t+j-1}\right)R_t^{t+j} + q_t\, h_t^1 \equiv \sum_{j=1}^{6}\left(\left(1-\tau_{w,t+j-1}\right)w_{t+j-1}\, l_{t+j-1}^{j}\, h_{t+j-1}^{j} + T_{t+j-1}^{j}\right)R_t^{t+j} \qquad (8)$$

The present value of the lifetime expenditure, shown on the left hand side of the equation, is the sum of the gross consumption in each age group and the expenditure for quality of education in the first age group, while the present value of the lifetime income, shown on the right, is the sum of the disposable income and public transfer. $\tau_{c,t}\left(0<\tau_{c,t}<1\right)$ is the consumption tax rate in period t and $R_t^{t+j} \equiv \prod_{s=t+1}^{t+j}\left(1+r_s\right)^{-1}$. q_t is the expenditure for quality of education per effective labour unit. w_t and $\tau_{w,t}\left(0<\tau_{w,t}<1\right)$ are the wage income rate per effective labour unit and the wage income tax rate in period *t*, respectively. T_{t+j-1}^{j} consists of two types of public transfers: education subsidies in the first age group and public pension payments in the fifth and six age groups are shown as $\left(T_t^1, T_{t+4}^5, T_{t+5}^6\right) \equiv \left(\nu_{e,t}\, e_t\left(1-\tau_{w,t}\right)w_t\, h_t^1 + \nu_{q,t}\, q_t\, h_t^1, \zeta_{t+4}\, p_{t+4}\, h_{t+4}^5, p_{t+5}\, h_{t+5}^6\right)$. $\nu_{e,t}\left(0<\nu_{e,t}<1\right)$ and $\nu_{q,t}\left(0<\nu_{q,t}<1\right)$ are the rates of SOC and SEQ. p_t is the public pension payment rate per effective labour unit.

Individuals maximize their lifetime utility in (7) under their lifetime budget constraint (8) and human capital formation (2) with respect to their choice of consumption, c_{t+j-1}^{j},education time, e_t, and expenditure on quality of education, q_t.

First of all, we can obtain the levels of e_t and q_t by simply maximizing lifetime budget as:

$$e_t^* = \left(B\varepsilon\sum_{j=2}^{6}\frac{\left(1-\tau_{w,t+j-1}\right)w_{t+j-1}\, l_{t+j-1}^{j}\,\varphi^j}{\left(1-\tau_{w,t}\right)w_t\left(1-\nu_{e,t}\right)}R_t^{t+j}\right)^{\frac{1}{(1-\varepsilon)}}\left(B\theta\sum_{j=2}^{6}\frac{\left(1-\tau_{w,t+j-1}\right)w_{t+j-1}\, l_{t+j-1}^{j}\,\varphi^j}{1-\nu_{q,t}}R_t^{t+j}\right)^{\frac{\theta}{(1-\varepsilon-\theta)}} \equiv e\left(k_t\right) \qquad (9)$$

and

$$q_t^* = \left(B\theta\sum_{j=2}^{6}\frac{\left(1-\tau_{w,t+j-1}\right)w_{t+j-1}\, l_{t+j-1}^{j}\,\varphi^j}{1-\nu_{q,t}}R_t^{t+j}\right)^{\frac{1}{(1-\theta)}}\left(B\varepsilon\sum_{j=2}^{6}\frac{\left(1-\tau_{w,t+j-1}\right)w_{t+j-1}\, l_{t+j-1}^{j}\,\varphi^j}{\left(1-\tau_{w,t}\right)w_t\left(1-\nu_{e,t}\right)}R_t^{t+j}\right)^{\frac{\varepsilon}{(1-\varepsilon-\theta)}} \equiv q\left(k_t\right) \qquad (10)$$

It is worth noting that e_t^* and q_t^* do not depend on the human capital level; instead, their education time and expenditure for quality of education are determined regardless of their level of human capital.

Next, the optimal distribution of per capita consumption for each age group can be expressed by the following five Euler equations:

$$c_{t+j-1}^{j} = \left(\frac{1+\tau_{c,t+j-2}}{1+\tau_{c,t+j-1}} \gamma R_{t+j-2}^{t+j-1} \right)^{\sigma} c_{t+j-2}^{j-1} \qquad j = 2, 3, 4, 5, 6. \tag{11}$$

On the other hand, per capita assets for each age group are defined by:

$$a_{t+j-1}^{j} \equiv a_{t+j-2}^{j-1} R_{t+j-2}^{t+j-1} + \left(1-\tau_{w,\,t+j-1}\right) w_{t+j-1}\, l_{t+j-1}^{j}\, h_{t+j-1}^{j} + T_{t+j-1}^{j} - c_{t+j-1}^{j}\left(1+\tau_{c,t+j-1}\right) \qquad j = 2, 3, 4, 5, 6. \tag{12}$$

Thus, the optimal asset level in per capita terms in each period is obtained by substituting c^* and q^* in (12).

2.4 Government

In each period, the government levies taxes on consumption and wage income and issues debts. It also provides education subsidies, pension payments, other government expenditures and interest payments for the debt issues. Therefore, the government budget constraint in period t is:

$$\tau_{c,t}\, C_t + \tau_{w,t}\, w_t\, L_t + D_{t+1} = \nu_{e,t}\, e_t \left(1-\tau_{w,t}\right) w_t\, h_t^1 + \nu_{q,t}\, q_t\, h_t^1 + P_t + G_t + \left(1+r_t\right) D_t \tag{13}$$

Where C_t. P_t, G_t and D_t are aggregate consumption, the exogenously given pension payment, the exogenously given other government expenditures, and debt issues in period t, respectively. We simplify the analysis by assuming a balanced government budget through the adjustment of debt issues in each period. This adjustment also allows the changes of debt level that influence capital accumulation to be examined.[8] The aggregate variables are expressed as follows:

$$C_t \equiv \sum_{j=1}^{6} c_t^j, \tag{14}$$

$$P_t \equiv \sum_{j=5}^{6} \left(\zeta_t + 1\right) p_t\, h_t^j, \tag{15}$$

$$G_t \equiv \sum_{j=1}^{6} g_t\, h_t^j, \tag{16}$$

and

$$D_t \equiv \sum_{j=1}^{5} d_t\, h_t^j \tag{17}$$

g_t and d_t are as other government expenditures and debt issues per effective labour unit, respectively. We define $p_t h_t^j$, $g_t h_t^j$, and $d_t h_t^j$ as per capita expenditures to let p_t, g_t and d_t be constant in the steady growth path, where the economic growth rate becomes constant over time.

2.5 Dynamics

The dynamic system in this model is governed by both physical capital per

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[8] It is also possible to assume that the debt level is exogenously given, whereas tax levels are endogenously determined. Bouzahzah et al. (2002) set the wage income tax, which directly influences the selection of education time, as an endogenous variable.

effective labour unit and human capital. The former takes a constant value, while the latter achieves a constant growth rate in the steady growth path.

Given that in this model the goods market clears, the capital market equilibrium in period *t* is defined as the aggregate capital in the next period being equal to the aggregate assets in the present period less aggregate debt issues in the next period. T his is represented as:

$$K_{t+1} = \sum_{j=1}^{5} a_t^j - D_{t+1} \tag{18}$$

From (4) and (17), (18) can be rewritten in per effective labour unit as:

$$k_{t+1} = \left(\sum_{j=1}^{5} \hat{a}_t^j h_{t+1}^j - \sum_{j=1}^{5} d_{t+1} h_{t+1}^j \right) \Bigg/ \sum_{j=1}^{5} l_{t+1}^j h_{t+1}^j \tag{19}$$

where $\hat{a}_t^j$ is the asset per effective labour unit.

Second, modifying the dynamics of human capital accumulation in (1) using (4), (5), (6), (9) and (10), we can obtain the human capital growth rate, namely, the economic growth rate which depends only on k_t as:

$$\frac{h_{t+1}}{h_t} = 1 + B\xi \left\{ e\left(k_t\right)^{\varepsilon} \right\} \left\{ q\left(k_t\right)^{\theta} \right\} \tag{20}$$

Consequently, in the steady growth path k^*, $\hat{a}^*$, d^*, l^* and in (19) become constant. Moreover, substituting *k** into (20), *h* takes a constant growth rate in the path.

3. PARAMETER SETTING AND CALIBRATION

In this section, we describe the setting of parameters using Chinese data and calibrate the model explained in the previous section with the parameters. Considering one period as 10 years in this model, we use the most up-to-date available data during the past 10 years from 1998 to 2007, and input the annual average values into the model to determine the parameter values. Unless otherwise specified, the data are from the *China Statistical Yearbook* from 1999 to 2008. The parameter values are summarized in Table 1.

First, we set the parameters of human capital formation. The data we use are the average school life expectancy over a 10-year period (1998 to 2007), which is of 10.63 years (UNESCO, 2008), and the average education expenditure per senior secondary student over the same period (*China Statistical Yearbook*). Because our interest lies in the long-term economic growth, we set the human capital/economic growth rate to match the long-term economic growth rate figure of 2.5 percent comparable to that seen in many developed countries. The three values described above are assigned to (1), (9), and (10), which are then solved as a set of simultaneous equations to obtain values of the productivity parameter (*B*), and parameters for education time investment (ε) and quality education investment (θ). The parameter values of on-the-job training or human capital depreciation (φ^j) are from Ma's (2005) empirical data, which revealed, interestingly, that the wage profile in China does not follow an inverted U-shape often seen in developed countries but, instead, shows an increase with age.

Table 1. Parameter and Policy Variable Values

	Parameter/policy variable	**Value**
B	Human capital productivity	0.784
ε	Parameter for education time investment	0.650
θ	Parameter for quality education investment	0.150
φ^2	OJT/human capital depreciation in age group 2	1.061
φ^3	OJT/human capital depreciation in age group 3	1.201
φ^4	OJT/human capital depreciation in age group 4	1.325
φ^5	OJT/human capital depreciation in age group 5	1.429
φ^6	OJT/human capital depreciation in age group 6	1.429
A	Technology parameter	9.573
α	Capital income share	0.331
δ	Capital depreciation rate	0.390
γ	Time preference rate	0.840
σ	Intertemporal elasticity of substitution	1.500
τ_c	Consumption tax rate	0.128
τ_w	Wage income tax rate	0.399
ν_e	The rate of subsidy for opportunity cost of education (SOC)	0.201
ν_q	The rate of subsidy for expenditure on quality of education (SEQ)	0.786
p	Pension payment per effective labour unit	0.343
ζ	Retirement ratio	0.500
g	Other government expenditures per effective labour unit	1.273

Second, the production function parameters are obtained based on the national accounts to match the actual economic circumstances. The labour income share (1 - α) is calculated from the sum of the regional compensation of employees divided by the sum of the net regional products at factor cost. The capital income share (α) is determined for the production function to be homogeneous of degree one. Applying the elasticities and amount of total capital stock during the past 10 years, we can compute the technology parameters (A). The capital depreciation rate (δ) is derived from the average depreciation of fixed assets during the past 10 years.

Since we lack empirical data for China, we cannot determine the parameters for the utility function in a straightforward manner. Due to the lack of consistency in the values employed in various studies, controversy remains even in developed countries about the exact figure to use for these parameter values. Because we obtain realistic interest and saving rates later when we calibrate the model, the time preference rate (γ) and intertemporal elasticity of substitution (σ) are the same values as those of the European case described by Bouzahzah et al (2002).

Lastly, we assign seven policy variables as follows. The consumption tax rates (τ_c) and wage income tax rate (τ_w) are computed based on the final consumption expenditure, total wages and the amount of each tax revenue during the past 10 years. The rate of the SOC (v_e) are calculated from the government education expenditure per senior secondary student divided by the per capita net compensation of employees. The rate of the SEQ (v_q) is the share of government education expenditure per senior secondary student of the total education expenditure, including tuition and miscellaneous fees. The pension payment (*p*) is obtained from the total pension payment divided by the population over 65 years of age.[9] T he retirement ratio (ζ) is set as 0.5 because the average retirement age for male workers is 60 years of age.[10] The figure for other forms of government expenditure (*g*) is derived from total government expenditure minus total education expenditure, pension payments, and debt issues divided by the population.

Using these parameter values, we conduct calibration to obtain equilibrium values in the steady growth path. We define the steady growth path with the SEQ as the base case reflecting the current education system in China, and the SOC as the simulation case. Firstly, h_i^1 is normalized as one to calibrate the relative values per person because h_i^1 grows at a constant rate in the steady growth path.[11] We then obtain the capital stock per effective labour unit (k_0^*) as 4.263 for the base case and 4.448 for the simulation case.[12] [13] In addition, we obtain the equilibrium values of the rest of the endogenous variables and the human capital/economic growth rates.

4. SIMULATION RESULTS

4.1 Difference in human capital accumulation in the steady growth path

In this section, we compare the base case with the simulation case in human capital accumulation in the steady growth path. Figure 1 shows the difference in relative levels of human capital per person in each age group in the steady growth path when h_i^1 is set to one. Table 2 summarizes the difference in the equilibrium values of the human capital variables.

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[9] The recipients of pension payments include only retirees of government agencies and institutions covered by the government budget.

[10] The retirement age for females is 55 years.

[11] The absolute value can be obtained by multiplying the relative value by the h_i^1 level in a specific period.

[12] The subscript 0 in k_0^* indicates an initial value.

[13] By changing the exogenously given parameters of education investment (ε), we examine values of k_0^* to check the robustness of the model. When the parameter value changes from 0.650 to 0.640 and 0.660 in the base case, the value of k_0^* becomes 4.311 and 4.218. Therefore, we conclude that the model is sufficiently robust.

Figure 1. Difference in relative levels of human capital per person in each age group

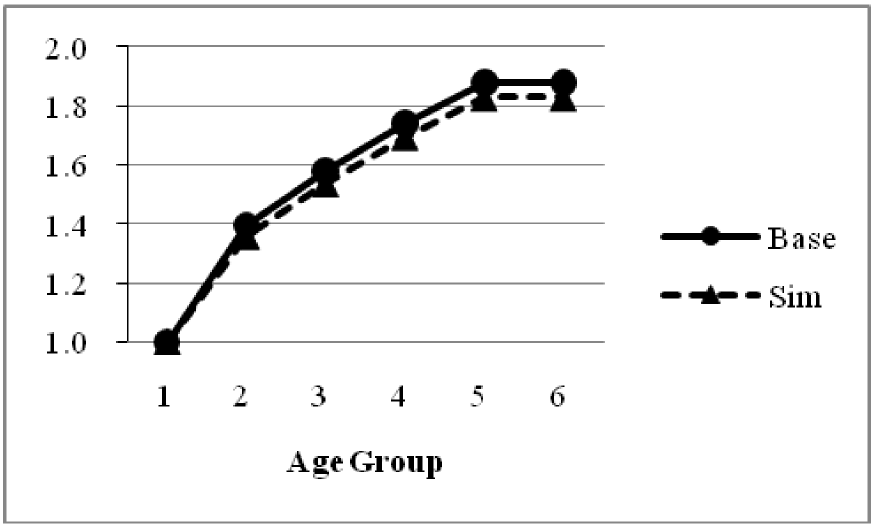


Table 2. Difference in human capital equilibrium values

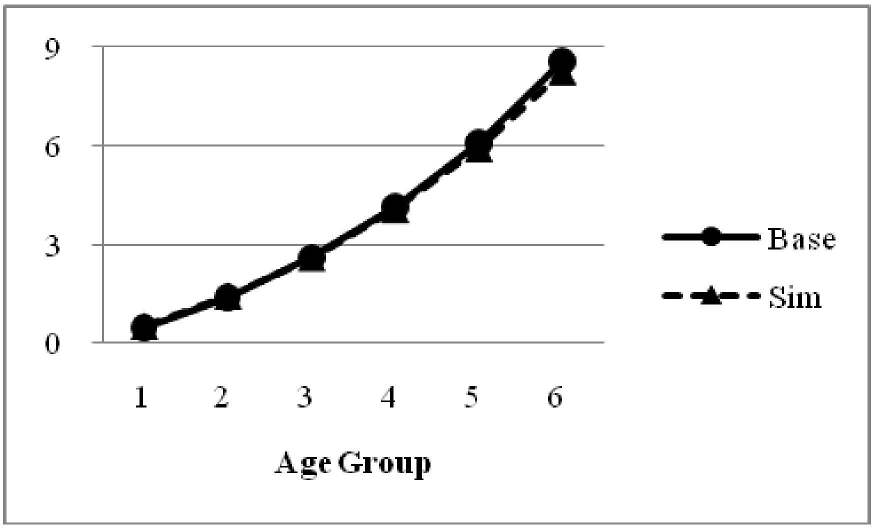
	Base	Sim
Education time per person (yrs)	2.28	2.22
Expenditure for quality of education per person (10,000 yuan/10 yrs)	1.388	0.234
Human capital/economic growth rate (%/10 yrs)	31.5	23.7
Education subsidies per person (10,000 yuan/10 yrs)	1.091	0.255
Debt issues per person (10,000 yuan/10 yrs)	5.262	5.541
Interest rate (%/10 yrs)	93.0	89.6
Lifetime utility per person in present value (60 yrs)	12.529	12.339

The first finding was that, while individuals accumulate human capital through on the job training from the second age group to the fifth age group, the decisions regarding education made in the first age group are a critical factor for accumulating human capital. Although, as shown in the first row of Table 2, there is no obvious difference in education time per person, (2.28 years for the base case and 2.22 years for the simulation case), nearly a six fold difference between the base case and simulation case exists in expenditure on quality of education per person (as shown in the second row of Table 2). Indeed, the net human capital/economic growth rate during the 10 years in the third row is 31.5 percent in the base case and 23.7 percent in the simulation case in the steady growth path. (The growth rate per year traces an equivalent 2.8 percent and 2.2 percent.) Similarly, the education subsidies per person decrease from 10,910 yuan to barely 2,550 yuan, as shown in the fourth row. Furthermore, although a smaller amount of resources is needed for educational investment in the simulation case, the debt issues per person is larger than those in the base case.

4.2 Welfare difference in the steady growth path

We next turn our attention to the differences in utility level in each age group between the two types of education subsidies. Figure 2 shows how the instantaneous utilities increase with advancing age in both cases. However, the utilities of the base case are consistently slightly larger at each age group than those of the simulation case. The smoothing over of consumption patterns that occurs during the lifecycle of individuals can be interpreted as stemming from the difference in interest rates. In fact, interest rates during the 10-year simulation period are 93.0 and 89.6 percent for the base case and simulation case, respectively (Refer to the fifth row of Table 2.). Even if we take the difference in interest rates into account by examining the lifetime utility at present, the utility is still larger in the base case than in the simulation case, that is, 12,529 in the base case and 12,339 in the simulation case in the sixth row of the table. Consequently, the base case can be considered superior to the simulation case in terms of welfare level, a result that can be attributed to the higher human capital accumulation in the base case.[14]

Figure 2. Difference in relative levels of instantaneous utility per person in each age group



These results suggest that by not considering the quality aspect, the model fails to measure the human capital level appropriately. Because both the SEQ and SOC can cause a distortion in education demand, we must examine carefully how the distortional effect is associated with changes in behaviour of individuals.

[14] Because the economic growth rate is higher in the base case than in the simulation case as shown in Table 2, we can confirm that the welfare levels in the base case exceeds the simulation case in each period.

5. CONCLUSION

In this paper, we conducted a macroeconomic simulation using national data in China based on the six-period OLG model of Bouzahzah et al. (2002) with human capital formation employed by Docquier and Michel (1999) and analyzed the effects on human capital accumulation/economic growth and welfare by comparing two types of education subsidies, the SEQ and SOC. It was revealed that the quality of education per person deteriorates and the economic growth can be expected to slow down with the introduction of the SOC in China. Because both the SEQ and SOC cause distortion in education demand, it may be precipitous to estimate human capital without considering the quality aspect.

Although this model was able to offer several long-term implications for the education policy based on Chinese data, certain important aspects were not considered. The most crucial concern is that only the extreme cases are compared in our analysis. We might expect different results if a blended policy (implementation of SOC and SEQ on a 50-50 basis) such as that described by Docquier and Michel (1999) were initiated. Another difficulty is that the transitional period was not included in the analysis. Because intergeneration conflict arises, especially when there is a wide gap in education quantity and quality between generations, we must take into consideration the government's short and mid-term policies. In spite of these limitations, this study has shown the potential significance of a numerical analysis that offers plausible and meaningful interpretations of economic growth and education policy in China.

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