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A Model of Human Capital Accumulation through Visiting Museums

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Abstract

This paper considers how a change of the education budget affects the economic growth rates, by using a model in which human capital of children is accumulated through visiting public museums as well as receiving educational input provided by their parents and the government. We show that (1) when the tax revenue for education is small enough, the economic growth rate decreases along with that the government increases the budget for museums. (2) When the tax revenue for education is not small enough, there is the budget allocation between the public museums and the public schools which maximizes the growth rate.

Keywords: Human capital, Education, economic growth.
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1 Introduction

Public museums are supplied by the government with a considerable national budget. Households can visit them with paying not so expensive entrance fees to get new knowledge and experiences from their collections and museum lectures. In this paper, we focus on the educational effects of public museums which contribute to accumulate human capital of children.

Human capital accumulation through education is recognized as one of the most important engines of economic growth. Therefore, it may be significant for the government to supply education systems effectively in order to enhance the human capital level and the growth rate in the economy.

When the government plan education policies, it is also important to consider household behavior because human capital level of children who become workers to pay labor taxes in future is partly determined by their parents' decision. In this paper, we examine effects of making use of museums by the households which is complement parental educational investment on the economic growth rates.

Many researchers, such as Azariadis and Drazen (1990), Stokey (1991), and Glomm and Ravikumar (1992), Zhang and Casagrande (1998), Kaganovich and Zilcha (1999), Wigger (2004), and Rojas (2004), among others, consider the human capital accumulation and growth using the overlapping generations' model.[1] Different from their papers, our model adds a new route to human capital accumulation by considering the possibility that children can improve their human capital level by visiting public museums.

[1] Not using the overlapping generations setting, Lucas (1988) has started to incorporate that human capital accumulation is one of the important engines of economic growth.

We show that when the tax revenue for education is small enough, the economic growth rate decreases along with that the government increases the budget allocation for museums. When the tax revenue for education is not small enough, there is the threshold level of budget allocation between the public museums and the public schools which maximizes the growth rate.

The remainder of this paper is organized as follows. Section 2 presents the model. Section 3 examines the growth effects of the educational budget for public museums. Concluding remarks are presented in Section 4.

2 The Model

We consider an overlapping-generations model of endogenous growth. The life of a representative individual is divided into three periods: a childhood, a young-working, and a retirement period. Each individual receives education to accumulate human capital in the first period, works and brings n children in the second period, and retires in the third period. We refer to a generation existing as workers in period t as generation t. Let N_t denote the number of working-aged individuals. Population growth rate is n. The government supplies public museums and public schools as a method of education policy by taxing the labor income of young-working individuals.

Young individuals receive a wage income, which is taxed away. They divide their income, $(1-\epsilon)w_t h_t$, among education expenditures for their children, ne_t, admission fees for museums, $(1+n)m_t$,[2] their current con-

[2]In this model, to analyze we assume that the entrance fees for adults and children are the same amount, although the real admission fees are usually different between adults and children. We also assume that parents have to spend the family's entrance fees to take their children to public museums in this model, although children those who can learn something from the collections and the museum lectures are seemed to be old enough to go to museums by themselves.

sumption, c_t^y, and savings, s_t, for their post-retirement consumption, c_{t+1}^o. Subsequently, individuals obtain principal and interest from their savings, $(1+r_{t+1})s_t$, and consume them after retirement.

Let h_{t+1} be the human capital level of each individual who is born at time t and called generation $t+1$. We assume that children accumulate human capital by visiting public museums as well as receiving educational input provided by their parents and the government. When parents take their children to museums by paying the entrance fees, the children obtain new knowledge and experiences from their collections and museum lectures those contribute to increase human capital.

Human capital is accumulated according to:

$$h_{t+1} = (e_t + \phi M_t)^{\gamma}(e_t^g)^{1-\gamma}, \tag{1}$$

where e_t is private educational input per child, such as textbooks and tutors, M_t is the amount of museum budget per capita, and $\phi \in (0,1)$ is assumed to be the proportion of that children can learn and improve their human capital from the museum budget per capita. The public-school quality provided by the government is e_t^g. In that equation, $\gamma \in (0,1)$ denotes the efficiency of education input provided privately and the effectiveness of education at the museums. Individuals determine the amount of private investment for their children, taking the value of ϕM_t and e_t^g as given.

The budget constraints of a member of generation t when young and retired are given, respectively, by

$$(1-\epsilon)w_t h_t = c_t^y + ne_t + (1+n)m_t + s_t, \tag{2}$$

$$(1+r_{t+1})s_t = c_{t+1}^o, \tag{3}$$

where ϵ is the education tax rate which is constant over time.

Each household derives utility from both material consumption in the second and third periods of life and human capital level of their children. The lifetime utility function of a household in generation t is expressed as

$$u_t = \mathrm{ln}c_t^y + p\mathrm{ln}c_{t+1}^o + \sigma n \mathrm{ln} h_{t+1}, \tag{4}$$

where $p(>0)$ and $\sigma(>0)$ represents the degree of preference for their retired period and the human capital of own children, respectively.

The households choose consumption in the second and third periods together with the education investment of their children so as to maximize lifetime utility (4) subject to the constraints (1)-(3).

Using the first-order conditions, we obtain the optimal values in equilibrium as:

$$c_t = \frac{1}{(1+p+n\sigma\gamma)}[(1-\epsilon)w_t h_t - (1+n)m_t + n\phi M_t],$$

$$c_{t+1}^o = \frac{p}{(1+p+n\sigma\gamma)}(1+r_{t+1})[(1-\epsilon)w_t h_t - (1+n)m_t + n\phi M_t],$$

$$s_t = \frac{p}{(1+p+n\sigma\gamma)}[(1-\epsilon)w_t h_t - (1+n)m_t + n\phi M_t], \tag{5}$$

and

$$e_t = \frac{\sigma\gamma}{(1+p+n\sigma\gamma)}[(1-\epsilon)w_t h_t - (1+n)m_t + n\phi M_t] - \phi M_t. \tag{6}$$

Competitive firms produce a single final good by employing both physical capital and effective labor input. The aggregate production function at time t is given by

$$Y_t = F(K_t, h_tN_t) = AK_t^{\alpha}(h_tN_t)^{1-\alpha},$$

where Y_t, A, K_t, and $\alpha \in (0,1)$ respectively denote the aggregate output, the productivity parameter, the physical capital that fully depreciates in the production process, and the share of physical capital. Firms hire physical capital and effective labor inputs up to the point at which the marginal product equals the factor price:

$$(1+r_t) = \frac{\partial Y_t}{\partial K_t} = A\alpha(\frac{K_t}{h_tN_t})^{\alpha-1},$$

and

$$w_t = \frac{\partial Y_t}{\partial(h_tN_t)} = A(1-\alpha)(\frac{K_t}{h_tN_t})^{\alpha}.$$

The government supplies public museums as an educational opportunity for children, using both a share η of the education-tax revenue and the total admission fees. Here, η is treated as a predetermined parameter and is constant over time. At time t, the total amount of museum budget per capita, M_t, and the value of public school investment per child e_t^g, are adjusted to balance the governmental budget constraints. The budget constraints governing the education policy at time t are given by

Public Museums; $\quad \eta\epsilon w_t h_t N_t + m_t(1+n)N_t = M_t(1+n)N_t,$

Public Schools; $\quad (1-\eta)\epsilon w_t h_t N_t = e_t^g n N_t.$

Thus, the value of education investment per child at time t are determined, respectively, as

$$\text{Public Museums;} \qquad M_t = \frac{\eta\epsilon w_t h_t + m_t(1+n)}{(1+n)}, \tag{7}$$

$$\text{Public Schools;} \qquad e_t^g = \frac{(1-\eta)\epsilon}{n} w_t h_t. \tag{8}$$

In here, we shall assume that the museum entrance fee is χ proportion of parents wage income as:

$$m_t = \chi w_t h_t, \qquad \chi \in (0,1). \tag{9}$$

By using (6) - (9), the human capital level of generation $t+1$ is represented as

$$h_{t+1} = \left(\frac{\sigma\gamma}{(1+p+n\sigma\gamma)}\tilde{I}\right)^{\gamma}\left(\frac{(1-\eta)\epsilon}{n}\right)^{1-\gamma} w_t h_t \equiv h^* w_t h_t, \tag{10}$$

where $\tilde{I} \equiv (1-\epsilon) - \{1+n(1-\phi)\}\chi + \frac{n}{(1+n)}\phi\eta\epsilon > 0$.

By employing the capital market-clearing condition, $K_{t+1} = s_t N_t$, (5), (7), (9) and (10), the per-capita growth rate at time t is constant over time:

$$(1+g_t) = \frac{\frac{Y_{t+1}}{N_{t+1}}}{\frac{Y_t}{N_t}}$$

$$= A(1-\alpha)\left(\frac{p}{n(1+p+n\sigma\gamma)}\tilde{I}\right)^{\alpha}(h^*)^{1-\alpha}$$

$$= A(1-\alpha)\left(\frac{p}{n(1+p+n\sigma\gamma)}\tilde{I}\right)^{\alpha}\left(\left(\frac{\sigma\gamma}{(1+p+n\sigma\gamma)}\tilde{I}\right)^{\gamma}\left(\frac{(1-\eta)\epsilon}{n}\right)^{1-\gamma}\right)^{1-\alpha} \equiv (1+g^*). \tag{11}$$

3 Museum Education

Let's examine how the budget proportion for public museums affects the growth rate in the economy. The following proposition summarizes the effect of the change of budget proportion for public museums on the growth rate.

Proposition 1.

(1) If $\epsilon \leq \tilde{\epsilon}$, then $\text{sign}(\frac{\partial(1+g^*)}{\partial\eta}) \leq 0$, for all $\eta \in (0,1)$,
(2) If $\epsilon > \tilde{\epsilon}$, then $\text{sign}(\frac{\partial(1+g^*)}{\partial\eta}) \geq (<) 0$, when $\eta \leq (>) \hat{\eta}$,

where $\hat{\eta} \equiv \frac{\{\alpha+\gamma(1-\alpha)\}n\phi\epsilon-(1-\alpha)(1-\gamma)(1+n)[(1-\epsilon)-\{1+n(1-\phi)\}\chi]}{n\phi\epsilon} \in (0,1)$,
and $\tilde{\epsilon} \equiv \frac{(1-\alpha)(1-\gamma)(1+n)[1-\{1+n(1-\phi)\}\chi]}{[\{\alpha+\gamma(1-\alpha)\}n\phi+(1-\alpha)(1-\gamma)(1+n)]} \in (0,1)$.

Proof. *See the Appendix.*

This proposition shows that the growth effect of the increase in public museum budget depends on the payroll education-tax rate, ϵ. When the tax rate and thereby the amount of education revenue is small enough ($\epsilon \leq \tilde{\epsilon}$), the economic growth rate decreases along with that the government increases the national budget for museums. When the tax revenue for education is not small enough ($\epsilon > \tilde{\epsilon}$), there is the threshold level of budget allocation between the public museums and the public schools which maximizes the growth rate.

4 Concluding Remarks

We have examined how the level of educational budget for public museums affects economic growth rates. We show that when the tax revenue for education is small enough, the growth rate decreases along with that the government increases the budget for public museums with decreasing the budget for public schools. We also demonstrate that when the tax revenue for education is not small enough, there is the threshold level of budget allocation between the public museums and the public schools which maximizes the growth rate.

Public museums are supplied and operated by the government with a large national budget. We, not only children but also adults, can learn and improve our human capital by visiting public museums. The result of our paper points out that the government should supply public museums, considering the educational aspects of public museums.

Appendix

Proof of Proposition 1.

By differentiating (11) with respect η, we obtain the following equation:

$$sign(\frac{\partial(1+g^*)}{\partial\eta})\geq 0$$

$$\Longleftrightarrow sign(\frac{\partial\tilde{I}^{\alpha+\gamma(1-\alpha)}(1-\eta)^{(1-\alpha)(1-\gamma)}}{\partial\eta})\geq 0$$

$$\Longleftrightarrow sign(\{\alpha+\gamma(1-\alpha)\}(1-\eta)\frac{n}{(1+n)}\phi\epsilon$$
$$-(1-\alpha)(1-\gamma)[(1-\epsilon)-\{1+n(1-\phi)\}\chi+\frac{n}{(1+n)}\phi\epsilon\eta])\geq 0$$

$$\Longleftrightarrow \eta \leq \frac{\{\alpha+\gamma(1-\alpha)\}n\phi\epsilon-(1-\alpha)(1-\gamma)(1+n)[(1-\epsilon)-\{1+n(1-\phi)\}\chi]}{n\phi\epsilon}$$
$$\equiv \hat{\eta}$$

Here, we assume that the entrance fee is not too expensive as:

$$[(1-\epsilon)-\{1+n(1-\phi)\}\chi]\geq 0$$
$$\Longleftrightarrow \chi\leq\frac{(1-\epsilon)}{\{1+n(1+\phi)\}}\equiv\tilde{\chi}\in(0,1)$$

At first, under this assumption, we have

$$\hat{\eta}\leq 0$$
$$\Longleftrightarrow \epsilon\leq\frac{(1-\alpha)(1-\gamma)(1+n)[(1-\epsilon)-\{1+n(1-\phi)\}\chi]}{[\{\alpha+\gamma(1-\alpha)\}n\phi+(1-\alpha)(1-\gamma)(1+n)]}\equiv\tilde{\epsilon}\in(0,1).$$

Thus, when $\epsilon\leq\tilde{\epsilon}$,

$$sign(\frac{\partial(1+g^*)}{\partial\eta})<0,$$

for all $\eta\in(0,1)$.

Secondly, when $\hat{\eta}\in(0,1)$, that is, when $\epsilon>\tilde{\epsilon}$, we have

$$sign(\frac{\partial(1+g^*)}{\partial\eta})\geq(<)0 \qquad if \qquad \eta\leq(>)\hat{\eta}.$$

This is the proof of Proposition 1.

Q.E.D.

References

[1] Azariadis C, Drazen A(1990) Threshold externalities in economic development *Quarterly Journal of Economics* 105, 501-526.

[2] Glomm G, Ravikumar B (1992) Public versus private investment in human capital: endogenous growth and income inequality. *Journal of Political Economy* 100, 818-834.

[3] Kaganovich M, Zilcha I (1999) Education, social security, and growth. *Journal of Public Economics* 71, 289-309.

[4] Lucas RE (1988) On the mechanics of economic development. *Journal of Monetary Economics* 22.3-42.

[5] Rojas JA (2004) On the interaction between education and social security. *Review of Economic Dynamics* 7, 932-57.

[6] Stokey N (1991) Human capital, product quality and growth. *Quarterly Journal of Economics* 106, 587-616.

[7] Wigger BU (2004) Are higher education subsidies second best? *Scandinavian Journal of Economics* 106, 65-82.

[8] Zhang J, Casagrande J (1998) Fertility, growth, and flat-rate taxation for education subsidies. *Economics Letters* 60, 209-216.