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NOTES

HOW DO ELEMENTARY AND HIGHER EDUCATION AFFECT HUMAN CAPITAL ACCUMULATION AND INEQUALITY? A NOTE

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We clarify the different effects of elementary and higher education on human capital accumulation and inequality. The productivity of elementary education plays a significant role in the widening of inequality regardless of the existence of multiple steady states. When the productivity of elementary education is low, the poor cannot afford higher education in the long run because the demand for education by the rich makes the price of education too high for the poor. However, the effect of its productivity on the attainable education level is ambiguous. A rise in the productivity of higher education always increases the education level.

Keywords: Elementary Education, Higher Education, Price of Education, Inequality

1. INTRODUCTION

The cost of education in Japan has increased significantly because of rising tuition fees for private and public universities and the growing need for supplementary private education to prepare for entrance examinations. Educational expenditures thus impose a greater burden on household budgets. Furthermore, a large increase in inequality in income has been identified recently. As shown in Galor and Zeira (1993), the intergenerational transmission of earning capacity through educational investment is a crucial factor in the increasing inequality in income because of credit market imperfection. Therefore, the increasing cost of education is a key factor in the increasing inequality in income.[1]

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In the second half of the 1990s, the Japanese government began implementing a revised education policy called *yutori kyoiku*. It reduced the number of school days and amount of course content. Nishimura (2003) argued that the less strenuous school education degraded the quality of public education. Furthermore, Tachibanaki and Yagi (2009) pointed out that a drop in the scholastic ability of elementary education would worsen the increasing inequality in income.

How do elementary and higher education affect human capital accumulation and income distribution? Here we consider elementary education (defined as compulsory) and higher education (defined as elective and with a fee) separately. We derive the price of higher education taking the increasing cost of education into account. We show that when the productivity of elementary education is low, the poor cannot afford higher education and income inequality widens regardless of the initial education levels of the rich and poor and the existence of multiple steady states. However, the effect of the productivity of elementary education on the attainable education level is ambiguous. A rise in the productivity of higher education, on the other hand, increases the education level.

Glomm and Ravikumar (1992), Bräuninger and Vidal (2000), and B*é*nabou (1996, 2000, 2002) examined the effects of educational policies, such as public versus private education, socioeconomic stratification, and education finance, on income inequality and economic growth. Galor and Moav (2006) investigated the timing of public education for the masses in a model that explains inequality and the process of economic development. This note examines the effects of elementary and higher education on human capital accumulation and income inequality. A lower productivity of elementary education leads to reduced incomes for parents with a low level of education. The poor then cannot afford the increasing cost of higher education, so income inequality rises. The income level of the poor is insufficient for educational expenditure because the large demand for education by the rich makes the price of education too high. The rising price of education directly increases the cost of education. The productivity of elementary education plays a significant role in the degree to which this rise in the price of education affects the increasing inequality. Note that increasing inequality in our model is because of genuine general equilibrium feedback, as in Bénabou (2000).[2]

2. MODEL

We consider a closed overlapping-generations economy. In the first period, individuals equally receive an elementary education. If parents decide to spend on higher education, their children receive this education in the first period as well. In the second period, they work. The population of each generation is assumed to be L, a constant. We assume that the initial numbers of rich and poor are, respectively, λL and $(1 - \lambda)L$. They are identical except for their education levels.

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2.1. Educational Sectors and Consumption Goods Sector

We first describe how education forms the stock of human capital. For simplicity, the capital stock of an individual is assumed to be linear as follows:

$$h(\bar{e}, e_{it}) = \eta\bar{e} + \gamma e_{it}, \quad \eta, \gamma > 0, \quad i = r,\ p, \tag{1}$$

where $h(\bar{e}, e_{rt})$ and $h(\bar{e}, e_{pt})$ are the human capital stocks of the rich and poor, respectively, $\bar{e}$ is the level of elementary education, and e_{rt} and e_{pt} are, respectively, the levels of higher education of the rich and poor, which are received in period t.

Second, we describe the elementary education sector. The government runs the institution of elementary education by collecting taxes to maintain a balanced budget. An increase in the amount of elementary education increases its cost. The cost of elementary education per schoolchild is represented by $v(\bar{e})$, where $v(0) = 0$, $v'(0) = 0$, $v'(\bar{e}) > 0$, and $v''(\bar{e}) > 0$. The difference between productivity and cost per schoolchild becomes part of disposable income when individuals work. The government is assumed to determine the level of elementary education to maximize the difference:

$$\max_{\bar{e}} \eta\bar{e} - v(\bar{e}). \tag{2}$$

The level of elementary education is thus set to

$$\eta = v'(\bar{e}). \tag{3}$$

When productivity is high, the amount of elementary education is high. This implies higher disposable income.

Third, we describe the higher education sector. We assume that individuals with the highest education level can become teachers. That is, teachers are among the rich. When the human capital of a teacher is high and the number of teachers per student is large, education will progress well. We assume diminishing returns in teachers because both teachers and students are individuals. The average education level per student is assumed to be produced subject to the following function:

$$e_{at} = (h(\bar{e}, e_{rt-1})\tau_t)^{\alpha}, \quad 0 < \alpha < 1, \tag{4}$$

where e_{at} is the average education level per student received in period t, $\tau_t \equiv L_t^T / L_t^S$ is the number of teachers per student, and L_t^T and L_t^S are the numbers of teachers and students in period t, respectively.

Tuition is used to pay teachers' wages. The price of education is defined as p_t. The institution has a balanced budget:

$$p_t e_{at} = h(\bar{e}, e_{rt-1})\tau_t. \tag{5}$$

The left-hand side of (5) shows tuition per student, and the right-hand side is the wage cost of teachers per student. The price of education is determined by a

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zero-profit condition.[3] Using (4) and (5), we can derive the price of education:

$$p_t = e_{at}^{(1-\alpha)/\alpha}. \tag{6}$$

The price of education increases with an increase in the average education level.

Finally, we describe the consumption goods sector in which there exist many competitive firms. While the rich are employed in the education and consumption goods sectors, the poor are employed in only the latter. For simplicity, the production function is assumed to be linear:

$$Y_t = h(\bar{e}, e_{pt-1})(1-\lambda)L + h(\bar{e}, e_{rt-1})\left(\lambda L - L_t^T\right). \tag{7}$$

2.2. Individuals

We assume that parental preferences depend on consumption and the human capital stock of their children. The utility maximization problem for an individual born in period $t-1$ is expressed as

$$\max_{c_{it}, e_{it}} \beta \ln c_{it} + (1-\beta)\ln h(\bar{e}, e_{it}), \quad 0 < \beta < 1, \tag{8}$$

$$\text{s.t.} \quad \eta\bar{e} - v(\bar{e}) + \gamma e_{it-1} = c_{it} + p_t e_{it}, \tag{9}$$

where $i = r, p$. c_{rt} and c_{pt} are the respective consumption levels of the rich and poor.

Normalizing the price of consumption goods to unity, income is represented by the level of the human capital stock. Taxes used for elementary education are assumed to be equally levied because individuals receive the same education level. Given borrowing constraints, disposable income is used for consumption and higher education. The demand for higher education is represented as

$$p_t e_{it} = (1-\beta)\gamma e_{it-1} + b(e_{at}), \tag{10}$$

where $i = r, p$, and using (6), we define

$$b(e_{at}) \equiv (1-\beta)(\eta\bar{e} - v(\bar{e})) - \beta\eta\bar{e}\gamma^{-1}p_t = (1-\beta)(\eta\bar{e} - v(\bar{e})) - \beta\eta\bar{e}\gamma^{-1}e_{at}^{(1-\alpha)/\alpha}.$$

The amount of disposable income determines the demand for higher education. The income elasticity for educational expenditure is greater than unity. Everyone faces the same intercept point for educational expenditure, which is represented by $b(e_{at})$. This point becomes negative when the productivity of elementary education is low compared with the price of education. In this case, the educational expenditure of individuals with a low education level becomes zero. Furthermore, when $b(e_{at}) < 0$, given the price of education, the ratio of educational expenditure to parental education level increases with an increase in the education level. When

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$b(e_{at}) > 0$, on the other hand, its ratio decreases with an increase in the education level.

3. DIFFERENT EFFECTS OF ELEMENTARY AND HIGHER EDUCATION

The dynamics of education for the rich and poor are mutually dependent through the price of education because the price of education is the weighted average of the demands by the rich and the poor:

$$e_{rt} = \frac{(1-\beta)[h(\bar{e}, e_{rt-1}) - v(\bar{e})]}{p_t} - \beta\eta\bar{e}\gamma^{-1}, \tag{11}$$

$$e_{pt} = \frac{(1-\beta)[h(\bar{e}, e_{pt-1}) - v(\bar{e})]}{p_t} - \beta\eta\bar{e}\gamma^{-1}, \tag{12}$$

where $p_t = e_{at}^{(1-\alpha)/\alpha} = (h(\bar{e}, e_{rt-1})\tau_{at})^{1-\alpha}$, $e_{at} = \lambda e_{rt} + (1-\lambda)e_{pt}$, and

$$\tau_{at} + \beta\eta\bar{e}\gamma^{-1}h(\bar{e}, e_{rt-1})^{-\alpha}\tau_{at}^{1-\alpha} - (1-\beta)\frac{\lambda h(\bar{e}, e_{rt-1}) + (1-\lambda)h(\bar{e}, e_{pt-1}) - v(\bar{e})}{h(\bar{e}, e_{rt-1})} = 0.$$

How does the price of education change dynamically? Using (6) and (10), which are, respectively, the supply and demand conditions, we can represent the dynamics of the average education level as

$$f(e_{at}) = g(e_{at-1}), \tag{13}$$

where $f(e_{at}) \equiv e_{at}^{1/\alpha} + \beta\eta\bar{e}\gamma^{-1}e_{at}^{(1-\alpha)/\alpha}$ and $g(e_{at-1}) \equiv (1-\beta)[\eta\bar{e} - v(\bar{e}) + \gamma e_{at-1}]$.

Figure 1 illustrates (13).[4] $g(e_{at-1})$ in (13) includes the average disposable income in period $t-1$, which is represented by the average education level in that period. $f(e_{at})$ in (13), on the other hand, includes the average educational expenditure and the price of education in period t in which both of them can be represented by the average education level in that period. The average education level in period $t-1$ determines the average education level in period t. That is, the price of education is determined. Starting from $e_{a,-1}$ in Figure 1, the average education level increases and thereby the price of education increases. The education level converges to e^*. A rise in the productivity of higher education increases the education level in the steady state. The effect of the productivity of elementary education on the education level, on the other hand, is ambiguous. A change in η has two effects. The first effect is related to the income effect. An increase in the productivity of elementary education increases the demand for education because of an increase in parents' income. The second effect is related to the parental utility function. An increase in η increases the human capital stock of their children, and this reduces the demand for education.

We examine the case in which the intercept point for educational expenditure is negative in a steady state, i.e., $b(e^*) < 0$. This implies that parents with a

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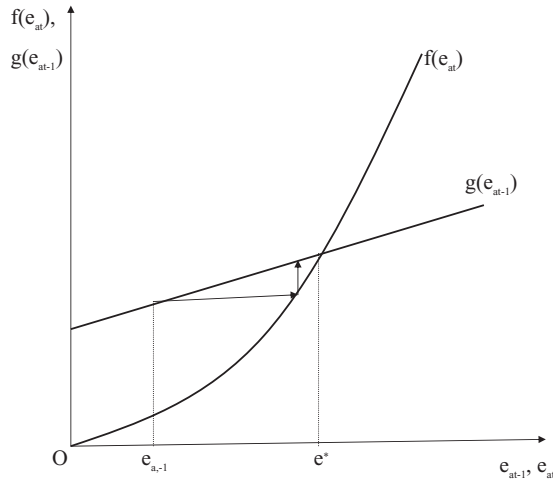

FIGURE 1. Dynamics of the average education level.

low level of higher education cannot finance educational expenditure for their children at the steady state. We define that $\Omega(e_a) \equiv f(e_a) - g(e_a)$. Obviously, $\Omega(e^*) = 0$. We also define the education level as $\hat{e}$ to make the intercept point for educational expenditure zero; i.e., $b(\hat{e}) = 0$. The price of education evaluated using $\hat{e}$ corresponds to the threshold for the educational expenditure of individuals with no higher education. Evaluating $\Omega(e_a)$ using $\hat{e}$, we get

$$b(e^*) < 0 \Leftrightarrow \Omega(\hat{e}) < 0 \Leftrightarrow \frac{1}{\beta}\left[1 - \frac{v(\bar{e})}{\eta\bar{e}}\right] < 1. \tag{14}$$

When the productivity of elementary education is low, $\Omega(\hat{e}) < 0$ is implied and $b(e^*) < 0$ holds because $\hat{e} < e^*$. In this case, the disposable incomes of parents with a low level of higher education become small. The income of the poor is then inadequate for educational expenditure as an increase in the price of education makes the expenditure a great burden on their budgets. A large demand for education by the rich makes the price of education too high for the poor.

Let us discuss the dynamics for which inequality (14) holds. Figure 2 shows the phase diagram.[5] Consider the case for which the initial point is represented by A. The initial education levels of both the rich and the poor are positive and their difference is small. The education levels increase for both in the early periods. The price of education is not too high for the poor to receive education because of a small difference in the income levels between the rich and the poor. Income inequality may be inconspicuous in these periods. However, the price of education increases more rapidly than the income of the poor because of the large demand for education by the rich. The education level of the poor decreases sooner or later. The average education level increases because of the more-than-offsetting increase in the education level of the rich, and thereby the price of education still

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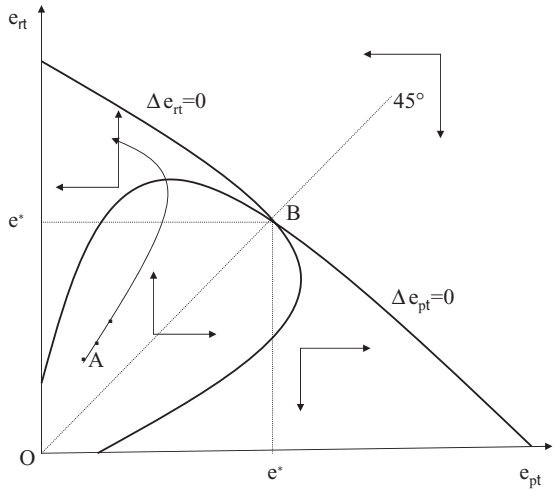

FIGURE 2. Phase diagram for case in which $b(e^*) < 0$.

increases. Increasing inequality then becomes serious. The education level of the poor falls to zero. The dynamics of education for the rich are the same as those of homogeneous individuals.[6]

Because the productivity of elementary education is crucial in inequality widening, the government should prevent the degradation of elementary education. In addition, government policies should reflect the fact that elementary and higher education have different effects on human capital accumulation and inequality.

NOTES

1. In the United States also, the increasing cost of education has made it more difficult for the poor to receive a higher education. See, for example, the *New York Times* (December 3, 2008).

2. Although Nakajima and Nakamura (2009) and Nakamura and Nakajima (2009) examined the effect of the increasing price of education on inequality, following Moav (2002) and Galor and Maov (2004, 2006), they allowed a zero bequest in the nonhomothetic utility function, which plays a crucial role in yielding multiple steady states. Furthermore, neither of them showed different effects of elementary and higher education.

3. Rothschild and White (1995) showed that prices charged to customers for what they get on net from the firm are competitive and support efficient allocation.

4. The dynamics of the average education level are the same as those for homogeneous individuals. Figure 1 considers the case in which $\alpha \leq 1/2$. Multiple steady states can emerge when the productivity of higher education is low in the case of $\alpha > 1/2$. A rise in its productivity can remove the poverty trap threshold. Note that our conclusion holds regardless of the multiplicity of steady states. Detailed results are available on request.

5. Point B is a saddle point. The saddle path is on the 45-deg line.

6. If the productivity of elementary education is high enough to ensure that $\Omega(\hat{e}) > 0$, $b(e^*) > 0$ holds. The income level of the poor is now enough to afford the rising cost of education. Income equality can be attained in the long run.

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