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The price of education and inequality[☆]

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ABSTRACT

Constructing a simple model that includes the price of education, this paper shows that the educational expenditure of rich households could prevent poor households from escaping poverty. The paper offers an explanation for persistent inequality.

1. Introduction

In some countries such as the U.S., Japan, and South Korea, students have to pay substantial fees for higher education, and the soaring costs of education sometimes cause controversy. In such a system, can education contribute to making the society more equal?

To theoretically examine this issue, the current paper constructs a simple model that incorporates an educational institute and the price of education. The model illuminates the following mechanism. The rich household's demand for higher education pushes up the price of education at a pace faster than one that the poor household can follow. Accordingly, the poor are gradually excluded from higher education, and consequently income inequality between the rich and the poor expands in the long run. This mechanism also implies that the high income of the rich, rather than trickle-down, could prevent the poor from escaping poverty.[1]

Many studies on persistent inequality, pioneered by Galor and Zeira (1993) and Banerjee and Newman (1993), have assumed an imperfect credit market and a non-convex technology as key factors.[2] Moav (2002) has shown that the second factor (a non-convex technology) can be replaced by a convex bequest function. While our paper follows Moav's framework, we add a new ingredient—the price of education—to the model. In Moav's paper, the poor can catch up with the rich if the initial education levels exceed a threshold. In contrast, our model suggests that regardless of how high the initial education level is, the poor may not catch up with the rich when the provision of higher education heavily depends on the revenues from tuition fees.[3]

2. Basic model

2.1. Identical households

This section examines the case of identical households as a benchmark. Identical households, totaling L in number, are born every period in an overlapping generations economy. Each household lives for two periods. A household born at period t − 1 receives bequest

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[1] The trickle-down mechanism proposed by Aghion and Bolton (1997) is as follows: as more capital is accumulated by the rich, more funds become available to the poor for investment purposes. Galor and Moav (2004) explain that physical capital accumulation by the rich raises the wage income of the poor, and thereby helps the poor escape from poverty.

[2] For example, see Ghatak and Jiang (2002) and Matsuyama (2000). Piketty (1997) argues that an imperfect credit market is the only factor necessary for the multiplicity of steady states, one of which has more unequal wealth distribution than the other.

[3] The current paper focuses on an education system that is privately funded. For the discussion on the desirability of public education, see Glomm and Ravikumar (1992), Bénabou (1996), Bräuninger and Vidal (2000), and Galor and Moav (2006).

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b_{t-1} from its parent. Using the bequest for education e_{t-1}, it forms human capital $h(e_{t-1})$. For simplicity, we assume that credit for educational expenses is not available.[4] Under the credit constraint, the educational expenditure is given by

$$p_{t-1}e_{t-1} = b_{t-1}, \tag{1}$$

where p_{t-1} denotes the price of education. In the next period, the household earns income $h(e_{t-1})$,[5] and spends it for both consumption c_t and bequest b_t. Following Moav (2002), Galor and Moav (2004), and others, we assume that the household's utility u_t is given as:

$$u_t = \beta \log c_t + (1-\beta)\log(b_t + \theta),$$

where a positive constant θ is incorporated in order to make bequest b_t a convex function of income. The budget constraint is given by

$$c_t + b_t = h(e_{t-1}).$$

For simplicity, let us assume that human capital is linear with respect to education:

$$h(e_{t-1}) = \gamma e_{t-1} + \delta.$$

As a result, the household will decide the amount of the bequest in the following way:

$$b_t = Ae_{t-1} - B \quad \text{if} \quad Ae_{t-1} - B \geq 0, \tag{2}$$

$$b_t = 0 \quad \text{if} \quad Ae_{t-1} - B < 0, \tag{3}$$

where $A = (1-\beta)\gamma$ and $B = \beta\theta - (1-\beta)\delta$. We assume $B > 0$, which implies that the bequest function is convex. Subsequently, we examine the case of (2). From Eqs. (1) and (2), the educational expenditure at period t is

$$p_t e_t = Ae_{t-1} - B. \tag{4}$$

2.2. Educational institute

Let us assume that a non-profit organization manages the production of education. Education is an outcome of collaboration between students and teachers. Accordingly, the total amount of education E_t may be subject to the Cobb–Douglas function:

$$E_t = \left(L_t^{\mathrm{S}}\right)^{1-\alpha}\left(h(e_{t-1})L_t^{\mathrm{T}}\right)^{\alpha},$$

which implies that if the number of students L_t^{S} and the total human capital of teachers $h(e_{t-1})L_t^{\mathrm{T}}$ are doubled, E_t is doubled. The education per student is given by

$$e_t = \frac{E_t}{L_t^{\mathrm{S}}} = (h(e_{t-1})\tau_t)^{\alpha},$$

where τ_t $(= L_t^{\mathrm{T}}/L_t^{\mathrm{S}})$ denotes the ratio of teachers to students. This implies that although an increase in the ratio of teachers to students can raise the education per student, the effect would be subject to

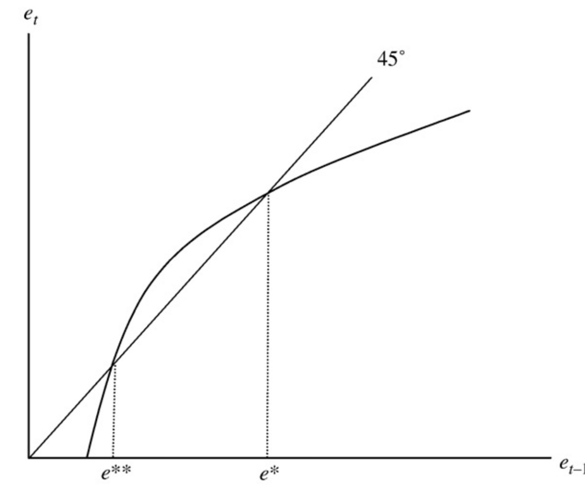

Fig. 1. Identical households.

diminishing returns. For convenience, we use the inverse form of the above production function:

$$h(e_{t-1})\tau_t = e_t^{1/\alpha}, \tag{5}$$

which means that as the education per student becomes higher, an additional increase in e requires increasing amounts of input per student (and hence the marginal cost would be increasing). When teachers have the same human capital as other workers, the teacher's wage should be $h(e_{t-1})$. In addition, we assume that the price of education p_t is determined by the zero-profit condition:[6]

$$p_t E_t = h(e_{t-1})L_t^{\mathrm{T}}.$$

Since $L_t^{\mathrm{S}} = L$ when all members of the generation become students, dividing both sides of the above equation by L gives

$$p_t e_t = h(e_{t-1})\tau_t. \tag{6}$$

2.3. Equilibrium dynamics of e

From Eqs. (4), (5), and (6), we obtain the equation describing the equilibrium dynamics of e:

$$e_t = (Ae_{t-1} - B)^{\alpha}, \tag{7}$$

which is drawn in Fig. 1. We assume that two stationary states exist. While stationary state e^{**} is unstable, stationary state e^* is stable. If the initial education level e_{t-1} is below the threshold e^{**}, e goes toward zero—the poverty trap catches households. However, if the initial level of e exceeds e^{**}, e goes toward e^*. This result is similar to the one in Moav's (2002) model.

3. Model with inequality

3.1. Dynamics of average education

Now let us divide households into two groups: rich households and poor households, and suppose that the only difference between them is in their initial levels of education. We focus on the situation in which the initial levels are above e^{**}:

$$e^{**} < e_{t-1}^{\mathrm{P}} < e_{t-1}^{\mathrm{R}}, \tag{8}$$

[4] Even if borrowing is possible, our results will not change when the upper limit of borrowing is set low.

[5] We implicitly assume that, in the competitive market of homogenous goods, firm j maximizes the profit $\Pi^j = Y^j - \sum_{i=1}^{L^j} wh_i(e_i)$ subject to the production function $Y^j = \sum_{i=1}^{L^j} h_i(e_i)$, where the goods price is normalized as unity; Y^j denotes the output of firm j; L^j the number of the workers employed by firm j; and w the wage rate of effective labor. In equilibrium, $w = 1$ must hold. As a result, the wage of worker i becomes $h_i(e_i)$.

[6] Using a model where the students are inputs, Rothschild and White (1995) show that efficient prices are zero-profit prices.

where e^{P} and e^{R} denote the education levels of the poor and the rich, respectively. Instead of Eq. (4), the educational expenditures of rich and poor households are given by

$$p_t e_t^{\mathrm{R}} = A e_{t-1}^{\mathrm{R}} - B, \tag{9}$$

$$p_t e_t^{\mathrm{P}} = A e_{t-1}^{\mathrm{P}} - B. \tag{10}$$

Let η denote the initial ratio of the rich to the total population: $\eta \equiv L^{\mathrm{R}}/L$. Then, the aggregate expenditure on education becomes

$$p_t\left(\eta e_t^{\mathrm{R}} + (1-\eta)e_t^{\mathrm{P}}\right)L = \left(A e_{t-1}^{\mathrm{R}} - B\right)\eta L + \left(A e_{t-1}^{\mathrm{P}} - B\right)(1-\eta)L.$$

Defining the average level of education as $e_t^{\mathrm{A}} = \eta e_t^{\mathrm{R}} + (1-\eta)e_t^{\mathrm{P}}$, we have

$$p_t e_t^{\mathrm{A}} = A e_{t-1}^{\mathrm{A}} - B. \tag{11}$$

Further, let us assume that the households that received more education (i.e., the rich) can become teachers and a teacher's wage is $h(e_{t-1}^{\mathrm{R}})$. Then, instead of Eqs. (5) and (6), we have the input function and zero-profit condition as follows:

$$h\left(e_{t-1}^{\mathrm{R}}\right)\tau_t = \left(e_t^{\mathrm{A}}\right)^{1/\alpha}, \tag{12}$$

$$p_t e_t^{\mathrm{A}} = h\left(e_{t-1}^{\mathrm{R}}\right)\tau_t. \tag{13}$$

From Eqs. (11)–(13), we get

$$e_t^{\mathrm{A}} = \left(A e_{t-1}^{\mathrm{A}} - B\right)^{\alpha}. \tag{14}$$

Eq. (14) is identical to Eq. (7), and hence e^{A} goes toward e^*. From Eqs. (12) and (13), we obtain

$$p_t = \left(e_t^{\mathrm{A}}\right)^{(1-\alpha)/\alpha}. \tag{15}$$

Thus, the price of education increases along with e^{A}.

3.2. Dynamics of e^R and e^P

While the behavior of average education is similar to that in the case of identical households, the education levels of the poor and the rich behave differently. Taking into account Eqs. (14) and (15), we can rewrite Eqs. (9) and (10) as

$$e_t^{\mathrm{R}} = \frac{A e_{t-1}^{\mathrm{R}} - B}{\left[\eta A e_{t-1}^{\mathrm{R}} + (1-\eta)A e_{t-1}^{\mathrm{P}} - B\right]^{(1-\alpha)}}, \tag{16}$$

$$e_t^{\mathrm{P}} = \frac{A e_{t-1}^{\mathrm{P}} - B}{\left[\eta A e_{t-1}^{\mathrm{R}} + (1-\eta)A e_{t-1}^{\mathrm{P}} - B\right]^{(1-\alpha)}}. \tag{17}$$

Notice that e^{R} and e^{P} are connected to each other through the price of education. Fig. 2 describes the behavior of e^{R} and e^{P} given by Eqs. (16) and (17), respectively. Point E in Fig. 2 is a saddle point, and therefore e^{P} does not reach e^* while e^{R} passes through e^* as indicated by arrow C. Thus, we have the following proposition.

Proposition 1. *Even if the initial education levels of both the poor and the rich exceed e**, the poor cannot attain e*. The education level of the poor may increase initially, but after some periods, it starts decreasing due to the rising price of education. On the other hand, the rich raise their education levels beyond e*, overcoming the effects of the rising prices.*

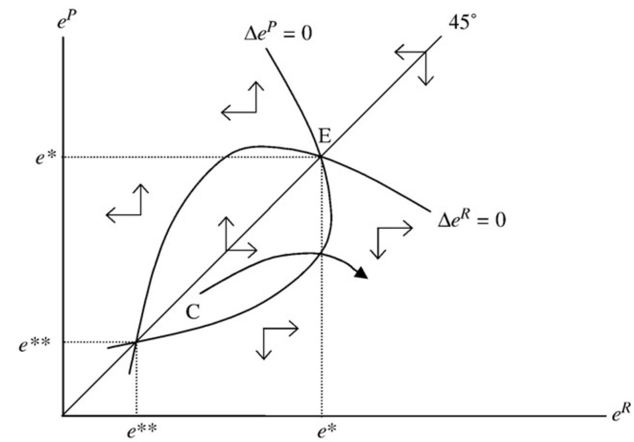

Fig. 2. Rich households and poor households.

Notice that if there were no rich household ($\eta = 0$) or $e_{t-1}^{\mathrm{R}} = e_{t-1}^{\mathrm{P}}$, Eq. (17) would have been $e_t^{\mathrm{P}} = (A e_{t-1}^{\mathrm{P}} - B)^{\alpha}$. Then, since $e_{t-1}^{P} > e^{**}$, the poor could have attained e^*. Thus, our model suggests that the high income of the rich, rather than trickle-down, may prevent the poor from escaping low income.

4. Conclusion

Our model describes the following situation. Assume an education system that depends on revenues from tuition fees. When the initial gap between the rich and the poor is narrow, the poor may raise their education levels in the early periods. However, such periods would not last long because rich households' demand for education increases at a faster pace and thereby raises the price of education. The poor would not be able to follow the pace at which the price of education is increasing. In the end, the poor would be excluded from education. This could be an explanation to the rise in income inequality.

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