Pollution, Health Status and Economic Growth

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Abstract. In view of the developed or underdeveloped countries will be faced the problems of pollution, aging, obesity and other health problems. We will apply an endogenous growth model embodying the pollution protection, health and foreign aid. We find that the aid-tying ratio has a positive impact on the equilibrium growth rate. The growth effect of an increase in the tying-ratio of aid on health is uncertain.

Keywords: foreign aid, pollution abatement, economic growth

1. Introduction

Economic growth has a direct positive impact on the level of output of a country; and the presence of positive externalities in the system in a highly potent engine of economic growth. Positive externalities arise from public infrastructural capital, health capital, while negative externalities come from environmental pollution, congestion effect due to physical capital accumulation, etc. These kinds of externalities lead to coordination failure of private agents who take decisions without internalizing these externalities. Recently, a number of theoretical studies, such as Aísa and Pueyo (2006), and Bhattacharya and Qiao (2007), have investigated the relationship between health and economic growth. These studies, however, ignored the importance of international health aid on the economic growth and social welfare of low- and middle-income countries

The growth and welfare effects of aid make up the central theme, but the findings are not consistent. A number of previous empirical studies have observed that the foreign aid has had a positive effect on the economic growth rate of the recipient countries. Such studies include Davenport (1970), Levy (1987), and Mosley et al. (1987). Others studies have found that the effect of foreign aid is insignificant on economic growth in poor countries. Notable examples in the literature are Pillai (1982), Collier and Dehn (2001), and Easterly (2003). The common characteristic of the empirical literature on aid and growth is the lack of a theoretical framework.

Chenery and Strout (1966) examined this issue using the Harrod-Domar model of exogenous growth. More recently, Chatterjee and Turnovsky (2007) extended the case to a model of endogenous growth by considering tied aid that is completely linked to infrastructure investment. However, according to the Organization for Economic Cooperation and Development (OECD) 2006 Report, most aid is only partially tied to the economic infrastructure, social infrastructure, and multiple sectors (at rates of 17%, 40%, and 6%, respectively) and so on.[1] In addition, as a result of increased environmental consciousness and protection, donor countries require that aid be tied to environmental protection (e.g., the United Nations' nature swap aid) or health care. Figure 1 illustrates the development of health aid since 1973. From this figure, it can be seen that health aid has been increasing at an average annual growth rate of 5.4%, and this growth rate even accelerated to 13% between 1998~2002.

Based on such an observation, we attempt to use a simple endogenous growth model with special focus on the role of environmental pollution, health capital and foreign aid. It investigates the growth effects of the allocation of foreign aid in the case of the recipient economy.

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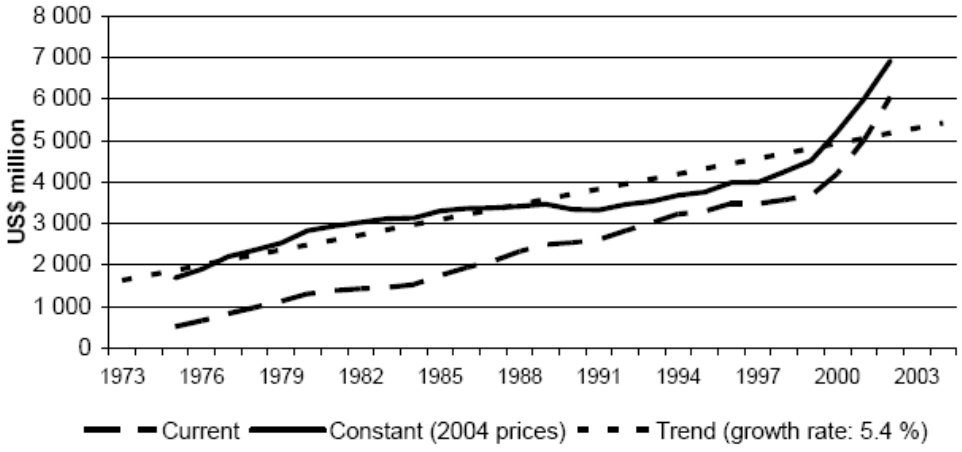
[1] Economic infrastructure includes transportation and storage, communications, energy generation and supply, banking and financial services, and business and other services, whereas social infrastructure includes education, health, population policies and so on. Multisectors include general environmental protection, women in development and other multi-sectors.

The remainder of this paper is organized as follows. Section 2 presents the analytical framework. Section 3 examines the growth effect of the allocation of aid on health and pollution abatement. Section 4 offers some concluding remarks.



2. The model

We consider an economy that consists of a representative, infinitely-lived household and a government. The representative household derives positive utility from consumption C and health status H, and derives negative utility from the stock of pollution P. The objective of the representative household is to maximize the discounted sum of future instantaneous utilities:

$$Max \int_0^{\infty} U(C,H,P)e^{-\rho t}dt \tag{1}$$

where U is the utility function and ρ is the subjective time preference rate. To avoid unnecessarily complex mathematical operations, we specify the instantaneous utility function as:

$$U(C,H,P) = \ln C + \xi \ln H - \eta \ln P; \quad \xi,\eta > 0 \tag{2}$$

where ξ and η measures the impacts of health and pollution on the utility of the household, respectively.

The goods production function is assumed to take a Cobb-Douglas form, that is:

$$Y = H^{\beta}K^{1-\beta} \tag{3}$$

where output, Y, is produced with a constant returns to scale technology that uses the health capital H, and the private capital stock K as inputs.

At each instant of time, the representative household faces a flow constraint of capital accumulation based on the difference between revenue (output plus government transfers *T*) and consumption expenditure. The household's budget constraint is given by:

$$\dot{K} = Y - C + T \tag{4}$$

where a dot over a variable denotes the rate of change with respect to time

The household chooses consumption *C* to maximize utility in equation (1), subject to the budget constraint in equation (4). The current-value Hamiltonian function is given by:

$$L = \ln C + \xi \ln H - \eta \ln P + \lambda[H^{\beta}K^{1-\beta} - C + T] \tag{5}$$

where λ is the co-state variable that can be interpreted as the shadow value of the private capital stock measured in utility terms.

From equation (5), the first-order optimality conditions are as follows:

$$\frac{1}{C} = \lambda \tag{6a}$$

$$[(1-\beta)H^{\beta}K^{-\beta}]\lambda = -\dot{\lambda} + \rho\lambda \tag{6b}$$

$$\lim_{t\to\infty} \lambda K e^{-\rho t} = 0 \tag{6c}$$

The pollution flow can be described as being positively related to the production function and negatively related to public abatement M, and then the accumulation of the pollution stock is given by:

$$\dot{P} = \left(\frac{M}{Y}\right)^{-\mu} Y \tag{8}$$

Health capital implies the physical efficiency of the representative worker; and all the workers derive equal benefit from the expenditure on health capital made by the government and loss from the environment pollution. The law of accumulation of the stock of health capital is given by the following equation:

$$\dot{H} = G_H^{1+\omega} P^{-\omega} \tag{9}$$

As for the government, the country receives foreign aid R. Following Chatterjee and Turnovsky (2007), the amount of aid is measured by ϕ percent of output Y of the economy (i.e. $R = \phi Y$). In addition, a portion υ of the aid is required for spending on health and infrastructural investments, with rates of δ and $(1-\delta)$ percent, respectively, while the $(1-\upsilon)$ portion of the aid is a lump-sum transfer to the household. The government budget constraint can be clearly described as follows:

$$g = M + G_H = R - T \tag{10a}$$

$$T = (1-\upsilon)R \tag{10b}$$

$$M = \upsilon(1-\delta)R \tag{10c}$$

$$G_H = \upsilon\delta R \tag{10d}$$

$$R = \phi Y \tag{10e}$$

3. Long-Run Growth

In this section, let us show here how aid allocation governs the long-run equilibrium of the economy. First, following Futagami et al. (1993) and Barro and Sala-i-Martin (1995), we define the following new stationary variables which remain constant along the balanced-growth path:

$$x = \frac{C}{K}, \quad y = \frac{K}{H}, \text{ and } \quad z = \frac{P}{H}$$

The dynamic system of the economy in terms of the transformed variables x, y, and z. The steady-state equilibrium can be derived by setting $\dot{x} = \dot{y} = \dot{z} = 0$, and then we can then analyze the impact of aid allocation on the long-run growth rate $\tilde{\gamma}$ as follows:

$$\frac{\partial\tilde{\gamma}}{\partial\upsilon} > 0 \quad \text{and} \quad \frac{\partial\tilde{\gamma}}{\partial\delta} \lessgtr 0 \tag{11}$$

Equation (11) indicates that the economic growth rate is enhanced by increasing the aid-tying ratio υ, while the impacts of an increase in the tying-ratio of aid on health δ on the growth rate are uncertain.

4. Concluding Remarks

Underdeveloped countries are very well known for being characterized by their low income, their shortages of basic life necessities and the scarcity of their medical facilities (resources), all of which increase the risks of diseases reaching epidemic proportions. Such outbreaks of epidemics will cause labor production efficiency to be low, with the result that the country is unable to break out of poverty.

Developed countries as well as international organizations provide foreign aid for poor countries, and expect that they will escape from the poverty that ensnares them in accordance with the humanitarian effort. Under these circumstances, it needs to be asked, however, whether the economic growth of the recipient countries improve because of their accepting foreign aid. Besides, with increased environmental consciousness and protection, donor agencies often require that aid be tied to environmental protection. What

influence, then, does such a limitation have on the economic growth and welfare levels of the recipient countries? In order to understand these questions, we try to use a simple endogenous growth model embodying foreign aid, expenditures on pollution abatement and health, and then investigate the allocation of aid and their relationships with economic growth from the point of view of the recipient economy.

There are two main findings in this paper. Firstly, the economic growth rate is found to increase with the aid-tying ratio, because the share helping the production of goods is increased. Secondly, an increase in the tying-ratio of aid on health has an ambiguous impact on the equilibrium growth rate.

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