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Aid Effectiveness, Governance and Public Investment

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Aid Effectiveness, Governance and Public Investment[1]

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Abstract

To analyze ways in which aid can be made more effective, we develop a growth model in which aid finances infrastructure investment and pro-poor spending. We assume that the recipient countries are aid-dependent in the early phase of development and ultimately become independent. In the model, donors can accelerate the independence of a recipient from aid by investing in infrastructure. We demonstrate that even a small increase in aid can improve aid effectiveness and that aid effectiveness depends more on growth rates than on the efficiency of government. This paper also evaluates Japan's aid, which has strength in economic infrastructure.

Keywords: aid effectiveness; governance; infrastructure; pro-poor expenditure; Japan's aid
JEL classification: F35; O11; O20

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1 Introduction

How aid should be allocated among developing countries and under what circumstances it can be used to promote growth have been discussed extensively in the literature on aid effectiveness, and yet there is no clear answer to these questions, as will be seen below. As in Easterly (1999), even in the 1990s, economists in international financial institutions were applying the Harrod-Domar model, which had long since been discarded in the academic literature. The model calculates investment requirements for a target growth rate but unfortunately does not offer any clue to understanding how aid works. This episode illustrates that donors have devoted considerable resources to encouraging development and reducing poverty in recipient countries, without knowing how to improve aid effectiveness.

The question at issue is the relationship between policy and aid effectiveness. Burnside and Dollar (2000) find that aid has a positive impact on growth in developing countries with good policies, but has little effect in the presence of poor policies.[1] Their finding suggests that the poverty-efficient allocation of aid depends on the quality of policy and that countries with better policies should receive more aid inflows (Collier and Dollar, 2002). However, some researchers provide empirical evidence that contradicts this finding (Dalgaard and Hansen, 2001; Lensink and White, 2001; Dalgaard et al., 2004; Easterly et al., 2004; Roodman, 2007; Rajan and Subramanian, 2008). These studies focus on inter-recipient allocation, which has the maximum effect on growth or poverty reduction. At present, therefore, we know little about the poverty-efficient, inter-recipient allocation.

We also lack insight into what constitutes efficient inter-sectoral allocation in a recipient country. Many papers provide empirical evidence that transport and other economic infrastructure has a positive effect on growth (Easterly and Rebelo, 1993; Gupta et al., 2005; Neanidis and Varvarigos, 2007; Canning and Pedroni, 2008). Recently, however, donors have been focusing on pro-poor expenditure (PPE) in sectors such as health and education, rather than on infrastructure (Paternostro et al., 2007). Donors place greater emphasis on Millennium Development Goals (MDGs), and hence allocate more to social sectors. As a result, economic sectors receive

[1] Although they focus on fiscal, monetary and trade policies, other national characteristics such as good institutions and corruption may also affect aid effectiveness. See, for example, Dalgaard and Hansen (2001), Collier and Dollar (2002), Mosley et al. (2004) and Rajkumar and Swaroop (2008).

a relatively small proportion of total aid provided by most donors.

The purpose of this paper is to show how to make aid effective by presenting a simple and tractable framework for analyzing aid policies. As we explain below, we explicitly model public investment, which contributes growth, as well as PPE, and hence the model takes into account inter-sectoral allocation. This model can be used to evaluate the policy of donors such as Japan, which consistently places importance on the role of infrastructure investment in recipient countries.

A distinguishing feature of this study is that we consider a process in which aid-dependent countries ultimately become independent. In fact, countries such as Japan and Singapore were dependent on foreign aid in the early stages of their own development. Today, of course, Japan is one of the world's largest donors of aid and Singapore is entirely aid-independent. These examples demonstrate that countries can become less dependent on aid if they achieve rapid growth (while others may become more aid-dependent, if they experience low growth). In theory, there are many growth models in which aid is a determining factor, but they assume that recipient countries continue to receive aid indefinitely in a steady state (Lensink and White, 2001; Chatterjee et al., 2003; Chatterjee and Turnovsky, 2007; Neanidis and Varvarigos, 2007; Kalaitzidakis and Kalyvitis, 2008). As mentioned above, if recipients sustain growth, they become less dependent on aid. Hence, we assume in our model that aid-dependent countries ultimately become independent.

The second feature of this study is that we focus on the effect of total aid over the long run rather than on the influence of short-term aid flows. In reality, aid flows vary across countries and over time because the amount required to cover the costs of investment and PPE varies, as does tax revenue. It is not appropriate to assume that the effect of a dollar increase in aid is constant across countries and over time.[2] To avoid this, we use total aid over the long run rather than aid flows in the steady state.

More importantly, inter-sectoral allocation varies across recipient countries. Aid directed at infrastructure is greater in some countries than in others. Moreover, even though public investment contributes to economic growth, the point when projects yield returns varies across

[2]Some studies provide evidence for diminishing returns to aid. See, for example, Lensink and White (2001) and Collier and Dollar (2002).

projects (Clemens et al., 2004). Note that PPE may also have a positive impact on productivity in the long run because it reduces infant mortality rates, as shown in Mosley et al. (2004) and Gomanee et al. (2005). In addition, the extent to which aid finances growth-enhancing investment varies, depending on the recipient's tax revenue. Hence, examining the short-term relationship between the amount of aid and growth rates does not necessarily provide useful information about aid effectiveness. In this paper, to clarify the effect of a dollar increase in aid, we assume that every year recipients require a constant level of PPE, which is calculated by an ex ante poverty level and a target level, and that PPE and infrastructure investment are financed by tax revenue and foreign aid (aid is used if tax revenue is insufficient). In this framework, we can measure aid effectiveness by calculating the growth effects of total aid over the long run (growth rate/total aid).

In the next section, we present a theoretical model in which a recipient government uses tax revenue to pay for the costs of infrastructure and PPE. Foreign aid compensates for deficits; as long as the economy grows, tax revenue increases and hence deficits and aid inflows decrease. In this model, the timing of independence (the point at which donors stop giving aid) depends on the level of poverty, the rate of tax, the efficiency of government, population growth and the target rate of growth.

In Section 3, we derive the target growth rate that maximizes the impact of total aid on growth. High target growth rates require more aid for infrastructure initially but higher growth rates increase tax revenue later and enable a recipient to become aid-independent more quickly. Hence, higher target growth rates do not necessarily increase total aid in the long run. We find that there is a target growth rate that maximizes the ratio of steady-state growth rate to total aid over the entire period. In this paper, this ratio is used as the measure of aid effectiveness. We calculate the desirable target growth rate numerically using parameters for the economic conditions of recipient countries.

In Section 4, to extract more practical information from the model, at given rates of growth, we examine what policies are effective and can accelerate independence from foreign aid. We find that a rise in target growth rates can improve aid effectiveness without creating a large financial burden because it accelerates the independence. We also examine the effect of governance and that of tax rates on aid effectiveness. In Section 5, we evaluate Japanese aid, which supports infrastructure investment in Asian developing countries, and conduct experiments to investigate the efficient allocation of aid. Our experiments suggest that governance affects aid effectiveness but its impact is much smaller than that of target growth rates. Unlike the poverty-efficient allocation in Collier and Dollar (2002), which emphasize the importance of a good policy environment for aid to work, our result implies that donors can improve aid effectiveness by giving aid to slow-growing economies, even if these recipients have bad policies and institutions.

2 Theoretical Framework

2.1 Basic set-up of the model

We develop a simple growth model to examine the relationship between a target growth rate and aid inflows required to balance the government budget. The representative, infinite-lived household in a recipient country seeks to maximize utility given by

$$U = \sum_{t=0}^{\infty} \beta^t \frac{c_t^{\gamma}}{\gamma} \tag{1}$$

where c_t is consumption at time t, $0 < \beta < 1$ is the subjective discount rate and $\gamma < 1$ (γ determines the elasticity of intertemporal substitution). We consider the representative household in the economy to simplify the analysis; however, we implicitly assume shortages of government services such as healthcare and primary education. We introduce transfer payments that compensate for the lack of services. This income transfer represents PPE. In addition, the government spends on public capital that can improve the productivity of private factor inputs. If tax revenue is insufficient, donors provide financial assistance. We denote the per capita aid at time t by a_t, and aid flows to this recipient at time t are given by

$$a_t L_t = s L_t + I_t^G - \epsilon \tau Y_t \tag{2}$$

where L_t is population at t, I_t^G is public investment, Y_t is national income, τ is the tax rate on income, $\epsilon \in (0, 1]$ represents the efficiency of the government, and s is the per capita transfer

(PPE), which is constant over time.[3] The efficiency of government ϵ, which measures the level of governance, is the proportion of tax revenue that is actually used for PPE and public investment; $1-\epsilon$ is the proportion of revenue that is wasted because of corruption and red tape. No resource is wasted only if $\epsilon = 1$, and small values of ϵ correspond to weak governance. This implies that financing aid projects and programs are inefficient because of corrupt officials and red tape in countries where governance is weak.[4]

Each household uses labor, private capital and public capital, which is provided to producers without user charges. The accumulation equation for private capital K_t is

$$K_{t+1} = (1-\delta)K_t + (1-\tau)Y_t - c_t L_t \tag{3}$$

and the accumulation equation for public capital G_t is

$$G_{t+1} = (1-\delta_G)G_t + I_t^G = (1-\delta_G)G_t + \epsilon\tau Y_t + a_t L_t - sL_t \tag{4}$$

where δ and δ_G are depreciation rates for private capital and public capital, respectively. Since the government transfer represents goods and services directly given to people suffering from a lack of basic needs, s does not contribute to the accumulation of private capital in (3). While ϵ affects the accumulation of public capital in (4), it does not change tax revenue and hence does not have an impact on after-tax income in (3). The second equality in (4) implies that aid flows shown in (2) compensate for the lack of tax revenue.

The production function is

$$Y_t = y_t L_t = A k_t^{\sigma} G_t^{1-\sigma} L_t \tag{5}$$

where $0 < \sigma < 1$, $y_t = Y_t/L_t$ and $k_t = K_t/L_t$. This production function is used in Futagami

[3]In practice, total PPE can change over time. As an economy grows, PPE may decrease; however, if growth exacerbates inequality, PPE may increase. Even if income distribution does not change, population growth can increase the population below the poverty line and then PPE increases. In this paper, by assuming that the per capita transfer is constant, we examine the effect of an increase in total PPE, which is caused by population growth, and that of an increase in tax revenue, which is caused by economic growth.

[4]Here, we assume that the wasteful use of resources is proportionate to the size of government revenue. While aid resources from donors may also be wasted, we assume that tax revenue is more likely than aid to be wasted. There are two justifications for this assumption. First, aid can mitigate the incentives for social groups to engage in rent-seeking activities as shown in Svensson (2000). Second, repayment obligations can prevent recipients from wasting aid resources in the case of loan, which is used for infrastructure aid. Note that, even in our setting, this inefficiency makes donors overpay corrupt governments for given levels of PPE and infrastructure investment.

et al. (1993). We assume that the rate of population growth is $n \geq 0$; hence $L_{t+1} = L_t(1+n)$. From (3), we obtain $k_{t+1} + c_t + nk_{t+1} = (1-\delta)k_t + (1-\tau)y_t$, which is the household budget constraint.

Each household maximizes (1) subject to the constraint above, given the level of public capital at every t. The solution must satisfy the first-order conditions and the transversality condition. The first-order conditions are given by

$$c_t^{\gamma-1} = \beta\lambda_{t+1} \tag{6}$$

$$\lambda_{t+1}(1+n) = \beta\lambda_{t+2}\{1-\delta+(1-\tau)\sigma A k_{t+1}^{\sigma-1} G_{t+1}^{1-\sigma}\} \tag{7}$$

where λ_t is the Lagrange multiplier on the household budget constraint. From (6) and (7), we obtain

$$\frac{c_{t+1}}{c_t} = \left(\frac{\beta}{1+n}\right)^{\frac{1}{1-\gamma}} \left(1-\delta+(1-\tau)\sigma A\left(\frac{G_{t+1}}{k_{t+1}}\right)^{1-\sigma}\right)^{\frac{1}{1-\gamma}} \tag{8}$$

We obtain, from (3),

$$\frac{k_{t+1}}{k_t} = \frac{1}{1+n}\left(1-\delta+(1-\tau)A\left(\frac{G_t}{k_t}\right)^{1-\sigma} - \frac{c_t}{k_t}\right) \tag{9}$$

and, from (4),

$$\frac{G_{t+1}}{G_t} = 1-\delta_G + \left(\epsilon\tau A k_t^{\sigma} G_t^{1-\sigma} + a_t - s\right)\frac{L_t}{G_t} \tag{10}$$

2.2 Balanced growth

Equations (8), (9) and (10) describe the dynamic behavior of the economy. The remainder of this paper focuses on a balanced growth path, in which k_t and c_t grow at the constant rate g, which is the target growth rate of G_t determined by donors (as will be explained below). We define $x_t \equiv G_t/k_t$ and $z_t \equiv c_t/k_t$. We obtain, from (8) and (9),

$$\frac{z_{t+1}}{z_t} = \frac{c_{t+1}}{c_t}\frac{k_t}{k_{t+1}} = \left(\frac{\beta}{1+n}\right)^{\frac{1}{1-\gamma}} \left(1-\delta+(1-\tau)\sigma A x_{t+1}^{1-\sigma}\right)^{\frac{1}{1-\gamma}} \frac{1+n}{1-\delta+(1-\tau)A x_t^{1-\sigma} - z_t} \tag{11}$$

and, from (9) and (10),

$$\frac{x_{t+1}}{x_t} = \frac{G_{t+1}}{G_t}\frac{k_t}{k_{t+1}} = \frac{(1+g)(1+n)}{1-\delta+(1-\tau)Ax_t^{1-\sigma}-z_t} \tag{12}$$

The stationary solution of the system ($x_{t+1} = x_t = x$, $z_{t+1} = z_t = z$) shows that, from (11),

$$z = 1-\delta+(1-\tau)Ax^{1-\sigma} - \left(\frac{\beta}{1+n}\right)^{\frac{1}{1-\gamma}} \left(1-\delta+(1-\tau)\sigma Ax^{1-\sigma}\right)^{\frac{1}{1-\gamma}}(1+n) \tag{13}$$

and, from (12),

$$z = -(1+g)(1+n)+1-\delta+(1-\tau)Ax^{1-\sigma} \tag{14}$$

Equations (13) and (14) determine the steady state values of x and z. Unlike growth models with public capital such as Barro (1990), the government does not have to finance public investment through taxation on domestic income alone. As described in (4), foreign aid compensates for the lack of tax revenue. Since our purpose is to evaluate aid policies, we assume that donors control the target growth rate g along a path determined by (10).

Assumption The donor chooses a sequence of aid flows $\{a_0, a_1, ..., a_T\}$ to achieve the constant target growth rate of public capital g.

This assumption implies that the donor gives aid to the recipient from time 0 to T. As will be shown, T represents the time period over which the donor gives aid and depends on the target growth rate g, population growth rate n, tax rate τ, and transfer s. Suppose that at time $t = 0$ tax revenue is not enough to finance PPE and infrastructure investment. As this economy grows, tax revenue increases. At time $t = T$, the recipient government raises enough money and becomes financially independent from donors. This paper focuses on the period from time 0 to T. To ensure consistency, however, we assume that after time T the recipient government gives resources to other poorer countries and retains the target growth rate g (the recipient will eventually become a donor).

From (10), for the steady state values of x and z, the per capita aid at time t is given by

$$a_t = s+(g+\delta_G)\frac{G_0}{L_0}\left(\frac{1+g}{1+n}\right)^t - \epsilon\tau Ax^{-\sigma}G_0(1+g)^t \tag{15}$$

where G_0 and L_0 are, respectively, public capital and population at time 0. We define T as the earliest possible time t that satisfies $a_t \leq 0$.[5] The first term of the right-hand side of (15) is the per capita transfer, the second term represents the cost of public investment and the third term denotes tax revenue. We assume that $a_0 > 0$. As the recipient country grows, tax revenue increases and reduces the burden of foreign aid; once $a_t \leq 0$ holds at time T, aid is not necessary after that. Thus, T represents how long the donor gives aid to the recipient. From (15), aid inflows at each t are given by

$$a_t L_t = (g + \delta_G) G_0 (1+g)^t - (\epsilon \tau A x^{-\sigma} G_0 (1+g)^t - s) L_0 (1+n)^t \tag{16}$$

The second term of the right-hand side suggests the following: 1) when tax revenue is not sufficient because of low income, as the population increases, aid inflows increase; 2) once tax revenue outweighs the cost of PPE, as the population and income increase, aid inflows decrease steadily. Thus, population growth increases aid inflows when income is low. However, if tax revenue outweighs the cost of PPE, population growth as well as income growth decreases aid inflows. Even when $n = 0$, as long as $g + \delta_G < \epsilon \tau A x^{-\sigma} L_0$ holds at $t = 0$, aid decreases as tax revenue increases. In this paper, we focus on the case where aid decreases to zero. If $n > 0$, aid surely decreases to zero. Figure 1 illustrates a time path of aid inflows (time t on the horizontal axis and $a_t L_t$ on the vertical axis).

The time path of aid depends on parameters such as the rate of population growth and the rate of tax. As illustrated in Figure 1, in this model the amount of aid varies over time while the economy grows at a constant rate. This suggests that it is not appropriate to measure aid effectiveness based on the impact of aid flows in the short run. In this paper, we measure aid effectiveness based on the total aid from time 0 to T. The present value of the total aid flows is given by

$$AID \equiv \sum_{t=0}^{T} \frac{a_t L_t}{(1+r)^t} \tag{17}$$

where r is the interest rate, which is exogenous. Note that AID depends on T. Since infrastructure aid has a negative effect on T, an increase in aid flows does not necessarily increase

[5] In (15), a time t that satisfies $a_t = 0$ is not necessarily an integer. However, by definition, T is an integer in the discrete time model.

AID.

3 Target growth rate and aid effectiveness

This paper follows the literature and measures aid effectiveness using the growth impact of aid. Since economic growth reduces poverty, as shown in Ravallion and Chen (1997) and Dollar and Kraay (2002), it is appropriate to use the growth impact of aid to measure aid effectiveness. However, some forms of aid have no direct impact on growth; a substantial amount of aid is directed at PPE sectors, which contribute to welfare rather than growth, as demonstrated by Mosley et al. (2004) and Gomanee et al. (2005). They show that aid for PPE sectors improves infant mortality in recipient countries. Aid for PPE sectors does not promote growth (at least not in the short run) and hence there is a tradeoff between growth and welfare. Even if all types of aid ultimately reduce poverty, the timing of the effects varies. Given the variety of aid objectives and the difference in inter-sectoral aid allocation across recipients, it is difficult to measure aid effectiveness. To address this problem, we assume that, in each period, aid is first used for PPE and the remainder is allocated to infrastructure, which contributes to growth. Consequently, a high priority is given to direct poverty-reducing expenditures in each period. There is a required amount of aid for PPE; the amount s is determined by the level of poverty and the target level of poverty reduction. Moreover, we use the effect of total aid in (17) rather than the short-run effect of aid flows.

In what follows, we find a target growth rate that maximizes g/AID. The denominator is total aid in (17), which depends on g, as shown in (16), and hence both the numerator and the denominator are dependent on g. Note that the effect of g on AID is not monotonous. While a high rate of g increases aid flows in earlier periods, it negatively affects T. Thus, g affects how much donors give aid in each period, how long donors give aid to the recipient, and the steady state value of x. This makes it difficult to solve the maximization problem analytically. Below, we will find the desirable target growth rate numerically by specifying parameters.[6]

We assume that the per capita cost for PPE depends on the level of poverty. Specifically,

[6] The growth rate g can take any positive value. For practical reasons, we focus on the range between 0 to 100 percent. Although a rate of growth near 100 percent may seem unrealistic, it is feasible in a case in which many donors give aid to a very small recipient.

we assume that the level of s is determined by

$$sL_t = pg \cdot z \cdot L_t \frac{h_0 - h}{h_0} \tag{18}$$

The equation shows that s depends on the ex ante head-count ratio h_0, the target level of head-count ratio h, the poverty line z and the poverty gap ratio pg, which is the mean shortfall from the poverty line. By definition, $pg \cdot z \cdot L_t$ represents the amount required for all individuals living below the poverty line to consume z. Note that $(h_0 - h)/h_0$ is the degree to which poverty reduction has been attained ($h_0 \geq h > 0$ by definition); if $h = 0$ (there is no poverty after giving aid), $(h_0 - h)/h_0 = 1$ and the per capita cost for PPE is $pg \cdot z \cdot L_t$. Thus, given the levels of h_0, pg and z, the target level h determines s from (18); s is large when the target level of h is low and the extent of poverty is severe (pg and h_0 are high). In this paper, we assume that $(h_0 - h)/h_0 = 0.5$ as in the Millennium Development Goals (MDGs), Goal 1 of which involves halving, between 1990 and 2015, the proportion of people suffering from extreme poverty and hunger.

Our choices of parameters are given in Table 1. The rate of population growth n is assumed to be equal to the mean annual rate for middle- and low-income countries between 1990 and 2006 from the World Development Indicators (WDI) CD-ROM 2008. We use data from the World Bank's PovcalNet for poverty measures: the poverty line is assumed to be equal to \$1.25/day (z is \$456/year), and the poverty gap pg equal to the mean of the 1990 value and the 2005 value. PovcalNet is based on estimates from the following six regions: East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, South Asia, Sub-Saharan Africa.[7] The rate of tax is set equal to 0.1. The value is based on the average ratio of tax revenue to GDP for low-income countries in 2000 from WDI. We set the depreciation rate at 0.05 for private capital and at 0.025 for public capital, which generally has a longer service life.[8] Data on the efficiency of government is not available although there appears to be a widespread belief that governments in developing countries are inefficient. We assume that the government wastes 50 percent of tax revenue. Our choices of other parameters are standard.

[7] See PovcalNet (http://go.worldbank.org/NT2A1XUWP0) for details. The value of pg in Table 1 is the average of the six regions.

[8] Fraumeni (1997) shows depreciation rates and service lives for many types of assets.

The preference parameter γ is set at -1.5, as in Chatterjee and Turnovsky (2007). We set the discount rate in (17) at 0.1.

In this model, there is a restriction on the parameter σ, which determines the output elasticity of each input. As shown in (5), to focus on a balanced growth path, we assume that the sum of the output elasticity of private capital and that of public capital is one. Hence, if we specify the output elasticity of public capital, then that of public capital σ is determined. There are many estimates for the output elasticity of public capital. The estimate that has earned the greatest attention was produced by Aschauer (1989). His estimate based on U.S. data is 0.39. Ford and Poret (1991) use data on ten OECD countries; their estimates range from 0.29 to 0.77. There are also papers on low-income countries. For example, Canning (1999) finds that the output elasticity of communication infrastructure is 0.14 using panel data for a cross-section of countries. In Binswanger et al. (1993), which use data from India, the elasticity of road with respect to agricultural output is about 0.2.[9] There are also many papers on the elasticity of private capital. For example, the estimates of Senhadji (2000), who uses time-series data on 66 countries, range from 0.13 to 1.00, and the average is 0.55. Thus, the estimates vary across papers and countries. In this paper, we set the output elasticity of public capital at 0.35, which is somewhat smaller than the estimate of Aschauer (1989). Then, the elasticity of private capital σ is 0.65. Assuming competitive markets implies that the elasticity of public capital ($1-\sigma = 0.35$) is equal to the labor share of income; this value is consistent with the estimates of the labor share in developing countries, which is smaller than in OECD countries (Diwan, 2001; Harrison, 2002).

Technology parameter A and the initial values of inputs G_0/L_0 are scale variables, which determine T in (15). We set $A = 2$, $G_0 = 0.4$, and $L_0 = 1$. In this case, we can set a realistic target growth rate. Figure 2 illustrates the relationship between the target growth rate g (horizontal axis) and aid effectiveness g/AID (vertical axis). In this figure, the efficient level of g that maximizes g/AID is around 0.25. As Figure 3 shows, T (vertical axis) is minimized when g (horizontal axis) is around 0.18 to 0.23. This explains the desirable target growth rate in Figure 2.

[9] See Straub (2008) for a recent survey of the literature.

In this example, we obtain $T = 36$ for the level of g that minimizes T and this implies that the recipient country can be independent if the growth rate is 0.18 for 36 years. As mentioned above, this result depends on parameters. If technology parameter A is set at 2.5 instead of 2, we obtain $T = 29$ instead of $T = 36$. Our result that donors have to give aid for 36 years even if they choose the ideal target growth rate is a realistic prediction. Note that Japan experienced high growth rates (about 10 percent) after the Second World War and received aid from donors for about two decades.[10] This fact suggests that 36 years is a realistic length of time for recipients when the level of technology and the initial stock of (per capita) public capital are lower.

The key result from Figure 2 is that, when donors choose a large g, they have to give more aid in the short run but can make aid more effective in the long run. This suggests that choosing a small g makes aid ineffective.

Since it is difficult to solve the problem analytically, we perform several numerical exercises (instead of comparative static exercises) to investigate the effect of a change in variables such as s, G_0, ϵ, and n on the efficient level of g (and on T corresponding to the level of g). Initially, all the parameters are fixed at the levels in Table 1. We obtain the following result: 1) the efficient level of g increases (the corresponding T increases) as transfer s increases; 2) the efficient level of g is large (the corresponding T is large) when the initial stock of public capital G_0 is small; 3) the efficient level of g increases (the corresponding T decreases) as the efficiency of government ϵ improves; 4) the efficient level of g is large (the corresponding T is small) when the rate of population growth is high. These results suggest that donors should choose a large value of g for recipients suffering from extreme poverty and a lack of infrastructure. We show that aid is more effective in recipients with efficient governments (T decreases as ϵ rises, as in the third result). This seems to be consistent with the Burnside and Dollar (2000) result, in which aid works only in recipients with good policies. However, our result does not necessarily imply that donors should choose a large value of g for (allocate more aid resources to) recipients with efficient governments because in those countries aid effectiveness is relatively high, even with a small value of g. We discuss this result in more detail in the next two sections.

[10] Japan received GARIOA funds, which were used to supply food, petroleum, fertilizers and medical supplies, from the United States since 1946. In the period 1953-1966, Japan also received loans from the World Bank and invested in infrastructure.

4 Actual aid policy and aid effectiveness

In the section above, we have found a target growth rate that maximizes the impact of aid on growth. In practice, however, even if choosing a high target growth rate is more efficient, it is often difficult to sustain that rate because donors have a limited budget. In this section, to provide useful policy implications, we examine what policies can improve aid effectiveness given the growth rate and parameters that characterize the recipient economy in Table 1. We first examine the effect of a change in g from the current level. If a small increase in g has a large positive effect on aid effectiveness, it suggests that the present level of infrastructure investment is too low; in this case, donors can improve aid effectiveness at no extra cost. Finding the relationship between the additional cost of an increase in g and its benefit is therefore useful for policymakers.

Generally speaking, the current level of infrastructure investment is not enough to sustain the efficient level of g derived in the section above. The proportion of all bilateral aid targeting the economic infrastructure sector is only 10.8 percent in 2005; the proportion of all bilateral aid targeting the social sector is 30.8 percent; and the proportion of all bilateral aid directed at debt reduction is 28.5 percent.[11] Denoting the efficient level of g as g^*, the model shows that an increase in g has a positive effect on aid effectiveness as long as $g < g^*$ holds as in Figure 2. Hence, the low level of aid that goes to the economic infrastructure sector suggests that aid is not effective.

Table 2 reports the target growth rate g in Column 1, the corresponding T in Column 2, AID (1 in the benchmark case) in Column 3 and aid effectiveness in Column 4. As a benchmark, we use $g = 0.027$, which is the average rate of growth for low- and middle-income countries in the period 1990-2006, from WDI (other parameters we use are given in Table 1). This growth rate is clearly lower than g^* in Figure 2; the corresponding T is more than 100 years. As the results in the table show, we can decrease T to 36 by increasing g to 0.18. Note that, while AID increases as g rises to 0.05, AID decreases as g increases as long as $0.05 < g < 0.18$. Moreover, AID is smaller than the benchmark value for $g \in [0.08, 0.023]$ in this table; for $g = 0.18$, AID is minimized and AID is increasing with g if $g > 0.18$. Aid effectiveness in Column 4 is increasing

[11]See Development Aid at a Glance: Statistics by Region 2007 (http://dx.doi.org/10.1787/111051032563).

with g if $g < 0.25$ and decreases with g if $g > 0.25$. This numerical exercise shows that even a small increase in AID can decrease T dramatically (a 0.7 percent increase in AID decreases T by 41 years). If donors can accept a higher burden in the short run, they can decrease AID, which is a burden in the long run. In other words, if the target growth rate is low because of budget limitations, it has a large negative effect on aid effectiveness.

There is a tradeoff between a short-run cost and a long-run cost. If donors cut the spending for infrastructure investment in the short run, it increases the spending in the long run. To decrease AID, donors should increase spending on infrastructure in the short run (as long as $g < g^*$ holds). In practice, donors tend to be focused on their annual budget. For example, Japan, the largest donor in the mid-1990s, has scaled back its aid budgets recently because of a decrease in tax revenue.[12] As long as donors consider their annual budget constraints, an increase in s leads to a decrease in infrastructure investment, which decreases the target growth rate, and hence aid becomes less effective. Thus, even if it is possible to increase aid effectiveness without increasing costs in the long run, in practice it is difficult to improve aid effectiveness by increasing infrastructure investment.

As suggested by Mosley et al. (2004) and Rajkumar and Swaroop (2008), the impact of public spending depends on governance and the level of corruption. In our model, the parameter ϵ measures the efficiency of the government, which depends on the level of corruption and red tape. Now we show the impact of ϵ on aid effectiveness. Table 3 shows the efficiency of government in Column 1, the corresponding T in Column 2, AID (1 in the benchmark case) in Column 3, and aid effectiveness in Column 4. As a benchmark, we use $g = 0.027$ as before (other parameters are given in Table 1). As the results in the table show, T decreases to 110 and AID decreases by 1.4 percent if ϵ increases from 0.5 to 0.6; T and AID decrease with a rise in ϵ. Since g is constant in this case, a decrease in AID makes aid more effective. If ϵ increases to 1, which implies that the government is efficient, AID decreases by 7.2 percent and T decreases from 116 to 90. To obtain the same effect on T, donors have to increase g to 0.04 (see the third line in Table 2); in this case, AID increases by 0.6 percent. In reality, it is difficult to improve the efficiency of government. Hence, the results in Table 3 show the difference in aid effectiveness

[12] See Kawai and Takagi (2004).

across recipient countries with different levels of ϵ.

Our model also shows that the tax rate τ affects aid effectiveness. Developing countries generally have difficulty in collecting tax revenue. The ratio of revenue to GDP is smaller in low-income countries than it is in developed countries (Tanzi and Zee, 2000). In Table 1, we set $\tau = 0.1$; as the tax rate rises, aid flows (at time t) required to sustain the same level of infrastructure investment decrease. Table 4 shows tax rates in Column 1, the corresponding T in Column 2, AID (1 in the benchmark case) in Column 3, and aid effectiveness in Column 4. As before, the other parameters we use are given in Table 1. The results in Table 4 show that a 5 percent rise in τ (starting from the benchmark) reduces T by 11 years and AID by 2.5 percent. While T decreases with a rise in τ if $\tau < 0.35$, it increases with τ if $\tau > 0.35$. Thus, T and AID are minimized and aid effectiveness is maximized when $\tau = 0.35$. This result suggests that there is a tax rate that maximizes aid effectiveness.[13] The reason why T increases consistently with tax rates higher than 0.35 is that the steady state level of public capital x determined by (13) and (14) is too high. For a high tax rate, to sustain high productivity, the economy must have a high level of x and hence a large amount of aid inflows. In this case, T must also be large. As discussed above, for low-income countries, it is difficult to collect revenue and tax rates higher than 0.35 are unrealistic. Hence, it is unlikely that T and AID increase as tax rates increase (because the actual tax rate is likely to be lower than the tax rate that maximizes aid effectiveness).

The results in Tables 2-4 show that choosing a high target growth rate, making the government more efficient, and raising tax revenue can decrease T. These three policies result in more effective aid. However, the effects of the three policies vary. A high target growth rate results in a high growth rate of consumption and increases the steady-state levels of x (public capital/private capital) and z (consumption/private capital) determined by equations (13) and (14). On the other hand, the efficiency of government does not affect the steady-state levels of x and z because ϵ does not appear in (13) and (14). A high tax rate increases the steady state level of x but does not affect that of z. Consequently, only a high target growth rate

[13] Note that this tax rate is equal to the output elasticity of public capital, which is 0.35 as in Table 1. This is consistent with the result of Barro (1990). He shows that the growth-maximizing tax rate is equal to the output elasticity of public services.

increases both public capital and consumption while the efficiency of government and tax rates do not affect consumption (tax rates affect the level of public capital only). Hence, when these three policies achieve the same level of T, choosing a high target growth rate needs more aid resources than the other two policies because it increases the level of consumption whereas the other two policies do not. The difference between improving the efficiency of government and raising tax revenue is that only the latter increases the level of public capital. Hence, improving the efficiency of government requires fewer aid resources to shorten the period of giving aid.[14]

5 Evaluation of the impact of aid in six Asian countries

5.1 The role of Japan's aid

The parameters we use in the previous section reflect the average developing country. In this section, we evaluate Japanese aid directed at economic infrastructure in Asia, where some recipients achieve high rates of economic growth.

As mentioned above, while many studies provide empirical evidence that infrastructure positively affects economic growth, the proportion of aid targeting economic infrastructure is small. Among all bilateral donors, Japan is the exception. Japan has had a traditional strength in giving aid for economic infrastructure (Cassen and Associates, 1994; Kawai and Takagi, 2004). As in the OECD's International Development Statistics (IDS), the percentage of total Japanese bilateral aid that goes to economic infrastructure is on average about 50 percent (calculated using annual data, 1990-2007). The proportion is 56 percent in South Asia and 20 percent in Sub-Saharan Africa. Although multilateral aid and recipient governments also finance infrastructure investment, as will be seen, the proportion of Japan's aid is not negligible. In this section, we use data for China, Indonesia, Philippines, Cambodia, Thailand, and Bangladesh. Japan was the largest bilateral donor for these countries in the 1990s.[15] In this paper, economic infrastructure includes the following sectors: transport, telecommunications, energy, and water.

In Table 5, ρ_J is the proportion of Japanese aid for infrastructure in each recipient country.

[14]This does not necessarily imply that improving the efficiency of government is the best way to improve aid effectiveness.

[15]Also in Malaysia, Korea and Singapore, Japan used to be the largest bilateral donor. However, in these countries, $a_0 > 0$ in (15) does not hold because they have a small value of pg in 1990 ($t = 0$)

This proportion represents Japan's contribution to "the engine of growth" in our model and is calculated as follows. The model shows that, in a balanced growth path, the growth rate of public capital g is equal to the growth rate of income and that of consumption, and $I_t^G/G_t = g + \delta_G$ from (2), (5) and (10). Assuming that g is the growth rate in the real world and $\delta_G = 0.025$, we obtain I_t^G/G_t. Public investment I_t^G is financed not only by Japanese aid but also by other donors and domestic sources, and hence the proportion of Japanese investment (ρ_J) in all public capital formation of the recipient (I_t^G) indicates the contribution of Japanese aid to I_t^G/G_t, which is calculated from data on the growth rate g and the depreciation rate δ_G. For example, if $\rho_J = 0.2$, it implies that Japan's contribution to the engine of growth I_t^G/G_t is 20 percent. Below, we assume that the proportion of Japan's aid is constant from the beginning and calculate T and g/AID with and without Japanese aid. Using data on aid from the OECD's Creditor Reporting System (the average over the period 1986-1990) and on government expenditure from the Asian Development Bank's Key Indicators for Asia and the Pacific (expenditure by function, central government in 1990), we calculate ρ_J. Note that government expenditure for economic infrastructure is available only for the central government. Also note that while "off-budget" aid has been prevalent, some donors adopt an "on-budget" approach, such as general budget support. If aid projects are "on-budget," infrastructure investment by the recipient government is partly financed by foreign sources and then the sum of infrastructure aid from all donors and the government spending on infrastructure is overstated (ρ_J is understated). The accuracy of the variable is open to question. However, our focus is not on the size of ρ_J itself but on the impact of ρ_J on T and g/AID; we examine whether the relative sizes of ρ_J across recipients are associated with their impacts.

Table 5 shows the parameters for each country and the corresponding T and g/AID with and without Japanese aid. For each country, the first line gives the rate of per capita GDP growth, the rate of population growth, the initial stock of infrastructure, the poverty gap ratio, and the proportion of Japanese investment in total public capital formation. The second line shows the corresponding T and aid effectiveness; g, T and g/AID in the case without Japanese aid are given in the third line. Parameters not shown in this table are the same as those in Table 1; we assume that preference and production parameters, the rate of tax, and the size of population at $t = 0$ are the same for all six countries. We calculate g and n using annual data for each country and they are the average over the period 1990-2006. The initial level of infrastructure is set equal to 0.5 (greater than the world average 0.4 in Table 1) for Thailand, 0.2 for China, Philippines and Indonesia, and 0.1 for Bangladesh and Cambodia.[16] For China and Indonesia, we use data on the poverty gap for rural area, where people are poorer (data on the poverty gap is available for rural and urban areas for those two countries alone).

The results show that, given the growth rate in the real world, each of these countries must receive aid over the long term. Even high-growth countries such as China and Thailand need aid for about 100 years; T is very large for Philippines because of the low growth rate, and for Bangladesh and Indonesia because of both low growth rates and high poverty gap ratios. Japan's contribution ρ_J is 0.66 in Cambodia, which implies that growth would be much lower without Japan's assistance. In contrast, the ρ_J for Bangladesh is very low and hence Japan's contribution has little effect on g and T. For China and Thailand, ρ_J is relatively large, but it is less than 15 percent for Philippines and Indonesia. Interestingly, the impact of Japan's contribution is not necessarily associated with the relative size of ρ_J. The impact of ρ_J on T is much larger in Philippines and Indonesia than in China, where ρ_J is larger. The impact of ρ_J on aid effectiveness is large (a 75 percent increase) in Philippines, but is small (a 31 percent increase) in China. The reason for this is as follows. If the growth rate is close to the efficient level, the effect of a change in g is small, as shown in Tables 2 and 3. If the growth rate is low, as it is in the Philippines, a small decrease in g has a very large effect on g/AID and T. In summary, aid effectiveness is high in high-growth countries (Thailand, Cambodia and China) and low in countries with low g (Philippines and Bangladesh). Without Japan's contribution, aid effectiveness would be much lower in Cambodia (because of the scale of Japan's support) and Philippines (because of the low growth rate). These results confirm that high growth rates contribute to aid effectiveness.

The results above raise an important question for donors: what is the efficient inter-recipient allocation? If the allocation decision of a donor has little effect on aid effectiveness in each recipient, then donors should focus on recipients where aid will be effective (this is the case

[16] Although this is a very rough calculation, it is based on data on telephone mainlines (per 100 people) and paved roads (percent of total roads) from WDI.

where aid effectiveness is determined only by the recipient's policies and institutions). However, if aid effectiveness depends on growth rates as we have shown, the answer is different. If donors invest substantial resources into infrastructure as Japan does, it has a positive effect on growth rates and hence improves aid effectiveness. This impact on aid effectiveness is larger in low-growth economies, as shown in Table 2 (the impact on T is also larger in low-growth economies as shown in Table 3). Hence, it is better to allocate more aid resources to low-growth countries.

5.2 How much does the efficiency of government matter?

Finally, we discuss the poverty-efficient allocation of aid suggested by Collier and Dollar (2002). Their efficient inter-recipient allocation is calculated based on their empirical observations that aid is effective in countries with good policies. It suggests that to make aid more effective donors should allocate more aid to countries with good policies and institutions. In this subsection, applying our model to six Asian countries, we examine whether aid is more effective in countries with more efficient governments.

In Table 6, we show the effect of a decrease in growth rates and the effect of a change in the efficiency of government. The first two columns report T and g/AID from the second line of Table 5 for each country (the benchmark). The second two columns show T and g/AID for the case where g decreases by 1 percent. A decrease in g has a large effect on T in low-growth countries such as Bangladesh, Philippines and Indonesia. In these countries, a decrease in g also has a large impact on aid effectiveness. These results again suggest that aid directed at economic infrastructure in low-growth countries can improve aid effectiveness significantly.

The effects of a change in the efficiency of government are shown in the fifth and the sixth columns. The results show that a decrease in ϵ leads to an increase in T although it has little impact on aid effectiveness in the sixth column (even after we multiply g/AID by 100). The impact of a decrease in ϵ on T is large in Philippines, which originally had a large T because of a low-growth rate, and relatively small in China and Cambodia where growth rates are high. Only in Thailand, a decrease in ϵ generates a significant difference in aid effectiveness because the denominator AID is small and hence a modest change in AID leads to a large change in g/AID (AID is small in Thailand because pg and T are small). A rise in ϵ from 0.5 to 1 decreases T in all countries, as shown in the seventh column, although it has little impact on aid effectiveness in all countries except Thailand, as shown in the eighth column. Thus, a change in the efficiency of government affects the period during which aid is received but it has few repercussions for aid effectiveness.

In practice, although the efficiency of government can influence aid effectiveness, it has little effect on the ranking of recipients according to aid effectiveness. Suppose that only the Philippines makes radical improvements in the efficiency of government (from 0.5 to 1). This does not affect aid effectiveness at all, as shown in the table. Suppose instead that the efficiency of government becomes worse only in Thailand (from 0.5 to 0.4). In this case, aid is still most effective in Thailand. These results have the following implications. Growth rates have significant implications for aid effectiveness, but the efficiency of government has little effect because the impact of g on T is larger than that of ϵ. Hence, aid effectiveness is low in a low-growth country with an inefficient government; even if the country can improve the efficiency of government drastically, it has little impact on aid effectiveness as long as the growth rate is low. Our exercises therefore demonstrate that allocating more aid to countries with good policies does not improve aid effectiveness significantly. The key policy implication of our results is that donors should allocate more resources for infrastructure investment to low-growth countries. This allocation rule decreases T and improves aid effectiveness in many countries; with total aid fixed, this rule enables more recipients to achieve financial independence earlier.

Note that the impact of growth rates on aid effectiveness in our model raises questions about empirical evidence for aid effectiveness in the literature. In many papers, the dependent variable is the growth rate of recipients and aid is a regressor; in the regression analysis, the coefficient estimate on aid is interpreted as aid effectiveness. However, if growth rates affect aid effectiveness as in Figure 2, the assumption that the coefficient is constant across countries is not valid. In countries where the growth rate is high and close to the efficient level, an increase in infrastructure investment has little effect on aid effectiveness. If these high-growth countries have good policies, the model suggests that the impact of aid is small in countries with good policies. This may be part of the explanation of mixed evidence regarding aid effectiveness.

6 Conclusions

In this paper, we have attempted to find a policy that enhances aid effectiveness. The key feature we add to this simple growth model is that recipient countries are aid-dependent in the early phase of their development but ultimately become independent. In this paper, since aid flows vary over time, we focus on the effect of total aid in the long run instead of the effect of aid flows in the short run. Moreover, we also consider a difference in inter-sectoral allocation in the model.

Our main results are summarized as follows: 1) if a recipient has severer poverty problems and a lower level of public capital, donors should choose a higher target rate of growth; 2) in reality, the level of infrastructure investment is so low that it makes aid ineffective; 3) in the late 1980s, Japan's contribution to public capital formation was large in certain Asian countries, but its impact on aid effectiveness is not necessarily associated with the volume of aid because aid effectiveness depends on growth rates; 4) although governance affects aid effectiveness, improving it has a very small impact on aid effectiveness in low-growth countries.

Our result that aid effectiveness depends on growth rates has an important policy implication. Burnside and Dollar (2000) and Collier and Dollar (2002) suggest that donors should allocate more to countries with good policies. Our model also suggests that governance affects aid effectiveness. However, we also show that allocating more to countries with good policies is not necessarily the best way to improve aid effectiveness. Our numerical exercises suggest that donors should allocate more to economic infrastructure in low-growth countries and focus on governance only after recipients achieve a relatively high growth rate. As long as aid for economic infrastructure can enhance growth, this allocation rule shortens the period during which aid is required for many recipients, and hence, with total aid fixed, this rule gives earlier financial independence to more recipients.

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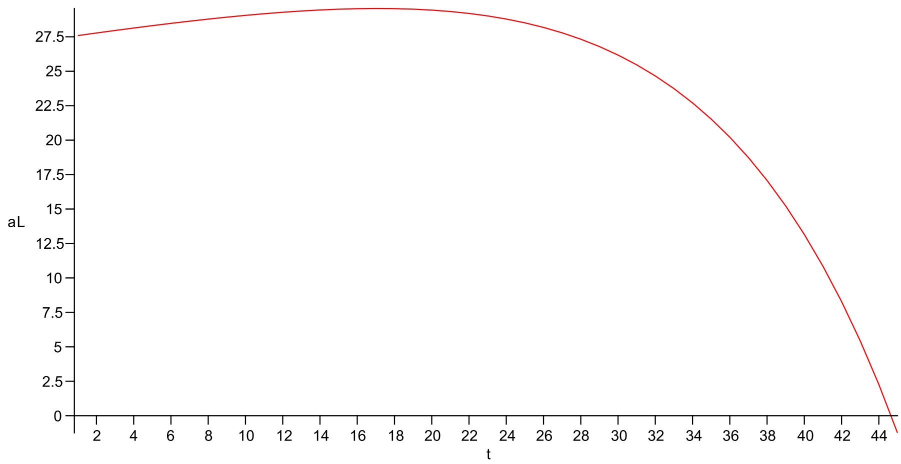

Figure 1: Time path of aid flows

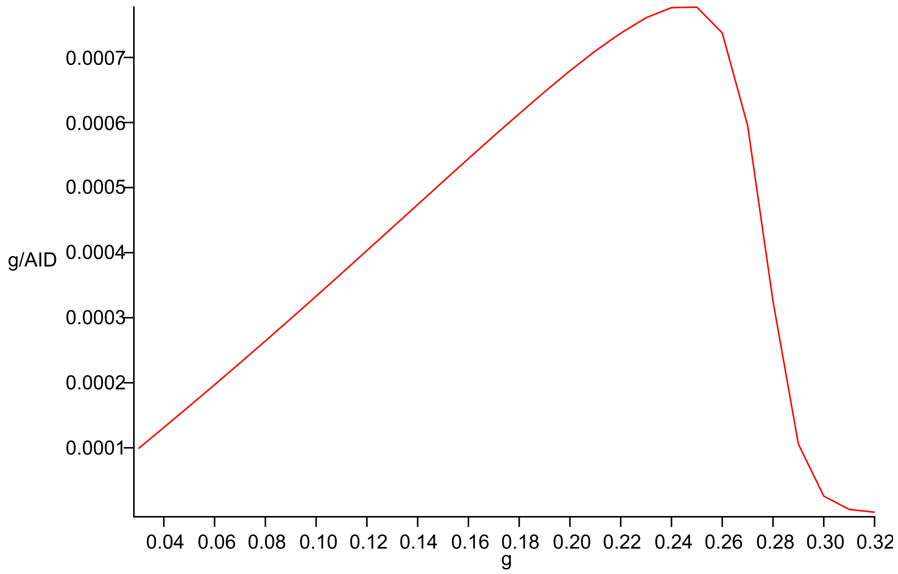

Figure 2: Target growth rate and aid effectiveness

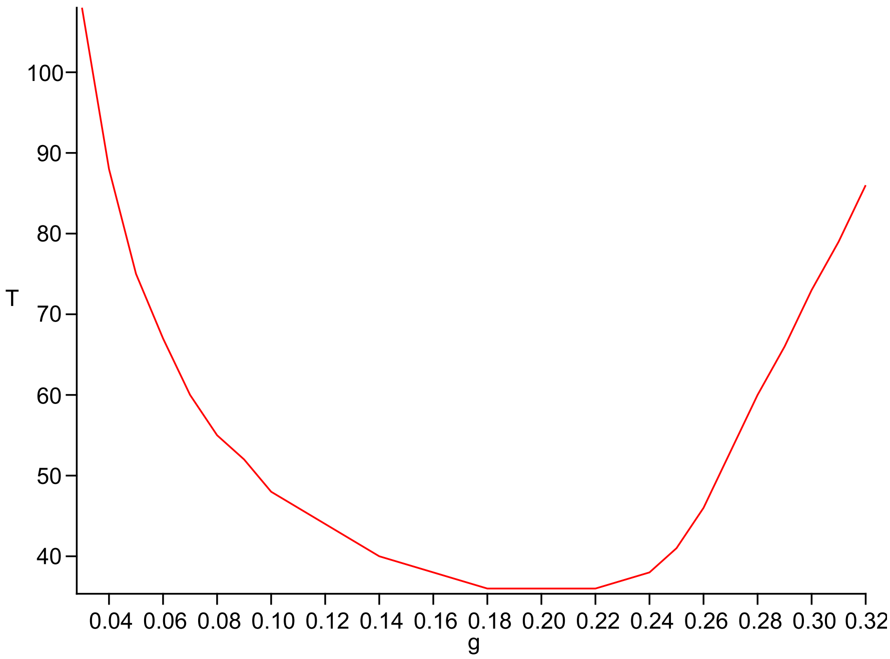

Figure 3: Target growth rate and period of receiving aid

n	z	pg	τ	δ	δ_G	ϵ	β	γ	r	σ	A	G_0	L_0
0.015	456	0.11	0.1	0.05	0.025	0.5	0.95	-1.5	0.1	0.65	2	0.4	1

Table 1: Parameters

	g	T	AID	$100 \cdot g/AID$
Benchmark	0.027	116	1	0.009
	0.03	108	1.002	0.010
	0.04	88	1.006	0.013
	0.05	75	1.007	0.016
	0.06	67	1.005	0.020
	0.07	60	1.003	0.023
	0.08	55	0.999	0.026
	0.09	52	0.995	0.030
	0.10	48	0.991	0.033
	0.15	39	0.972	0.051
	0.18	36	0.968	0.061
	0.20	36	0.971	0.068
	0.23	37	0.997	0.076
	0.25	41	1.061	0.078
	0.28	60	2.841	0.033

Table 2: Target growth rate and aid effectiveness

	ϵ	T	AID	$100 \cdot g/AID$
	0.3	136	1.029	0.0087
	0.4	125	1.014	0.0088
Benchmark	0.5	116	1	0.0089
	0.6	110	0.986	0.0090
	0.7	104	0.971	0.0092
	0.8	99	0.957	0.0093
	0.9	94	0.942	0.0095
	1	90	0.928	0.0096

Table 3: Efficiency of government and aid effectiveness

	τ	T	AID	$100 \cdot g/AID$
	0.05	139	1.032	0.0086
Benchmark	0.10	116	1	0.0089
	0.15	105	0.975	0.0091
	0.20	99	0.956	0.0093
	0.25	95	0.944	0.0094
	0.30	93	0.937	0.0095
	0.35	92	0.934	0.0095
	0.40	93	0.936	0.0095
	0.45	94	0.942	0.0095
	0.50	97	0.951	0.0094

Table 4: Tax and aid effectiveness

Recipient		g	n	G_0	pg	ρ_J	T	$100 \cdot g/AID$
Bangladesh		0.031	0.020	0.1	0.144	0.036		
							252	0.0069
	without ρ_J	0.029					269	0.0064
Cambodia		0.061	0.024	0.1	0.126	0.664		
							131	0.0147
	without ρ_J	0.004					1849	0.0010
China		0.088	0.009	0.2	0.166	0.185		
							94	0.0193
	without ρ_J	0.067					117	0.0147
Indonesia		0.034	0.014	0.2	0.105	0.095		
							201	0.0111
	without ρ_J	0.028					242	0.0092
Philippines		0.014	0.022	0.2	0.069	0.142		
							443	0.0063
	without ρ_J	0.008					767	0.0036
Thailand		0.041	0.010	0.5	0.017	0.207		
							104	0.0885
	without ρ_J	0.027					150	0.0582

Table 5: Contribution of Japan's infrastructure investment

	Benchmark		-0.01 in g		-0.1 in ϵ		+0.5 in ϵ	
Recipient	T	$100 \cdot g/AID$	T	$100 \cdot g/AID$	T	$100 \cdot g/AID$	T	$100 \cdot g/AID$
Bangladesh	252	0.0069	368	0.0047	260	0.0069	230	0.0069
China	94	0.0193	104	0.0171	99	0.0193	83	0.0194
Indonesia	201	0.0111	280	0.0078	208	0.0111	180	0.0111
Cambodia	131	0.0147	155	0.0123	135	0.0147	119	0.0147
Philippines	443	0.0063	1523	0.0018	459	0.0063	393	0.0063
Thailand	104	0.0885	132	0.0668	110	0.0878	85	0.0917

Table 6: Effect of changes in g and ϵ