# Aid, Policies, and Growth

*By* Craig Burnside and David Dollar*

## APPENDIX ON THE NEOCLASSICAL MODEL

Here we use a simple neoclassical growth model to motivate the form of our empirical growth equation. Our intention in doing this is to provide some examples, though there might be many more, of models in which the relationship between aid and growth resembles the one we estimate in our paper. The neoclassical model we discuss is one in which aid is viewed simply as a lump-sum transfer from abroad, and there are no strategic interactions between governments that need concern us. Later, we discuss how sensitive the predictions of the neoclassical model would be to the introduction of strategic behavior on the part of policy-makers.

A series of interesting experiments can be performed in the context of a perfect foresight, one-sector, neoclassical model. We assume that there is a single good over which households have isoelastic preferences, once they have satisfied a subsistence level of consumption.[1] Assuming households are infinitely lived, lifetime utility is given by

$$\sum_{t=0}^{\infty} \beta^t \frac{\left(C_t - \overline{C}\right)^{1-\gamma} - 1}{1-\gamma},$$

where $C_t$ represents time-*t* household consumption, $0 < \beta < 1$ is the discount factor, $\gamma > 0$ is the coefficient of relative risk aversion and $\overline{C}$ is a subsistence level of household consumption.

For simplicity we assume that each household operates its own technology using its beginning of period-*t* capital, $K_t$, and a single unit of labor which is supplied

* The World Bank, Washington DC 20433. Views expressed are those of the authors and do not necessarily represent official opinions of the World Bank.

[1] As Lawrence J. Christiano (1989) and Sergio Rebelo (1992) have argued, including a subsistence level of consumption in the specification of preferences within a neoclassical model is a useful way of explaining the positive empirical relationship between income levels and savings rates.

inelastically. The production function is assumed to be given by $Y_t = AK_t^{\theta}$, with $A > 0$ and $0 < \theta \leq 1$.

Net household income is taxed on the margin at the rate $\tau$, and households receive lump-sum transfers from the government given by $T_t$. Given that we assume that there is no international private capital mobility, the household budget constraint is

$$C_t + I_t - \delta K_t \leq (1-\tau)(Y_t - \delta K_t) + T_t,$$

where $I_t$ is time-*t* investment.[2] Capital evolves according to

$$K_{t+1} = (1-\delta)K_t + I_t,$$

where $0 < \delta < 1$.

The government is assumed to make consumption purchases $G_t$. For simplicity we have assumed that these government purchases do not enter into the utility of private households. If we changed this assumption, to allow government purchases to have a positive impact on utility, it would change some of our conclusions, though not necessarily those regarding the impact of foreign aid on growth. We assume that government purchases are financed by taxes net of transfers as well as by foreign aid. For the purposes of this section, we assume that time-*t* foreign aid is received in the form of a lump-sum transfer from abroad, $F_t$.[3] If we exclude the possibility of both domestic borrowing and printing money, the government's flow budget constraint is given by

$$G_t \leq \tau(Y_t - \delta K_t) - T_t + F_t.$$

The economy as a whole, therefore, has the resource constraint

$$C_t + I_t + G_t \leq Y_t + F_t.$$

It is worth noting that both in the model, and in the context of actual data, an injection of foreign aid does not show up instantly as an increase in GDP, and, therefore, GDP growth. In both the model and actual economies, assuming that production takes place on the technological frontier, GDP depends only on domestic factors of production and the

[2] Strictly speaking the budget constraint should allow for borrowing and lending between households. However, allowing for this does not change any implications of the model for aggregate behavior, since we are assuming that all households are identical.

[3] An alternative, but equivalent, assumption would be that the government can use international capital markets to convert the grant component of any loan into an immediate capital flow.

state of technology. Assuming labor supply is unaffected, aid only affects GDP when it is used to augment the stock of capital. If it is consumed, there is an increase in GNP inclusive of transfers, but not GDP. If some fraction of it is invested, then aid causes an increase in capital, and consequently domestic output.

We consider several special cases of the model. First, suppose that $\theta = 1$ and that $\overline{C} = 0$, so that returns to capital are constant and subsistence consumption plays no role in the model. Under these circumstances it is straightforward to show that consumers will choose to have constant consumption growth given by

$$\frac{C_{t+1}}{C_t} = g = \left(\beta\tilde{R}\right)^{1/\gamma},$$

where $\tilde{R} = (1-\tau)(A-\delta)+1$. The initial level of consumption is given by

$$C_0 = (R-g)K_0 + \frac{R-g}{R}\sum_{t=0}^{\infty} R^{-t}(F_t - G_t),$$

where $R = A - \delta + 1$.

So suppose we consider two economies, one in which $F_t = G_t = 0$, for all *t*, while in the other $G_t = 0$ for all *t*, $F_t = 0$ for $t > 0$ and $F_0 > 0$.[4] In the first economy, which receives no aid, $C_0 = (R-g)K_0$ while in the second economy, which receives aid at time 0, $C_0 = (R-g)K_0 + (R-g)F_0/R$. What this tells us is that when the inflow of aid takes place, part of it, $(R-g)F_0/R$, is consumed. The rest of it, $gF_0/R$, is additional investment.

We can also show that in the first economy the growth rate of GDP is constant and equal to $g$ in every period. However, in the second economy, growth between period 0 and period 1 is given by $g + (gA/R)(F_0/Y_0)$, while growth after that returns instantly to the rate $g$.

It is interesting to note that the impact of aid on the growth rate of output depends not only on the size of the injection relative to GDP, $F_0/Y_0$, but also on the level of

[4] Both economies are ones in which taxes levied on income are rebated, in full, through lump-sum transfers to households.

distortionary taxes through the $gA/R$ term. The higher are distortionary taxes, the less effective will be the injection of aid, other things held equal.

We think of the effect aid has on growth, in this example, as its *direct* effect through a one time increase in capital accumulation. Not surprisingly, the size of the direct effect depends on the incentives to accumulate capital.

If we maintain the same assumptions but allow the subsistence level of consumption to be nonzero we get other effects as well. We will now have the result that

$$\frac{C_{t+1}-\overline{C}}{C_t-\overline{C}} = g = \left(\beta\tilde{R}\right)^{1/\gamma},$$

which implies that the level of consumption beyond the subsistence level will grow at the constant rate, $g$. The model becomes somewhat more complicated to solve, but it turns out that if we repeat the experiment with the two economies described above, the one receiving aid will have a higher growth rate in period 1 by the amount of the direct effect: $(gA/R)(F_0/Y_0)$. This is because, as before, households will consume exactly $(R-g)F_0/R$ of the injection of aid, while the rest, $gF_0/R$, is invested in capital.

But in this case, there are further effects. This is because the growth rate of output in the model with subsistence consumption is not constant but increases as the capital stock grows and asymptotes to $g$. An injection of aid raises the capital stock, and by so doing not only raises output directly, but also moves the country onto a transition path with higher growth rates. This *indirect* effect, which, in our two economy experiment, is initially given by

$$\frac{\overline{K}}{K_0}\frac{R^{-1}F_0}{K_0+R^{-1}F_0}(g-1),$$

where $\overline{K}=\overline{C}/(R-1)$, shrinks over time, and will be smaller the higher the country's capital stock is at the time of the aid injection (the further it is from the subsistence level of consumption). It will also be small if the injection of aid is small relative to the country's initial capital stock. The indirect effect also depends on the tax rate through $g$.

Different indirect effects occur in versions of the same model with diminishing returns to capital, i.e. $\theta<1$. When there is no subsistence level of consumption, the

model with $\theta < 1$ implies a monotonically declining growth rate of output as the capital stock grows. This is a case in which the indirect effect is negative. When we combine subsistence consumption with $\theta < 1$, for countries with low capital stocks the growth rate rises as the capital stock grows, peaks, and then declines along the transition path. In this case the indirect effect is positive or negative depending on the size of the capital stock at the time of the aid injection. The indirect effects that arise from different parameterizations of the model are illustrated in Figure 1.

To summarize this discussion, we have shown that injections of aid have two effects on economic growth within the context of simple neoclassical models. First, there is a direct effect that depends on how much of the injection of aid is transformed into additional investment. Second, there is an indirect effect arising from the fact that when aid affects the capital stock, it also affects an economy's location along its transition path to some long-run steady state. Both of these effects are a function of the magnitude of distortions in the economy, which we have modeled here as taxes on household income.

These findings motivate our empirical specification that allows for the possibility that the impact of aid on growth depends on government policies that affect the size of distortions in the economy. It does this by incorporating interaction terms between measures of aid receipts and measures of economic policies.

While we form some of our intuition for the relationships among policy, aid and growth using the neoclassical model, other factors can complicate the picture. First, the example we gave above ignores incentive issues by assuming that aid is provided in a lump-sum manner. Suppose, instead, that some component of aid were tied to the income level of the recipient, and that as that income level rose the quantity of aid would decrease. In this case, the donor's rule for providing aid would act as a tax on capital accumulation in the recipient country. Overall capital accumulation would rise as long as the direct impact of donated capital was greater than the indirect tax effect, but the impact of the aid would be less than in the lump-sum case.

Second, our simple examples above assume that the government of the recipient country does not consume the injection of aid through increased government spending on goods and services. In the economy that received the aid injection we assumed the

pattern of government purchases was identical to that in the economy that received no aid. This means we are implicitly assuming that the injection of aid is transferred lump sum to households, who make optimal decisions about its allocation between household consumption and investment. There are many reasons why this implicit assumption may not be reasonable. In reality foreign aid is intermediated by governments, and these are not always best thought of as benevolent entities that simply transfer the funds to households or firms. Political figures face a variety of incentives that may cause them to use aid in socially suboptimal ways. Given this, it is possible that aid would have little or no impact on overall economic prosperity in a recipient country. Paul Mosley and John Hudson (1996) and Jakob Svensson (1996, 1997) have shown that when the donor-recipient relationship is modeled as a noncooperative game, moral hazard can reduce the effectiveness of foreign aid. Aid may simply relax the budget constraint of the recipient government, without having much impact on the amount of that budget that ultimately is used to purchase capital. Furthermore, the donor government can also be part of this game for reasons other than benevolence. Donor interest may lead to the suboptimal use of aid and dampen any positive impact that it has.

While these factors and many others suggest that the positive impact of aid is likely to be smaller than what is predicted by the neoclassical model described above, our priors about the impact of aid are still driven by that example. Whatever marginal contribution aid makes to growth, we expect aid to be most effective in combination with good policy. Furthermore, we expect that the effects of good policy would be enhanced by foreign aid.

# References

Christiano, Lawrence J. “Understanding Japan's Saving Rate: the Reconstruction Hypothesis.” *Federal Reserve Bank of Minneapolis Quarterly Review*, Spring 1989, *13*(2), pp. 10-25.

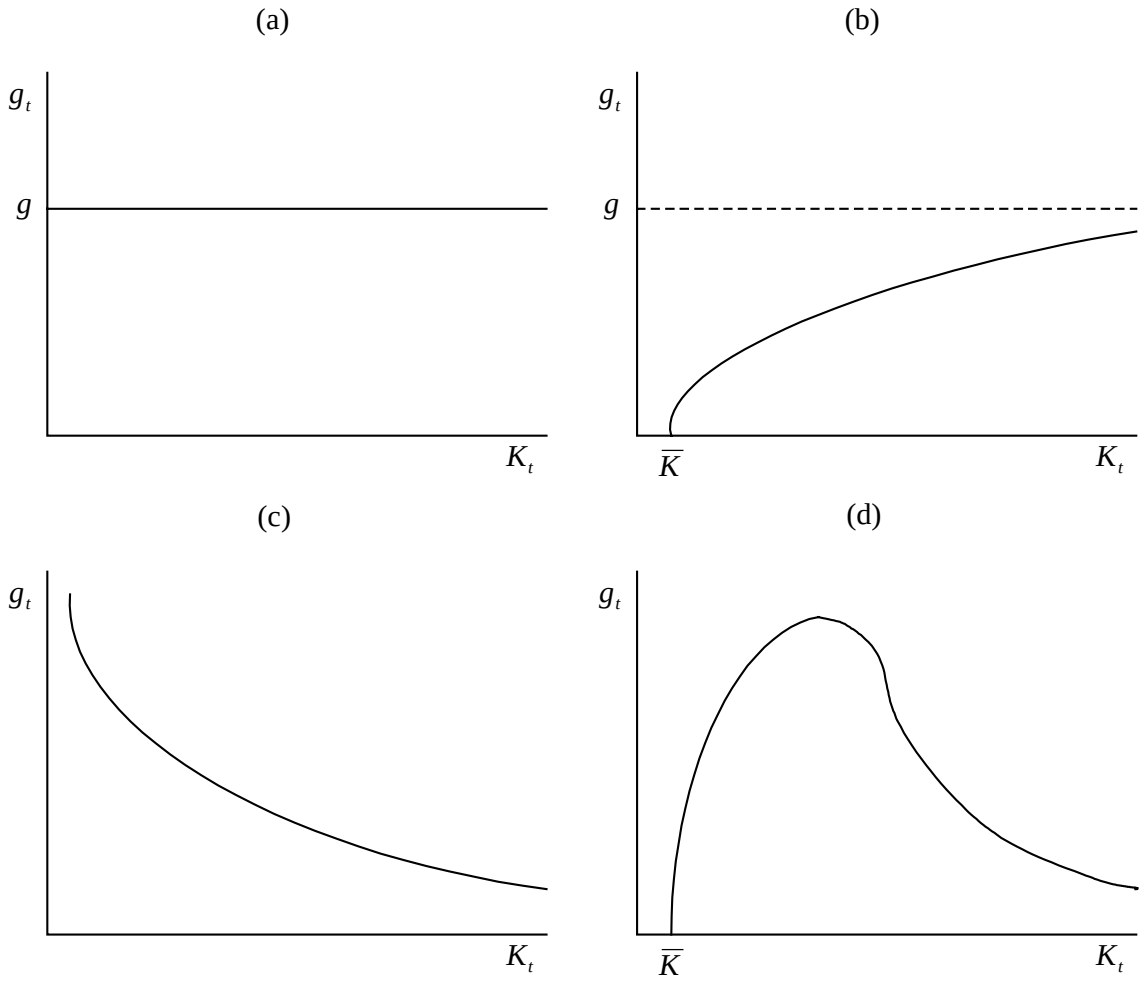
Mosley, Paul and John Hudson. “Aid, Conditionality and Moral Hazard.” University of Reading Department of Economics and Department of Agricultural Economics and Management Discussion Papers in Development Economics, Series G, Volume III (1995/96), No. 26, 1996.

Rebelo, Sergio. “Growth in Open Economies.” *Carnegie-Rochester Conference Series on Public Policy*, July 1992, *36*, pp. 5-46.

Svensson, Jakob. “Collusion Among Interest Groups: Foreign Aid and Rent Dissipation.” Working paper, Policy Research Department, World Bank, 1996.

——. “When Is Foreign Aid Policy Credible? Aid Dependence and Conditionality.” Policy Research Working Paper No. 1740, World Bank, 1997.

FIGURE 1—INDIRECT EFFECTS OF AID ON GROWTH IN THE NEOCLASSICAL MODEL




Notes: Each panel shows the growth rate of output, $g_t$, as a function of the level of capital, $K_t$, along the economy's transition path. An injection of aid, to the extent that it is invested, causes an increase in the capital stock that would not otherwise have occurred. Hence, the indirect effect of the injection of aid on growth is to move the economy onto a different part of the transition path. Panel (a) uses a model with constant returns to capital, and no subsistence level of consumption, so there is no indirect effect. Panel (b) uses a model with constant returns to capital and a positive subsistence level of consumption, so the indirect effect is positive. Panel (c) uses a model with diminishing returns to capital and no subsistence level of consumption, so the indirect effect is negative. Panel (d) uses a model with diminishing returns to capital, and a positive subsistence level of consumption, so the effect is ambiguous.