On the Empirics of Foreign Aid and Growth

Dalgaard, Carl-Johan and Hansen, Henrik and Tarp, Finn

2002

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by Carl-Johan Dalgaard, Henrik Hansen and Finn Tarp

Abstract

This paper takes a fresh look at three issues in the aid effectiveness debate. First, we assess the theoretical case for foreign aid. Using an endogenous growth version of the standard overlapping generations model, we show that aid can be an effective policy tool in spurring growth in poor countries. This model also furnishes a theoretical foundation for the approach taken in many empirical studies. Second, we demonstrate that cross-country data, which underpin traditional cross-section based conclusions about the aid-growth link, are fully consistent with the positive evidence on aid effectiveness that emerge from recent panel-based regressions. Third, we reexamine the case for policy-based conditionality. Our empirical analysis suggests that aid is generally effective, even in "bad" environments. However, the degree to which aid enhances growth depends on climate-related circumstances.

Outline

1. Introduction

The usefulness of foreign aid in promoting growth in developing countries has been an area of controversy ever since Rosenstein-Rodan in 1943 advocated in favor of aid to Eastern and South-Eastern Europe. However, the last few years have witnessed a gradually forming consensus view that aid works. Indeed, panel-based empirical studies have repeatedly concluded that foreign aid does impact positively on growth. This encouraging conclusion has not yet caught the attention of the academic and policymaking community. Instead, it has been overshadowed by a parallel debate regarding "necessary conditions for aid effectiveness". In particular, is "good" macroeconomic policy a prerequisite for a positive impact of aid on GDP growth?[1] Technical issues about the choice of functional forms and econometric technique have been at the core of specialist disputes. Meanwhile a sense of "aid-fatigue" has spread. Browsing through successive editions of leading textbooks in development economics provides telling illustrations of how the confidence of our profession in the effectiveness of foreign aid has dwindled. In the first edition of "*Leading Issues in Economic Development*", Meier (1964) dedicated a full 18-page section to the issue of foreign aid. He started out asking: "How much aid?". By the time of the sixth edition (Meier, 1995), the treatment of foreign aid had been cut into half, and the questions in focus were "Why official assistance?" and "Does aid work?". In the 2000 edition (Meier and Rauch, 2000), "foreign aid" is not even listed in the index.

As far as we can tell, skepticism about the validity of recent empirical findings is fuelled by two important considerations.

First, the theoretical foundation for trusting in aid as a growth enhancing factor is spongy. Generation after generation of students have grown up with Meier's textbook, simple aggregate models such as the Harrod-Domar model and growth programming in the two-gap tradition. Yet, the bulk of this kind of work is by now rather dated, and several theoretical treatments of recent date suggest that the effectiveness of aid is doubtful (Boone, 1996; Tornell and Lane, 1999; Obstfeld, 1999; Svensson, 2000). Moreover, the early aid-growth work was nested in a theoretical framework where savings behavior is exogenous. Thus, the fungibility of aid whereby aid is "diverted" from investment to consumption is treated as an exogenous phenomenon. This makes analytical contributions based on this approach vulnerable to the Lucas-critique, and it would appear that the credibility gap has by now widened to canyon like dimensions. In Section 2, we therefore reexamine the case for aid transfers in a theoretical framework where fungibility can arise endogenously.

Second, taking a candid look at the data, it does appear that aid is not at all

[1] See Burnside and Dollar, 2000; Collier and Dehn, 2001; Dalgaard and Hansen, 2001; Guillamont and Chauvet, 2001; Hansen and Tarp, 2000, 2001; Hudson and Mosley, 2001; Lensink and White, 2001 and Lu and Ram, 2001, among others.

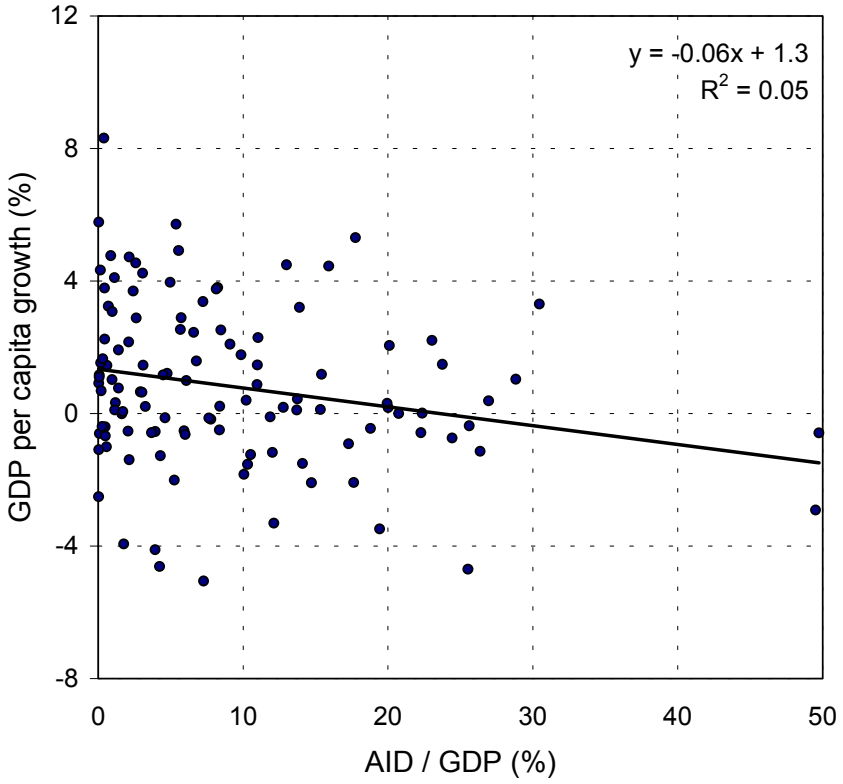

Figure 1: Real per capita GDP growth vs. the Aid to GDP ratio. Data are annual averages over the period 1979-1998 for 114 counties. *Source:* World Development Indicators 2001.

effective, and the aid effectiveness debate abounds with correlations such as those in Figure 1 and 2. Figure 1, in particular, has repeatedly been used to illustrate the weak nature of the relationship between aid and growth (from Griffin, 1970 to the World Bank, 1998). To be sure, the older cross-country empirical literature, surveyed in White (1992) and Hansen and Tarp (2000), has over and over again been referred to in order to substantiate that aid is an ineffective tool in spurring growth in third world countries. The apparent inconsistency between the old and the new empirical evidence is intriguing. Therefore, in Section 3, we carefully examine the cross-country correlations and demonstrate why we believe that plots of cross-country averages are distorted by identification problems and heterogeneity biases. Once these problems are taken into account, cross-plots of aid versus growth and savings support the panel data regression results of a positive impact of aid on growth.

On this background, we dig deeper in Section 4 and ask whether "good" policies are a prerequisite for foreign aid to work as argued by Burnside and Dollar (1997, 2000), the World Bank (1998) and Collier and Dollar (2001, 2002). We briefly

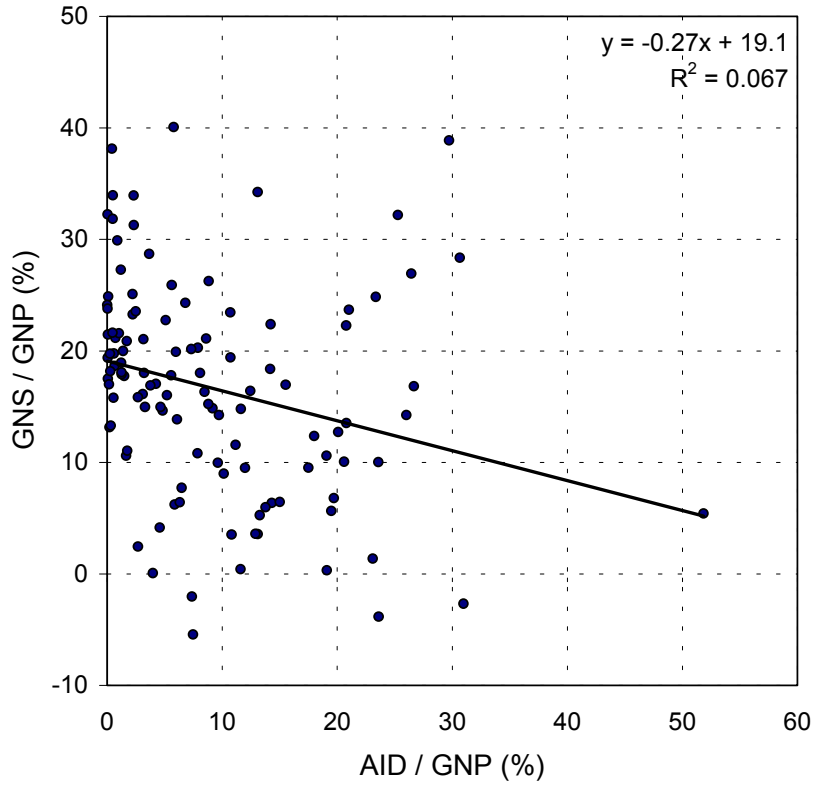

Figure 2: Gross National Savings relative to GNP vs. Aid to GDP. Data are annual averages over the period 1979-1998 for 114 counties. Gross national savings include current transfers. *Source:* World Development Indicators 2001.

explain why the particular empirical results in Burnside and Dollar (2000) have been questioned by other researchers, and why we find that aid is effective even in "bad" environments. Finally, based on the theoretical analysis of section 2 and the work of Sachs and his co-authors (e.g. Bloom and Sachs, 1998; Gallup, Sachs and Mellinger, 1999), we hypothesize that geography matters for aid effectiveness. In a Burnside-Dollar type growth equation, it appears that aid is much more effective in countries outside the geographical tropics. By way of conclusion we suggest that future research into the causes of climate-related differences in the impact of aid on growth could prove to be useful in designing more effective foreign assistance.

2. On Aid Transfers and Growth Theory

The effectiveness of foreign aid depends on whether the transfer involved is used in a productive and socially meaningful way. It is equally obvious that foreign aid inflows can be diverted, either directly or indirectly, due to fungibility. If one is

willing, as a first approximation, to suppress political-economy considerations, a central concern is whether the incentives of households and producers are such that aid donations can be successful in raising living standards. In order to address this issue systematically, the analytical framework has to allow for fungibility as an endogenous phenomenon. Two prominent workhorses within the field of economic growth that allow for optimizing behavior on the part of both producers and consumers, are the infinite horizon model (due to Ramsey, 1929; Cass, 1965; Koopmans, 1965) and the overlapping generations model (Diamond, 1965). Accordingly, these models are natural starting points for investigating the potential for foreign aid to spur growth.

The Ramsey-Cass-Koopmans model has been the more frequent choice in the recent theoretical literature on aid effectiveness. When aid is assumed to be in the form of a simple transfer of income, which is distributed equally among the citizens of society, a very strong result holds: A permanent increase in foreign transfers will raise the long-run level of per capita consumption one for one, but leave the level of capital per worker unaffected. In other words, aid is fully fungible. This result is invariant to assumptions made regarding production technology, i.e. whether growth is exogenous or endogenous.[2] Thus, unless the model is somehow modified, aid is ineffective if the goal is to raise long-run income.[3]

It needs to be recognized, however, that the basic "aid-ineffectiveness result" is not embedded in the assumption of optimizing behavior on the part of households. Instead it is due to the assumption of infinitely lived individuals. In fact, the conclusions emerging from analyzing the effectiveness of aid in a Diamond framework are not as clear cut as those emerging from the infinite horizon analysis. To show this formally, we develop a simple two-period endogenous growth version of the Diamond model, where aid enters as a pure transfer. It emerges that foreign aid can have a positive effect on growth.

2.1. The Model

Consider a closed economy where activity extends infinitely into the future, but individuals live only two periods. Time is discrete, and denoted by $t = 1, 2 \ldots$. The economy produces a homogenous good which can be either consumed or saved (invested).[4] The markets for output and factors of production, labor and capital, are competitive. For simplicity, the population is assumed to be constant.

[2]See Obstfeld (1999) for an analysis of aid effectiveness both within a standard infinite horizon model and within the Uzawa-Lucas model.

[3]Examples of such modifications can be found in Boone (1996), Dalgaard and Hansen (2001) and Tornell and Lane (1999).

[4]As a result, the aid transfer can either be interpreted as a transfer of capital or income.

Output, Y_t, is produced using a standard Cobb-Douglas technology

$$Y_t = \Omega^{\beta} K_t^{\beta} \left(E_t L\right)^{1-\beta}, \tag{1}$$

where K_t is the stock of capital, L the total labor force, E_t an index measuring labor efficiency, and Ω a time-invariant constant. Empirically, Ω could be thought of as capturing, in a very crude way, productivity differences attributable to country specific factors.[5] The work surveyed in Sachs (2001), for example, suggests that differences in climate appears to make a difference in terms of how effectively capital, labor and technology combine to produce output. An alternative interpretation of Ω is that it reflects the institutional environment, which is likely to change only very slowly with time.[6]

Given the production function the producers will acquire capital and hire labor until the marginal product equals the real rate of interest, r_t, and the real wage, w_t, respectively[7]

$$r_t = \beta \frac{Y_t}{K_t}$$

$$w_t = (1-\beta) \frac{Y_t}{L}.$$

In order to allow for perpetual growth, labor efficiency is assumed to increase over time, as a consequence of learning-by-doing. In the spirit of Kaldor (1957), we formalize this by letting efficiency expand as output per worker increases:

$$E_t = y_t, \tag{2}$$

where $y_t \equiv Y_t/L$. Following Arrow (1962), Romer (1986) and Rebelo (1991), we assume that firms do not internalize the productive effects from learning. Using equation (2) in the production function (1) implies that total production can be written as $Y_t = \Omega K_t$, once the externality from learning-by-doing is taken into account. As a result, equilibrium factor prices become

$$r = \beta\Omega, \tag{3}$$

$$w_t = (1-\beta)\,\Omega k_t, \tag{4}$$

where $k_t \equiv K_t/L$. Thus, the real rate of interest will be constant over time, $r_t = r$ $\forall t$, while the wage will rise insofar as capital per worker grows.

Next, consider the consumers. In their first period of life, individuals supply one unit of labor in-elastically, and they receive a wage, w_t. We also let the representative young individual receive a transfer of income in the shape of foreign aid. To retain comparability with the infinite horizon result mentioned above, it is assumed that

[5] Ω is raised to the power of β solely to make the resulting formulas neater.

[6] Acemoglu et al. (2001) argue that the institutions put in place during early colonial times continue to impact on the growth performance of less developed economies to this very day.

[7] Capital depreciation is ignored.

the aid inflow is distributed equally among citizens. Specifically, if the per capita aid inflow is of size a_t, then the total income of the representative young individual in period t is $w_t + a_t$. In order to capture the flavor of a government that expropriates part of the inflow (or, the notion that not all inflows are put to "effective" use), assume that only the fraction $\pi \in [0,1]$ actually enters the budget of the individual. The remaining part of the inflow, $(1-\pi)\, a_t$, is assumed to be wasted.

On this background the individual will choose to divide income between consumption during youth, c_t^1, and savings, s_t. In sum, the first period budget constraint is

$$c_t^1 + s_t \leq w_t + \pi a_t. \tag{5}$$

In their second part of life individuals derive income from savings, and receive a transfer of aid. Hence, the period two budget constraint is

$$c_{t+1}^2 \leq (1+r)\, s_t + \pi a_{t+1}. \tag{6}$$

In what follows, aid inflows are allowed to grow over time, and we return to the empirical plausibility of this possibility. For now, let the growth rate of aid inflows ($\alpha > -1$) be exogenous. Thus $a_{t+1} = (1+\alpha)a_t$. Finally, assume that preferences are logarithmic,

$$U(c_t^1, c_{t+1}^2) = \ln c_t^1 + \frac{1}{1+\rho} \ln c_{t+1}^2, \tag{7}$$

where ρ is the rate of time preference. The problem of a representative young individual in period t is to maximize discounted lifetime utility subject to the budget constraints (5) and (6). Standard computations lead to the following closed form solution to the savings of the young individual

$$s_t = \bar{s} w + \bar{s} \left(1 - \frac{1+\rho}{1+r} (1+\alpha) \right) \pi a_t,$$

where the savings rate $\bar{s}$, is given by $1/(2+\rho)$.[8]

Note that aid, in general, has an ambiguous effect on savings. To see why, in a simple manner, consider the case where $\alpha = 0$. Under this assumption, aid will increase savings if (and only if) $r > \rho$, which is equivalent to the condition $\beta\Omega > \rho$. Increasing the level of aid, means that income in both periods of life is increased. If the optimal consumption-age profile is upward sloping, which corresponds to $r > \rho$, the consumer will respond to this "windfall gain" by increasing savings so as maintain the desired profile. On the other hand, if $r < \rho$ the opposite occurs. Consequently, it is not surprising that insofar as the aid transfer grows over the life

[8] As individuals are guaranteed an income in period 2, even in the absence of savings, households might prefer a corner solution where nothing is saved. If such a scenario were to arise, the economy would "close down" completely, as the entire capital stock is consumed during the second period of life. In what follows we focus on the more interesting case of an interior solution to the consumption/savings problem.

cycle ($\alpha > 0$) then it becomes more likely that the consumer will cut savings, in response to an upward shift in the level of aid, so as to smooth consumption.

Since the capital stock in any given period reflects the savings of the young in the previous period, the stock of capital per worker in period $t+1$ is given by $K_{t+1} = s_t L$. After substituting for s_t, w, and r, the growth rate of capital per worker can be written

$$\frac{k_{t+1}}{k_t} = \bar{s}\Omega\left(1-\beta\right) + \bar{s}\left(\frac{\beta\Omega - \rho - \alpha\left(1+\rho\right)}{1+\beta\Omega}\right)\frac{\pi a_t}{k_t}. \tag{8}$$

The full dynamics of the model are determined by the law of motion for capital per worker, and by $a_{t+1} = (1+\alpha)\, a_t$. The implications of foreign aid for growth will now depend on whether foreign transfers grow over time or not. We address these two cases in turn below.

2.2. Constant Aid

When the aid inflow per capita is constant ($\alpha = 0$), the dynamics of the model become very simple. Specifically, using $y_t = \Omega k_t$, equation (8) can be restated in terms of output growth:

$$\frac{y_{t+1}}{y_t} = \bar{s}\Omega\left(1-\beta\right) + \bar{s}\Omega\left(\frac{\beta\Omega - \rho}{1+\beta\Omega}\right)\frac{\pi a}{y_t}. \tag{9}$$

If the economy grows exponentially, a/y_t will eventually approach zero. Still, the transition is likely to take time, during which the above equation may provide some guidance for empirical work.

The lesson from equation (9) is that the overlapping generations analysis offers a more nuanced conclusion, regarding the effectiveness of aid, than the Ramsey-Cass-Koopmans model. In particular, if $\beta\Omega > \rho$, foreign aid has a positive effect on growth. Of course, the opposite could also be the case. Thus, whether the condition for aid to be effective is fulfilled or not is an empirical issue to be resolved.[9]

Equation (9) provides some structural foundation for the approach taken in many recent empirical investigations of the aid/growth nexus, in that the growth rate between t and $t+1$, is related to the aid to GDP ratio at time t. Moreover, the model lends theoretical support to the practice of interacting aid with e.g. institutional variables, since the marginal impact of an (exogenous) increase in a/y_t depends positively on Ω, capturing the influence from (slowly changing) structural

[9]It is worth noting, however, that the assumption $r > \rho$ is commonly invoked, and deemed plausible, within the field of economic growth. In particular, when studying endogenous growth in the infinite horizon model $r > \rho$ is always maintained. Otherwise, consumption per capita will be perpetually declining, or constant.

characteristics. The model also implies that such variables should be included on their own in empirical work.

Next consider the implications of government expropriation. As can be seen from equation (9), the effectiveness of foreign aid ought to be lower in countries where government rent-seeking is pervasive, i.e. where π is low.[10] The study by Svensson (2000) indicates that such a channel might be significant. It is worth stressing, however, that the mere presence of "rent-seeking" does not imply that aid becomes ineffective. For this to hold, the ruling elite must expropriate *all* inflows. If some inflows are allowed to enter the budget of the consumers (i.e. $\pi > 0$), and given $\beta\Omega > \rho$, aid will spur growth.

2.3. Growing Aid

Before we look into the consequences of growing aid, it is worth considering whether trend growth is an empirically plausible assumption. Figure 3, which shows a histogram of growth rates in aid per capita for 114 countries, suggest it is. In fact, in 43 countries the amount of foreign aid inflows exhibited a statistically significant positive trend, at the five percent level. On the other hand, 27 countries witnessed a significant *negative* trend in aid inflows, while the trend growth rate was insignificant in the remaining 44 countries.[11] Thus, Figure 3 does suggest that the case of growing foreign aid inflows is a scenario worth exploring.

When the amount of aid grows over time, the evolution of the economy can be characterized by the dynamics of the output-to-aid ratio, $x_t \equiv y_t/a_t$:

$$x_{t+1} = \frac{\bar{s}\Omega\left(1-\beta\right)}{1+\alpha}x_t + \frac{\bar{s}\Omega\pi\left[\beta\Omega-\rho-\alpha\left(1+\rho\right)\right]}{\left(1+\alpha\right)\left(1+\beta\Omega\right)} \equiv f\left(x_t\right).$$

As it turns out, if the model is to allow for a balanced growth path, where the aid to GDP ratio is constant, the growth rate of aid can neither be too high nor too low. If

$$\alpha > \bar{\alpha} \equiv \frac{\beta\Omega-\rho}{1+\rho},$$

aid will discourage savings, for the reasons discussed above. On the other hand, unless

$$\alpha > \hat{\alpha} \equiv \bar{s}\Omega\left(1-\beta\right) - 1,$$

[10] If the government is able to expropriate part of household labor income as well, then π will also enter the first term on the right hand side of equation (9).

[11] The three countries where aid inflows declined at rates above ten percent per year are BLR, KOR and DJI. At the other end of the spectrum, aid rose in excess of ten per cent per year in twelve countries: MOZ, IRN, ZAF, GNB, CHN, LAO, KHM, ZWE, VNM, MDA, NAM and ARM. Using a (Newey-West) robust variance estimator marginally changes the grouping of countries. The main result that most countries have had significant trend growth in per capita aid over the years is unchanged.

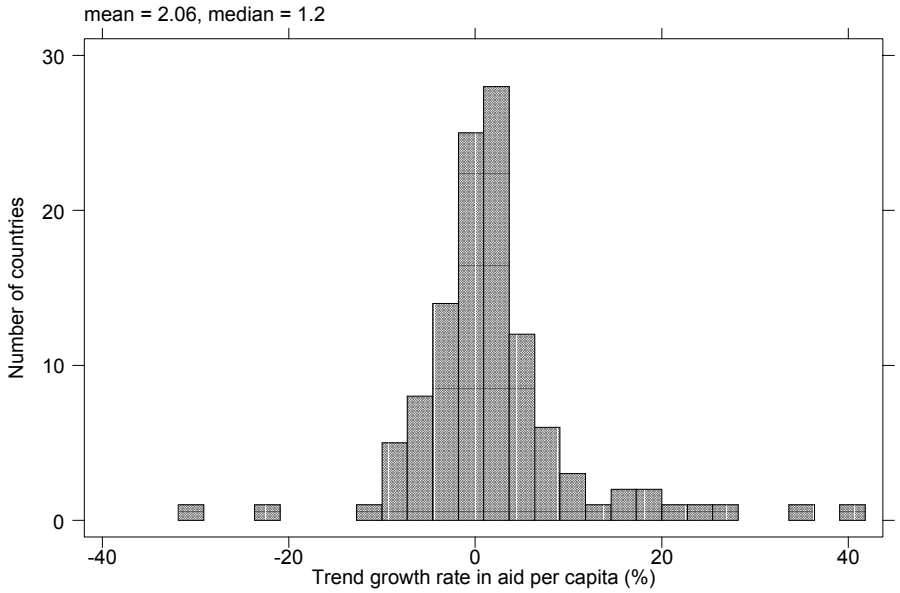

Figure 3: Histogram of growth rates in foreign aid per capita, 1970-99. The growth rates are least squares trend estimates. *Source:* World Development Indicators 2001.

the aid to output ratio will tend to zero. Thus, if $\alpha < \hat{\alpha}$ the dynamics of the model will be the same as in the preceding section, where the aid inflows were assumed constant.

Accordingly, balanced growth, with a constant aid to GDP ratio, is only possible if

$$\bar{\alpha} > \alpha > \hat{\alpha}. \tag{10}$$

Figure 4 shows the phase diagram for this case. Geometrically, the condition (10) ensures that the slope of $f(x_t)$ is less than one, and that $f(0) > 0$.[12] Given a positive initial output-to-aid ratio, x_0, the economy will eventually reach the balanced growth path, where the output to aid ratio is given by

$$x^* = \frac{\bar{s}\Omega\pi\left[\beta\Omega - \rho - \alpha\left(1+\rho\right)\right]}{\left[1+\alpha-\bar{s}\Omega\left(1-\beta\right)\right]\left[1+\beta\Omega\right]}.$$

As a consequence, along a balanced growth path the growth rate of income is

[12]The condition required for this scenario to be viable is that $\bar{\alpha} > \hat{\alpha}$. This condition is fulfilled if $\left(1+\beta\Omega\right)/\left[\left(1-\beta\right)\Omega\right] > \left(1+\rho\right)/\left(2+\rho\right)$. In order to ensure that this condition is met for *any* Ω and ρ, one would need to assume that $\beta \geq 1/2$. This is not an unreasonable requirement if one takes a broad view of capital so as to include human capital. An alternative way of approaching the plausibility of the condition could be the following. Suppose $\beta = 1/3$, which is a standard approximation. Next, calibrate Ω so that plausible values of r are attained (say, in the range zero to ten percent). Finally, use these numbers in the condition $\bar{\alpha} > \hat{\alpha}$. It emerges that the condition is easily met.

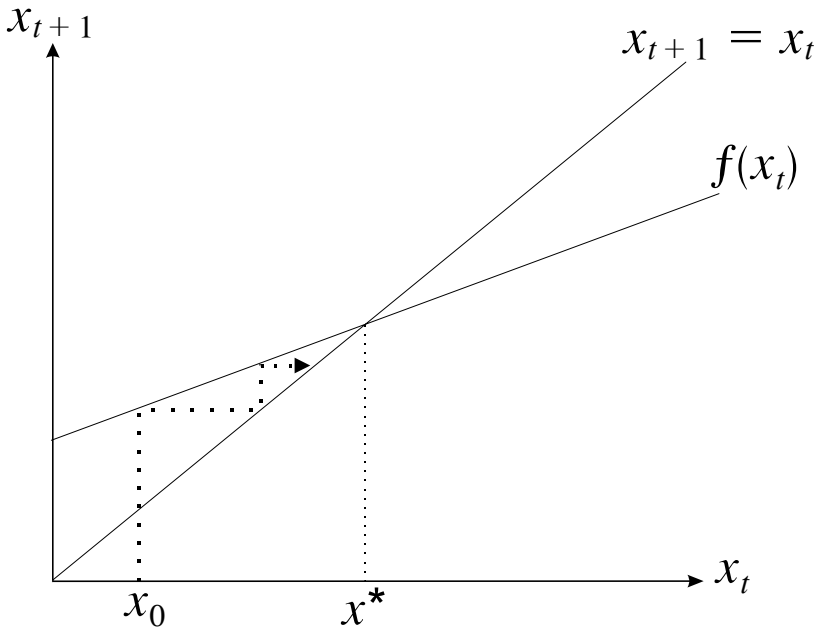

Figure 4: Phasediagram when $\bar{\alpha} > \alpha > \hat{\alpha}$.

determined by the growth rate of foreign aid:

$$y_t = \frac{\bar{s}\Omega\pi\left[\beta\Omega - \rho - \alpha\left(1+\rho\right)\right]}{\left[1+\alpha-\bar{s}\Omega\left(1-\beta\right)\right]\left[1+\beta\Omega\right]} \cdot a_0 \cdot \left(1+\alpha\right)^t.$$

Hence, at the balanced growth path, only permanent changes in the growth rate of foreign aid will have permanent growth effects. The level of aid matters, but only for the level of income per worker. The transition to the balanced growth path may, however, be a lengthy one.

The implications of the transitional dynamics can be assessed by picking an initial output to aid ratio. Considering many of the least developed economies, where an aid to GDP ratio around 10 per cent is not uncommon, it is sensible to consider a case where $x_0 < x^*$, i.e. where the initial level of income per worker is relatively low, compared to the aid inflow. As can be seen from Figure 4, during transition the growth rate of x will gradually decrease. Since a_t grows at a constant rate throughout, the growth rate of income per worker will decline. Thus, something akin to "conditional β-convergence" is at work: the growth rate of income per worker will be higher in economies that are further away from their future balanced growth path. Moreover, the long-run output-to-aid ratio is endogenous, and determined by structural characteristics (Ω, π and α). As a result, the relationship between initial aid to GDP and subsequent growth is not a simple one. Basically, the growth performance of two economies with the same aid to GDP ratio will differ insofar as their structural characteristics, and therefore x^*, differ. This underlines once again the importance of careful empirical work where relevant structural characteristics

are controlled for. Finally, it is interesting to note that this scenario provides a theoretical foundation for an aid "Laffer-curve" in terms of the growth rates: Increasing the growth rate of aid will spur growth, but only as long as $\alpha < \bar{\alpha}$. If the rate of growth is increased beyond $\bar{\alpha}$, consumer's will respond by reducing savings, and growth will suffer.

2.4. Endogenous Aid, Convergence and Total Factor Productivity

Based on the above analysis, it would appear that sufficiently large transfers (i.e., $\alpha > \hat{\alpha}$) ought to allow the poorest countries to converge in income relative to the presently developed economies. Yet, this attractive scenario is not likely to arise. For one thing, the ability of aid to raise growth is bounded from above by $\bar{\alpha}$. Moreover, recall that the growth rate of foreign aid was assumed exogenously given. This is unrealistic. Assume instead that the growth rate is tied to donor policies, and equally important, to GDP growth of donor countries. This can be represented formally in a simple manner, by allowing total aid donations (i.e. to the LDCs as a group) to be linked to total *donor* GDP, $\hat{y}_t$, by a factor, δ_t, which may itself be time-varying. Thus, at time t, total aid is given by

$$a_t = \delta_t \hat{y}_t.$$

Now, suppose the GDP of the donor community as a whole grows at a constant rate, g. Then the growth rate of aid will be

$$\alpha_t = \log\left(\delta_{t+1}/\delta_t\right) + g.$$

Clearly, if $\delta_{t+1} < \delta_t$, the growth rate of poor economies will fall short of growth in donor countries.[13] Only insofar as $\delta_{t+1} > \delta_t$ will the less developed economies (as a group) tend to "catch-up".[14] Since continual growth in δ is politically infeasible, this simple illustration shows that aid, *alone*, is unlikely to ensure convergence. In sum, although the analysis demonstrates that foreign aid can be an effective way of stimulating income growth in the third world, the model also makes clear that structural characteristics will have to change, if the poorest are to become richer *relative* to the developed world.

Analyzing the role of aid in a stationary overlapping generations economy would lead to conclusions similar in nature to those obtained above, given the assumptions on production technology and preferences. However, if one allows for a more

[13] A similar point was made already by Leontief (1965), who sought to calculate the necessary amount of aid that would allow the less developed group of countries to converge.

[14] This is a necessary but not sufficient condition. Suppose we allow for growth in the work force (which was ignored in the analysis above). In that case $a_t = \delta_t \hat{y}_t(\hat{L}_t/L_t)$, where $\hat{L}_t$ is the population in the donor countries, and L_t the population in the LDCs. Accordingly the growth rate of aid per capita is $\alpha = \log\left(\delta_{t+1}/\delta_t\right) + g + \hat{n} - n$, where $\hat{n}$ and n is the growth rate of the population in the group of donor countries and the LDCs, respectively, while g is growth in the per capita GDP of the donor community. Hence, if $\hat{n} < n$ then $\log\left(\delta_{t+1}/\delta_t\right) > 0$ is required to hinder divergence in per capita income.

general production technology, or utility function, a multiplicity of steady states may emerge, a prediction consistent with the hypothesis of club convergence.[15] If so, temporary inflows of foreign aid may have permanent effects on long-run activity, by shifting the economy away from a low-development trap into a high-income equilibrium, thus underpinning a more optimistic view of the potential for aid to stimulate a process of convergence.[16]

A final issue is the implied relationship between aid and total factor productivity. Recent research on the proximate sources of growth suggests that the bulk of the differences in income and growth, between "rich" and "poor" economies, is due to total factor productivity (see Klenow and Rodrigues-Clare, 1997; Easterly and Levine, 2001). The model developed above provides a reason why aid might have a positive effect on TFP. Note that the growth rate of TFP is (using equation (1))

$$\log \frac{Y_{t+1}}{Y_t} - \beta \log \frac{K_{t+1}}{K_t} = (1-\beta) \log \frac{E_{t+1}}{E_t}.$$

Since TFP growth is caused by learning by doing, and this in turn derives from capital accumulation, the model implies that aid can potentially have a conducive effect on TFP growth. In practice, other channels connecting aid to TFP may be at work, and some of these may work in the opposite direction. The impact of aid on TFP is therefore an empirical matter well worth exploring.[17] Doing so is beyond the scope of the present paper. Instead we now move on, first to the older, and subsequently to the more recent empirical evidence on aid and growth.

3. On the Correlations Between Aid, Growth and Savings

Much of the early empirical aid effectiveness contributions focused on cross-country correlations between aid, on the one hand, and the savings rate or GDP growth, on the other. Such investigations have regularly led to the conclusion that aid is (at best) ineffective in furthering growth. In what follows, we therefore take a closer look at the data, discussing first the aid-growth and subsequently the aid-savings relationship.

[15] See Galor and Ryder (1989) for a comprehensive treatment of this issue within the Diamond framework.

[16] Note, however, that in a stationary economy the real interest rate is endogenous. Bearing the condition for aid-effectiveness in mind, i.e. $r > \rho$, the model would potentially motivate an aid "Laffer-curve" in terms of levels, rather than growth rates.

[17] Hansen and Tarp (2001) show that foreign aid has no effect on growth once investment in capital – physical and human – is accounted for. This does not preclude the possibility that aid spurs total factor productivity *through* its effect on capital accumulation.

3.1. Output Growth and Aid

In debates about the aid-growth link, cross-plots such as the one in Figure 1 have been widely used. This may, however, be misleading due to two distinct analytical problems. The first is a problem of identification. The second relates to cross-country heterogeneity.

To illustrate the identification problem, consider a simple two-equation system of aid and per capita GDP:

$$\Delta \log y_{it} = g + \gamma\lambda_{1i} + \theta_1 a_{it} - \gamma(\log y_{it-1} - g(t-1)) + \varepsilon_{it}, \tag{11}$$

$$a_{it} = \lambda_{2i} - \theta_2 \log y_{it-1} + \eta_{it}. \tag{12}$$

In this system y_{it} is per capita GDP and a_{it} is the aid-to-GDP ratio in country i and period t. The change in log GDP, $\Delta \log y_{it}$, approximates the average growth rate from period $t-1$ to t.[18]

Equation (11) is the relation of interest in aid effectiveness studies. In the present formulation, the economies in question are assumed to converge to a steady state. This is modeled by the inclusion of lagged per capita GDP in conjunction with the country specific intercept, λ_{1i}, which we take to include country specific structural characteristics such as the institutional infrastructure (Ω in Section 2). The steady state growth rate in GDP per capita, in the absence of aid, is given by g, which may be endogenous, while the impact of aid on growth is θ_1.

Equation (12) is a model of aid allocation. In the present context it is as simple as possible. Aid to country i in period t is a function of lagged GDP per capita in the recipient countries and country specific factors gathered in λ_{2i}. Poverty orientation in aid allocation is well documented and the use of lagged income variables is standard in aid allocation studies capturing information and decision lags in donor countries. Two influential aid allocation studies by Dudley and Montmarquette (1976) and by Trumbull and Wall (1994) both find a significant negative impact of lagged GNP per capita on aid commitments. In a more recent study Alesina and Dollar (2000) use PPP adjusted GDP per capita as the income variable and five year averages of aid disbursements as the dependent variable. The result that most donors give more aid to poorer countries remains unchanged. Alesina and Dollar argue that historical and political factors, such as colonial past and support in UN voting, are also important in aid allocation decisions. Such factors are included in the country specific intercept λ_{2i}.

Assuming the two error terms ε_{it} and η_{it} are martingale difference processes orthogonal to the regressors and to each other, the system can be estimated equation wise using ordinary regression. The identifying assumption is the recursive nature of the system. Aid allocation is based on information about past income per capita while aid impacts on present and future growth rates in income. In the econometric

[18]The periods are often thought of as representing years but longer periods are possible.

jargon aid is weakly exogenous with respect to the parameter θ_1. But aid is not strongly exogenous as income Granger-causes aid.

However, the cross-plot in Figure 1 and many aid-growth regressions are based on cross-country studies using averages over 10-30 years. This simple transformation implies that the recursive structure of the aid-growth system is lost. Impact and allocation effects are no longer identified. In Appendix A it is shown how the two equations for averages over T periods can be given as

$$\begin{aligned}\Delta \log y_{i.} &= g + \tfrac{1-\psi^T}{T}\lambda_{1i} + \tfrac{1-\psi^T}{(1-\psi)T}\theta_1 a_{i.} - \tfrac{1-\psi^T}{T}\log y_{i0} \\ &\quad + \frac{1}{T}\sum_{t=1}^{T-1}\psi^t[\theta_1(a_{iT-t} - a_{i.}) + \varepsilon_{iT-t}] \end{aligned} \tag{13}$$

$$\begin{aligned} a_{i.} &= \lambda_{2i} - T(1 - \tfrac{1}{2}\tfrac{T+1}{T})\theta_2 \Delta \log y_{i.} - \theta_2 \log y_{i0} \\ &\quad -\theta_2 \sum_{t=1}^{T} \tfrac{T-t}{T}(\Delta \log y_{it} - \Delta \log y_{i.}) + \eta_{i.}, \end{aligned} \tag{14}$$

where $\psi = 1 - \gamma$, and the notation $x_{i.}$ indicates average over t.

Equations (13) and (14) illustrate a classical identification problem in econometrics. Growth and aid are positively related in the impact equation, while they are negatively related in the allocation equation. Notice that in both equations the impact of initial income is negative. If the number of periods, T, is not explicitly taken into account there are no parameter restrictions to exploit in this formulation, suggesting that conclusions about the effectiveness of aid may well be biased.

Moreover, note that the impact slope parameter $((1-\psi^T)/(1-\psi))\theta_1$ in the growth equation is down-weighted by the number of periods in the average, while the allocation slope parameter $1/\theta_2$ is only down-weighted by approximately one-half of the number of periods. A consequence of this scaling is that we should expect the negative allocation correlation to dominate in long-term averages.

A third interesting result is related to the growth rates in the aid transfers, given in Figure 3. The cross-country error term in equation (13) shows that countries with significant trend growth (positive or negative) will have larger errors than countries with constant aid inflows. This means that the cross-country aid-growth correlation is highly influenced by countries with "extreme" aid records.

The recent move away from pure cross-country analyses towards panel data analyses of averages over fairly short periods helps solve both the heteroskedasticity problem and, more importantly, the identification problem. At least, one would expect to find smaller bias in the estimated impact parameter. It is illuminating to see what happens graphically. Figure 5 is a cross-plot of 532 panel data observations using epochs of four years instead of the 20-year averages for the same 114 countries presented in Figure 1. The correlation between the average growth rate in GDP

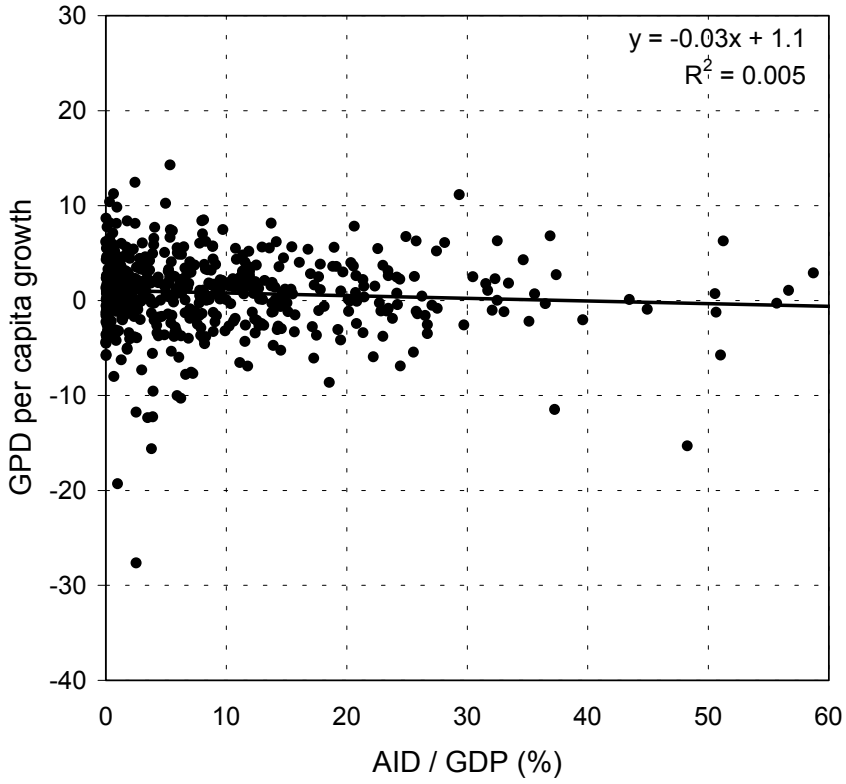

Figure 5: Real per capita GDP growth vs. the Aid to GDP ratio. Data are annual averages for five 4-year epochs (1979-1982 to 1995-1998) for 115 counties. *Source:* World Development Indicators 2001.

per capita and the average aid to GDP ratio based on epochs of four years is clearly less negative than the pure cross-country correlation based on 20 year averages in Figure 1. Moreover, the correlation is no longer significant. This is an indirect confirmation of the identification problem.

Still, the cross-plot in Figure 5 is based on an implicit assumption; strictly speaking, the assumption in this kind of graphic analysis is that institutions are either equal ($\lambda_{1i} = \lambda_1$ for all i) or unimportant for growth. We find this highly unlikely. Institutions are not equal across countries and they certainly matter for growth. This implies that the regression line in Figure 5 is subject to heterogeneity bias. Assuming institutions change slowly, a simple way to diminish the bias is to plot the epoch values while removing country specific effects. Figure 6 gives a cross-plot of these fixed effects panel observations for the 114 countries. Here the correlation between growth and aid inflows is positive and significant. We would argue that this verifies that differences in institutions influence the cross-country correlations

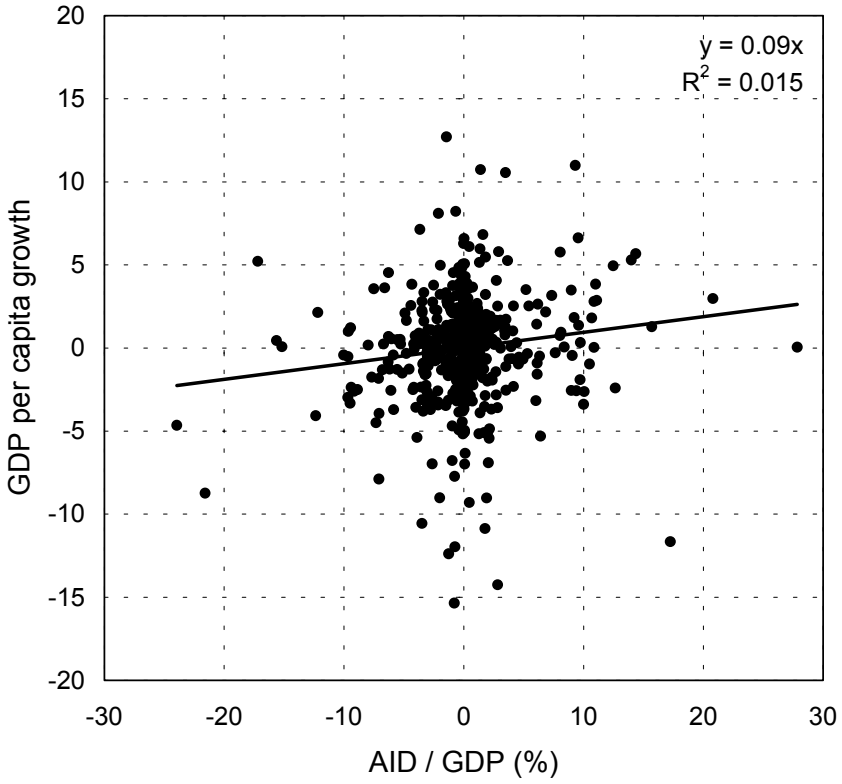

Figure 6: Real per capita GDP growth vs. the Aid to GDP ratio. Data are annual averages for five 4-year epochs (1979-1982 to 1995-1998) given as deviations from the country specific means. *Source:* World Development Indicators 2001.

in Figures 1 and 5 in a way that leads to misinterpretation of the data.[19]

3.2. Savings and Aid

Empirical work on aid effectiveness in the 1970s also focused on the relationship between domestic savings and the aid to GNP ratio. Indeed, many theoretical growth models give ample motivation: all else equal, if the savings rate increases, long-run income should rise. Hence, investigating the relationship between domestic savings and aid inflows appears as a convenient short-cut in studying aid effectiveness. Most studies uncovered a negative correlation between aid and savings, consistent with Figure 2, which shows a (significant) negative correlation between the average

[19] An important corollary of the identification problem is that the popular random effects estimator should be avoided in panel data regressions where aid is included as a regressor. The random effects estimator is basically a weighted average of the pure cross-country parameter given in Figure 1 and the fixed effects parameter in Figure 6, and we have shown that the pure cross-country coefficient cannot be interpreted as an impact parameter.

savings rate and the aid to GNP ratio. But what does this negative savings/aid correlation actually mean?

First of all the identification and heterogeneity problems are, naturally, also present in the aid-savings relationship insofar as savings is related to growth. But in addition to the econometric problems there are more fundamental theoretical issues, which may distort the interpretation of any aid-savings correlations.

Suppose, for example, that aid increases productivity growth. Following the permanent income hypothesis, this would induce agents to start consuming more so as to smooth consumption in line with the higher expected lifetime income. Accordingly, the savings rate falls if agents are sufficiently risk averse.

The implications of the Ramsey-Cass-Koopmans model amount to another way of approaching this. In this model, aid increases consumption one for one, but leaves investment and production unaffected in the long run. To see what this implies, denote total consumption, savings and the gross national product C, S and Q, respectively. By identity, GNP is the sum of GDP, or Y, and total aid inflows, A. Hence $Q = Y + A$. Let total consumption be given by $C = \tilde{C} + A$, where $\tilde{C}$ is the level of consumption if aid were absent. Accordingly, $S/Q = 1 - (\tilde{C} + A)/(Y + A)$. Note that an increase in A leads to an increase in the $(\tilde{C} + A)/(Y + A)$ ratio, as long as $\tilde{C} < Y$. Assuming this holds, it follows that when consumption increases on a one for one basis with aid, the savings rate will decline when A increases.

In sum, taking the negative correlation for granted, several conclusions are possible. They include that (i) aid discourages savings, (ii) aid increases the long-run growth rate of productivity or (iii) aid has *no* effect on accumulation whatsoever.

Even though these considerations make us skeptical about the aid effectiveness information in aid-savings correlations we give the "fixed effects" plot in Figure 7 to compare with Figure 2. The sample of countries is the same as in Figure 6, with each point representing four year averages of S_t/Q_t and A_t/Q_t. As for the aid-growth relation, the negative cross-country correlation (Figure 2) turns into a significant positive correlation. This result enhances our confidence in the existence of a positive relationship between aid and growth. Certainly, the above illustration is in line with evidence pointing to a conducive effect from aid on investments (Hansen and Tarp, 2001). In the next section we move on to cross-country growth regressions in which we take account of differences in policies and institutions by conditioning directly on policy and institutional measures instead of removing the effects using deviations from country specific means. Moreover, we discuss non-linear effects of aid.

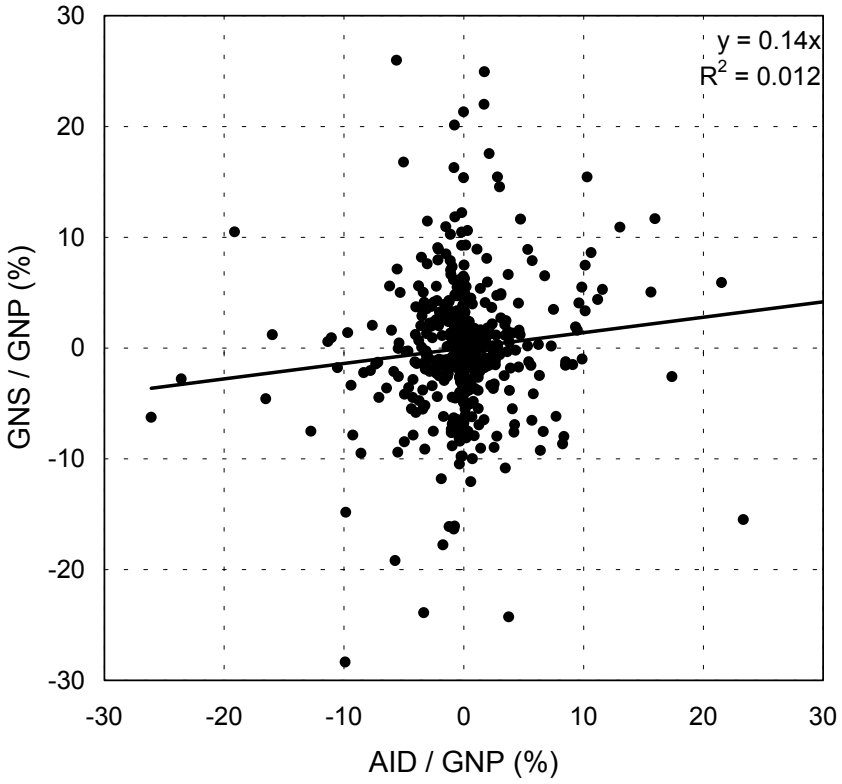

Figure 7: Gross National Savings relative to GNP vs. Aid to GNP. Data are annual averages for five 4-year epochs (1979-1982 to 1995-1998) given as deviations from the country specific means. Gross national savings include current transfers. *Source:* World Development Indicators 2001.

4. On Aid and Growth Regressions

Development economists have always stressed that "good" policy genuinely matters for growth, and also in the ongoing exchange of opinions about aid effectiveness there is little disagreement that policies matter for growth. Instead, the discussion centers around the question whether bad policies – in addition to being detrimental to growth – implies that aid is wasted or maybe even harmful, to an extent that this is of statistical and economic interest. Cast in terms of Figures 6 and 7 the question is whether the slopes of the regression lines are functions of policies or not.

Barro type growth regressions on panel data have been used extensively in this controversy about the importance of good macroeconomic policy in aid receiving countries. The origin of the debate was the analysis by Burnside and Dollar, first circulated as a World Bank working paper in 1996-97, later published in the *American Economic Review* (Burnside and Dollar, 1997, 2000). The results of this analysis

also provided part of the scientific background for the policy recommendations in the World Bank policy research report *Assessing Aid* (World Bank, 1998). The basic result was that aid spurs growth, but only in countries with good macroeconomic performance in the form of low budget deficits (preferably surpluses), low inflation and openness to trade. This influence of policy on the marginal impact of aid on growth was introduced in the regressions via an interaction term between aid and a policy index, later referred to as the Burnside-Dollar policy index.

While numerous writers have over the years suggested that such a link might be present, disagreement has always existed about the identification of *exactly which* policies are crucial. Hence, if the three policies emphasized by Burnside and Dollar were robust determinants of the "return" on aid, this would indeed be a major breakthrough. From this perspective, it is disappointing that this aid effectiveness result did not stand up to closer scrutiny. The studies by Dalgaard and Hansen (2001), Guillamont and Chauvet (2001), Hansen and Tarp (2000, 2001), Hudson and Mosley (2001), Lensink and White (2001) and Lu and Ram (2001) all test an interaction term between the Burnside-Dollar policy index and aid using either different data sets, different regression specifications or different estimators. They all find the interaction to be statistically insignificant. To our knowledge, the only study supporting the Burnside-Dollar interaction term is Collier and Dehn (2001). They include measures of export price shocks in the regression model, but this result appears sensitive to alternative measurements of the export price shocks.

The difficulty in finding a clear and positive estimate of interaction between policies and aid should not be regarded as an empirical curiosity. It makes perfect sense from a theoretical point of view as illustrated by Dalgaard and Hansen (2001). They develop a model where the interaction between aid and policy is ambiguous. In the model, aid increases the level of consumption. This reduces the degree of socio-political instability, which is good for growth.[20] Government activity is limited to raising taxes and providing public goods. Examples of the latter include a well-functioning court system, public security and so forth. In this example, "good policies" tend to reduce the ramifications of social unrest. Now, suppose aid only works through reducing instability, and suppose government intervention gradually manages to remove the harmful effects of social discontent (i.e., in terms of capital accumulation). In that case, the actions of the government will in fact tend to reduce the 'return' on aid. Nevertheless, government actions are, by themselves, stimulating growth. We view this as a simple illustration of a more general idea. In practice, aid is likely to affect growth through a host of channels. As a result, the return to aid is likely to be affected by numerous and widely differing policy measures. Some policies may be substitutes for aid inflows (as in the example above), while others are better perceived of as complements. This implies that a composite index of policies may encapsulate some components that enhance the

[20]The notion that foreign aid may buy political stability was early on suggested by Chenery and Strout (1966).

return to aid, while others diminish this impact. In the end, the net effect may well turn out insignificant.

Aside from provoking a heated debate on policy conditionality and selectivity in allocating aid, the Burnside and Dollar analysis also stimulated a series of results about non-linear effects of aid on growth. Indeed, the single most common result in recent empirical studies is that aid has a positive impact on real GDP per capita growth, but displays diminishing returns (Dalgaard and Hansen, 2001; Hansen and Tarp, 2000, 2001; Lensink and White, 2001). A possibly related finding is that instability of aid inflows appears to have a negative influence on growth, while the level of inflows has a positive impact (Lensink and Morrissey, 2000). In the same vein, Guillamont and Chauvet (2001) introduce a new interaction term and find important interactions between aid and an index measuring instability in terms of trade, real value of exports and agricultural value added.

As seen, a common finding in recent aid effectiveness studies is that determinants of the marginal impact of aid on growth appear to be more or less outside the direct control of the recipient countries. This is in stark contrast to the idea (and rhetoric) of the 1998 World Bank policy report. In recent research Collier and Dollar (2001, 2002) try to invigorate the debate by introducing the World Bank Country Policy and Institutional Assessment index (CPIA) in growth regressions. They show that an interaction term between aid and CPIA has a highly significant, positive effect, bringing us back to the claim that aid spurs growth in a good policy environment. However, the introduction of the CPIA index in the present context is questionable on several accounts.

First of all, the lessons to be drawn from the positive interaction term are in reality hard to pinpoint. The strength of the original Burnside-Dollar hypothesis was the claim that a small set of policies could be singled out as crucial. The CPIA index, on the other hand, assesses the quality of a country's present policy and institutional framework in 20 different dimensions.[21] Thus, in terms of drawing-up clear-cut recommendations for policy makers on how to enhance the effectiveness of aid, the analysis is not particularly helpful. Trade-offs between elements of the index are bound to arise in practice. For example, placing greater emphasis on budget balance (a component of "Economic Management") could conceivably be in conflict with improving access to health care, education etc. (the component "Building Human Resources" which belongs to the general group of "Policies for Social Inclusion/Equity").[22]

[21]These 20 items are assessed (by World Bank experts) on a scale from 1 to 6 (measuring "unsatisfactory for an extended period" to "good for an extented period"). Each item has a 5 percent weight in the overall rating. The items are grouped into four categories: "Economic Management", "Structural Policies", "Policies for Social Inclusion/Equity" and "Public Sector Management and Institutions".

[22]It is also interesting to take note of how the World Bank defines "quality" of a country's present policies and institutions. Quality means how conductive that framework is in fostering poverty reduction, sustainable growth, and the effective use of development assistance.

Table 1: Rank correlations with CPIA in 1999

	Overall Index	Economic Management	Structural Policies	Social Inclusion	Public sector Management
ICRG97 (43)	0.46	0.40	0.29	0.54	0.51
	[0.00]	[0.01]	[0.06]	[0.00]	[0.00]
Fraction of land in tropics (61)	−0.23	−0.26	−0.21	−0.23	−0.11
	[0.08]	[0.04]	[0.11]	[0.07]	[0.39]

Notes: Spearman rank correlations with p-values for test of independence in brackets. The number of observations are given in parentheses. The CIPA gradings for 1999 are obtained from *News and Notices for IMF and World Bank Watchers*, Vol. 2, No. 3, 2000.

A second concern is endogeneity. There is ample evidence, that "policies" and growth are jointly endogenous variables. For example, Clague et al. (1996) and Mauro (1995) argue that good economic performance increases institutional efficiency, and Mauro goes on to highlight that using expert evaluations may be problematic. The argument is that an evaluator is likely to conclude that a particular set of institutions is good if the country in question is growing rapidly.

Unfortunately, it is currently impossible to investigate directly whether endogeneity of the CPIA index is an issue,as the data are not in the public domain. However, indirect evidence does shed light on what any further analysis is likely to find.

In a recent study, Chong and Calderon (2000) use Granger-causality tests to examine possible feedback between two institutional quality measures (BERI and ICRG) and economic growth. Using 5-year averages, they find strong Granger-causal impact from growth to institutions while the causality from institutions to growth is weak. Using 10-year periods there is significant causality both ways. The Chong and Calderon analysis does not include the CPIA index, so it is instructive to compare the institutional quality indexes and the CPIA. We obtained CPIA data from *News and Notices for IMF and World Bank Watchers*, Vol. 2, No. 3, 2000. Even though this is not exactly the World Bank CPIA data, this variable would appear to be capable of providing a pretty good indication of the concordance between the CPIA and publicly available data.

In Table 1, we report Spearman correlations between the CPIA and the Knack and Keefer ICRG index in 1997.[23] In addition, we show correlations with the four sub-groupings, used to construct the overall CPIA index. There is quite a strong concordance between the ICRG index in 1997 and the CPIA in 1999, and independence of the two measures is rejected at conventional levels of significance. As shown by Chong and Calderon part of the changes in the ICRG index is caused by economic growth – or some underlying factor affecting both growth and institutional ratings. It is also of interest to note that the ICRG97 index is closely correlated with

[23]Knack and Keefer (1995) constructed a "Property rights index" (ICRG82) from five ICRG indicators: Corruption in government, rule of law, bureaucratic quality, repudiation of contracts by government and risk of expropriation. We use same indictors in an index for 1997 (ICRG97).

each of the sub-groups in the CPIA. Hence, it seems difficult to speak of "changing policies" without "changing institutions".

To be sure, these insights do not *per se* invalidate the regression results in Collier and Dollar (2001, 2002). However, they do justify a certain amount of skepticism regarding the policy relevance and appropriateness of using these regressions in counter-factual scenarios such as the re-allocation of aid based on good CPIA ratings. If the CPIA index is Granger-caused by growth it should not be used as an exogenous variable in forecasts and policy simulations. In finding a way around this problem, it seems worthwhile to move in the direction of applying strictly exogenous factors, with adequate explanatory power, in empirical work on the topic of how to allocate aid. In what follows we make a foray in this direction.

The second part of Table 1 shows that a key geographic variable is correlated with the components of the CPIA. Specifically, the fraction of land area in the geographical tropics in a given country is negatively correlated with the CPIA. The correlation is mainly though an association with the measures of economic management.[24] This finding is in full accord with the contributions by Bloom and Sachs (1998), Gallup, Sachs and Mellinger (1999) as well as other recent studies.

Both Bloom and Sachs and Gallup et al. show that geography, in the form of tropical land area, tropical diseases (malaria) and landlockedness, significantly influences growth in GDP per capita from 1965 to 1990 and in both studies several channels through which geography may impact on growth (and policy) are discussed. Acemoglu et al. (2001) offer an alternative explanation by relating geography to the nature of institutions created by European colonists. Thus, although the precise *modus operandi* of geography is open to debate, the exogeneity of tropical land area would appear unquestionable over the time horizon in question.

As regards a possible interaction of aid and geographic circumstances, the formal model presented in Section 2 certainly motivates taking a closer look insofar as bad climate leads to low factor productivity. Another possibility is that mortality matters for the return on aid. Suppose, for example, that foreign aid spurs human capital accumulation by improving the access to formal education. According to Sachs (2001), countries placed in temperate climate zones tend to have significantly longer life spans than individuals living in non-temperate climate zones, controlling for income. Obviously, a higher mortality rate will reduce the total effect of aid-induced human capital accumulation. Thus, a possible link between aid and climate may run through the association of the latter with health status. One can think of other likely candidates for an explanation. In any event, the hypothesis of an important interaction between aid and geographic factors is plausible, and therefore worth exploring.

In Table 2 we estimate models of average annual per capita GDP growth using

[24]See Bloom and Sachs (1998) for a description of the tropical area variable. We obtained the variable from the CID homepage: www.cid.harvard.edu.

Table 2: Growth regressions: The impact of aid and geography

	(1)	(2)	(3)	(4)
Estimation Method	GMM	GMM	GMM	OLS
Real per capita GDP (log)	−0.354	−0.241	−0.390	−0.672
	(0.47)	(0.33)	(0.53)	(0.95)
Budget surplus (% GDP)	0.094*	0.076*	0.072*	0.047
	(3.33)	(2.46)	(2.52)	(1.23)
Inflation	−1.293*	−1.278*	−1.118*	−1.139*
	(2.82)	(2.74)	(2.48)	(2.65)
Openness	1.788*	1.750*	1.753*	1.968*
	(3.61)	(3.73)	(3.76)	(3.89)
Assassinations	−0.455	−0.407	−0.370	−0.365
	(1.76)	(1.73)	(1.57)	(1.46)
Assassin. x Ethnic fract.	0.853*	0.812	0.759	0.725
	(1.96)	(1.92)	(1.82)	(1.66)
Ethnic fract.	0.468	0.746	0.589	0.021
	(0.53)	(0.89)	(0.69)	(0.03)
Institutional quality	0.881*	0.758*	0.763*	0.701*
	(4.39)	(3.79)	(4.04)	(3.64)
Sub-Saharan Africa	−3.208*	−2.492*	−2.217*	−1.357
	(3.63)	(3.02)	(2.72)	(1.55)
East Asia	1.333*	1.833*	1.845*	1.622*
	(2.11)	(3.08)	(3.07)	(2.65)
Aid (EDA/GDP %)	1.071*	1.110*	1.818*	1.480*
	(2.33)	(2.55)	(3.90)	(3.61)
Aid squared	−0.099*	−0.098*	−0.063	−0.018
	(2.36)	(2.60)	(1.54)	(0.76)
Fraction of land in tropics		−2.259*	−1.424*	−1.101*
		(4.90)	(2.40)	(2.06)
Aid x fraction of land in tropics			−1.099*	−1.402*
			(2.07)	(3.29)
P-value of Hansen J-test	0.58	0.77	0.78	
Observations	231	231	231	231

Notes: Panel regressions of 54 countries over five 4 year epochs (1974-77 to 1990-93). The dependent variable is real per capita GDP growth. Time dummies are included in all regressions. Robust t-statistics in parentheses in the OLS regression. * significant at 5 percent. Common instuments in GMM regressions: aid, aid squared, aid x openness, aid x inflation (all lagged one period). Instrument added in regression (3): "aid x fraction of land in tropics" lagged one period.

a panel of 54 countries over five 4-year epochs.[25] The baseline equation is similar to the specifications in Burnside and Dollar (2000) with the modifications in choice of instruments and impact of aid suggested in Dalgaard and Hansen (2001). Hence, in the baseline equation, growth is a function of initial income in each epoch, public savings as a per cent of GDP, inflation, openness, ethnic fractionalization, assassinations, quality of institutions, Sub-Saharan Africa and East Asia regional dummies, and aid. Arguably, some of the regressors are likely to be endogenous. However, to facilitate comparison with earlier results, we have chosen to keep the Burnside-Dollar type specification.

The results of the baseline model are in line with earlier findings. All variables have the expected/established signs, but the effects of initial income and ethnic fractionalization are imprecisely determined. Aid is modeled as an endogenous regressor and hence instrumented, basically using functions of lagged aid.[26] It appears once again that aid has a positive, but diminishing impact on growth.

In regression 2 of Table 2 we add the measure of the fraction of land area in geographical tropics. Note that tropical areas have a highly significant negative impact on growth. Moreover, the impact of other control variables remains largely unchanged compared to the baseline equation. Specifically, the Sub-Saharan Africa dummy only drops a little and retains statistical, as well as economic, significance; and the marginal impact of aid stays largely unchanged.

The impact of tropical land area is rather large in regression 2 compared to the findings in Bloom and Sachs and Gallup et al. One explanation for this result is given in regression 3 in which we add an interaction term between aid and the fraction of tropical land area. Again, there are only small changes in the impact of the basic control variables. Compared to regression 2 the direct negative growth effect of tropical areas is lowered to just above one percentage point, while the estimated impact of aid changes radically. Diminishing returns implied by the quadratic function are replaced by a spline function in which the marginal impact of aid in the sub-tropic and temperate zone countries is about twice the impact in tropical areas. According to these estimates, a one percentage point increase in the aid ratio in a tropical country (say, Cameroon) will spur a 0.7 percentage point increase in the growth rate. The same increase in a non-tropical country (say, Tunesia) is expected to lead to a 1.8 percentage point increase in the rate of growth.[27]

To avoid any further discussion about the use of instrumental variable regressions

[25]The data are from Burnside and Dollar (2000). Aid is measured using Effective Development Assistance as a percent of GDP (Chang, Fernandez-Arias and Serven, 1998).

[26]This choice of instruments is directly motivated by the allocation equation (12).

[27]The growth effect of increased aid may seem excessive. Yet, recall that in the present model it is not a permanent growth effect. There is probably conditional convergence taking place – partly working through aid allocation. Moreover, increasing the aid to GDP ratio in Cameroon by a one percentage point would require additional *grants* in the order of 92 million USD in 1999.

and the choice of instruments, we finally report results using OLS in regression 4. The main result is unaltered: Aid has a much higher impact on growth in non-tropical countries.

5. Conclusion

The need for growth and development is as great as ever if we are to come even close to the United Nations target of halving world poverty by 2015. The central message of the present paper is that aid can play a significant conductive role in reaching such a target. At the same time it should be recognized that aid is not a panacea for poverty reduction.

To substantiate the central message we studied aid effectiveness within a simple growth model based on first principles. Our analysis demonstrates that foreign aid – in the form of a simple transfer of income – is likely to spur growth under fairly standard assumptions with respect to preferences, technology, etc. At the same time, however, the model also demonstrated that the growth rate of foreign aid inflows is potentially an important parameter. Since a substantial group of the aid receiving countries has experienced significant trend growth in aid per capita, attention to this issue appears warranted. In particular, the analysis suggests that, when foreign assistance is expanded quickly it is harder to ensure that aid is effective. Exploring this issue further, quantitatively, appears to be useful. Finally, our model also provides a theoretical foundation for the approach taken in empirical work in recent years. This includes the practice of regressing the aid to GDP level on growth rates and allowing for interaction effects with slow moving structural characteristics.

Turning to the empirical results, we started out by demonstrating that cross-country data such as those underlying Figure 1 and 2 are fully consistent with the positive aid-growth results emerging from panel-based econometric work. Once we account for problems associated with identification and country specific heterogeneity, past and present research are reconciled. Looking at empirical relations between aid, on the one hand, and growth and saving on the other using standard fixed effects transformations clealy suggests that much of the debate about the macro effectiveness of foreign aid has been held back by focussing on pure cross-country correlations. The recent empirical evidence demonstrating that aid is effective is in our assessment convincing. Political decisions on curbing aid cannot be justified, arguing that aid has no impact.

We subsequently justified why we believe that the endogeneity of policies and institutions should be taken more serious than in much of the existing analytical work. This was followed by empirical evidence on the possible interaction between geographic circumstances and aid. The formal model developed in Section 2 motivates such interaction, and more generally we identified several reasons why climate may matter for the effect of aid. The climate-related differences in the impact of aid on

growth identified in this paper are important. We therefore suggest it would be a fruitful avenue for future research to investigate which mechanisms are driving the result. This information could potentially be used in the quest for designing more effective foreign assistance, to the benefit of the growth of poor nations.

Acknowledgements

The activities of EPRU (Economic Policy Research Unit) are financed through a grant from The Danish National Research Foundation.

We would like to thank Nikolaj Malchow-Møller for valuable criticism that led to significant improvements of the manuscript. In addition, we would also like to thank Jacob Gyntelberg, Rasmus Heltberg, Jens Kovsted, and Oliver Morrissey for many useful comments and suggestions. The usual disclaimer applies.

References

Acemoglu, D., S. Johnson and J. A. Robinson (2001). The colonial origins of comparative development: An empirical investigation. *American Economic Review 91*, 1369–1401.

Alesina, A. and D. Dollar (2000). Who gives foreign aid to whom and why? *Journal of Economic Growth 5*, 33–63.

Arrow, K. J. (1962). The economic implications of learning-by-doing. *Review of Economic Studies 29*, 155–173.

Bloom, D. and J. D. Sachs (1998). Geography, demography and economic growth in Africa. *Brookings Papers on Economic Activity 2*, 207–273.

Boone, P. (1996). Politics and the effectiveness of foreign aid. *European Economic Review 40*, 289–329.

Burnside, C. and D. Dollar (1997). Aid, policies and growth. Policy Research Working Paper 1777, The World Bank, Development Research Group, Washington, D. C.

Burnside, C. and D. Dollar (2000). Aid, policies, and growth. *American Economic Review 90*, 847–868.

Cass, D. (1965). Optimum growth in an aggregative model of capital accumulation. *Review of Economic Studies 32*, 233-240.

Chang, C. C., E. Fernandez-Arias, and L. Servén (1998). Measuring aid flows: A new approach. Working paper, The World Bank. Processed.

Chenery, H. B. and A. M. Strout (1966). Foreign assistance and economic development. *American Economic Review 56*, 679–733.

Chong, A. and Calderón (2000). Causality and feedback between institutional measures and economic growth. *Economics and Politics 12*, 69–81.

Clauge, C., P. Keefer, S. Knack and M. Olson (1996). Property and contract rights in autocracies and democracies. *Journal of Economic Growth 1*, 243–276.

Collier, P. and D. Dollar (2001). Can the world cut poverty in half? How policy reform and effective aid can meet international development goals. *World Development 29*, 1787–1802.

Collier, P. and D. Dollar (2002). Aid allocation and poverty reduction. *European Economic Review* forthcoming.

Collier, P. and J. Dehn (2001). Aid, shocks and growth. World Bank Working Paper 2688, The World Bank, Washington, D. C.

Dalgaard, C.-J. and H. Hansen (2001). On aid, growth and good policies. *Journal of Development Studies 37*, 17–41.

Diamond, P. (1965). National debt in a neoclassical growth model. *American Economic Review 55*, 1126–1150.

Dudley, L. and C. Montmarquette (1976). A model of the supply of bilateral foreign aid. *American Economic Review 66*, 132-142.

Easterly, W. and R. Levine (2001). It's not factor accumulation: stylized facts and growth models. *World Bank Economic Review 15*, 177-219.

Gallup, J. L., J. D. Sachs and A. Mellinger (1999). Geography and economic development. In B. Pleskovic and J. E. Stiglitz (Eds.) *Annual World Bank Confernce on Development Economics, 1998 Proceedings,* pp. 127-178.

Galor, O. and H. E. Ryder (1989). Existence, uniqueness, and stability of equilibrium in an overlapping-generations model with productive capital. *Journal of Economic Theory 49*, 360-375.

Guillaumont, P. and L. Chauvet (2001). Aid and performance: A reassessment. *Journal of Development Studies 37*, 66–92.

Griffin, K. (1970). Foreign capital, domestic savings and economic development. *Bulletin of the Institute of Economics and Statistics* (Oxford University) *32*, 99-112.

Hansen, H. and F. Tarp (2000). Aid effectiveness disputed. *Journal of International Development 12*, 375–398.

Hansen, H. and F. Tarp (2001). Aid and growth regressions. *Journal of Development Economics 64*, 547–570.

Hudson, J. and P. Mosley (2001). Aid policies and growth: In search of the Holy Grail. *Journal of International Development 13*, 1023–1038.

Kaldor, N. (1957). A model of economic growth. *Economic Journal 57*, 591–624.

Klenow, P. J. and A. Rodriguez-Clare (1997). The neoclassical revival in growth economics: has it gone too far? In B. S. Bernanke and J. J. Rotemberg, (Eds.) *NBER Macroeconomics Annual 1997*, pp 73-103. MIT Press, Cambridge and London.

Knack, S. and P. Keefer (1995). Institutions and economic performance: Cross-country tests using alternative institutional measures. *Economics and Politics 7*(3), 207–227.

Koopmans, T. C. (1965). On the concept of optimal economic growth. In *The Econometric Approach to Development Planning*, pp. 225-287. North-Holland, Amsterdam.

Leibenstein, H. (1960). *Economic Backwardness and Economic Growth: Studies in the Theory of Economic Development.* John Wiley. N.Y.

Lensink, R. and O. Morrissey (2000). Aid instability as a measure of uncertainty and the positive impact of aid on growth. *Journal of Development Studies 36*, 31–49.

Lensink, R. and H. White (2001). Are there negative returns to aid? *Journal of Development Studies 37*, 42–65.

Leontief, W. (1965). The rates of long-run economic growth and capital transfer from developed to underdeveloped areas. In *The Econometric Approach to Development Planning*, pp. 1039-1057. North-Holland, Amsterdam.

Lu, S. and R. Ram (2001). Foreign aid, government policies, and economic growth: Further evidence from cross-country panel data for 1970-1993. *International Economics 54*, 15–29.

Mauro, P. (1995). Corruption and growth. *Quarterly Journal of Economics 110*, 681–712.

Meier, G. M. (1964). *Leading Issues in Development Economics* (First edition). Oxford University Press.

Meier, G. M. (1995). *Leading Issues in Economic Development* (Sixth edition). Oxford University Press.

Meier, G. M. and J. E. Rauch (2000). *Leading Issues in Economic Development* (Seventh edition). Oxford University Press.

Obstfeld, M. (1999). Foreign resource inflows, saving, and growth. In K. Schmidt-Hebbel and L. Servén (Eds.), *The Economics of Saving and Growth*, Chapter 5, pp. 107–146. Cambridge, UK: Cambridge University Press.

Ramsey, F. (1929). A mathematical theory of savings. *The Economic Journal* 38, 543-59.

Rebelo, S. (1991). Long-run policy analysis and long-run growth. *Journal of Political Economy* 99, 500-521.

Romer, P. (1986). Increasing returns and long-run growth. *Journal of Political Economy 94*, 1002-1037.

Rosenstein-Rodan, P. N. (1943). Problems of industrialisation of Eastern and South-Eastern Europe. *Economic Journal 53*, 202-211.

Sachs, J. D. (2001). Tropical underdevelopment. NBER Working Paper W8119.

Svensson, J. (2000). Foreign aid and rent-seeking. *Journal of International Economics* 51, 437-61.

Tornell, A. and P. Lane (1999). The voracity effect. *American Economic Review 89*, 22-46.

Trumbull,W. N. and H. J. Wall (1994). Aid-allocation criteria with panel data. *Economic Journal 104*, 876-882.

White, H. (1992). The macroeconomic impact of development aid: A critical survey. *Journal of Development Studies*; 28, 163-240.

World Bank (1998). *Assessing Aid: What Works, What Doesn't, and Why.* World Bank Policy Research Report. Oxford: Oxford University Press.

A. Derivation of the cross-country aid impact and aid allocation equations

A.1. The impact equation

The growth equation (11) is identical to a first order autoregressive levels equation, where $\psi = 1 - \gamma$:

$$\log y_{it} - g\,t - \lambda_{1i} = \theta_1 a_{it} + \psi(\log y_{it-1} - g(t-1) - \lambda_{1i}) + \varepsilon_{it}.$$

From this formulation, present income (time T) can be expressed as a function of initial income (time 0) using the moving average representation

$$\log y_{iT} - g\,T - \lambda_{1i} = \sum_{t=1}^{T-1} \psi^t(\theta_1 a_{iT-t} + \varepsilon_{iT-t}) + \psi^T(\log y_{i0} - \lambda_{1i}).$$

Now, define average aid over the period $1, \ldots, T$ as $a_{i.} = \frac{1}{T}\sum_{t=1}^{T} a_{it}$; add and subtract this average and reduce the resulting equation to

$$\begin{aligned}\log y_{iT} = g\,T + (1-\psi^T)\lambda_{1i} + \{(1-\psi^T)/(1-\psi)\}\theta_1 a_{i.} \\ + \psi^T \log y_{i0} + \sum_{t=1}^{T-1} \psi^t\{\theta_1(a_{iT-t} - a_{i.}) + \varepsilon_{iT-t}\}.\end{aligned}$$

Finally, subtracting $\log y_{i0}$ and dividing by T we get the average growth rate on the left hand side

$$\begin{aligned}\Delta \log y_{i.} = g + \tfrac{1-\psi^T}{T}\lambda_{1i} + \tfrac{1-\psi^T}{(1-\psi)T}\,\theta_1 a_{i.} \\ - \tfrac{1-\psi^T}{T}\log y_{i0} + \frac{1}{T}\sum_{t=1}^{T-1} \psi^t\{\theta_1(a_{iT-t} - a_{i.}) + \varepsilon_{iT-t}\}.\end{aligned}$$

This is equation (13).

A.2. The allocation equation

Starting from equation (12) we average over T periods

$$\frac{1}{T}\sum_{t=1}^{T} a_{it} = \frac{1}{T}\sum_{t=1}^{T}(\lambda_{2i} - \theta_2 \log y_{it-1} + \eta_{it}). \tag{15}$$

The average of the lagged log income equals the initial log income and a weighted average of the year-to-year growth rates

$$\begin{aligned}
\frac{1}{T}\sum_{t=1}^{T} \log y_{it-1} &= \frac{1}{T}\sum_{t=0}^{T-1} \log y_{it} \\
&= \frac{1}{T}\sum_{t=0}^{T-1}(T-t)\Delta \log y_{it} + \log y_{i0} \\
&= \frac{1}{T}\sum_{t=0}^{T}(T-t)\Delta \log y_{it} + \log y_{i0}.
\end{aligned}$$

Adding and subtracting the average growth rate ($\Delta \log y_{i.}$) result in

$$\frac{1}{T}\sum_{t=1}^{T} \log y_{it-1} = T(1 - \tfrac{1}{2}\tfrac{T+1}{T})\Delta \log y_{i.} + \log y_{i0} + \sum_{t=0}^{T} \tfrac{T-t}{T}(\Delta \log y_{it} - \Delta \log y_{i.}).$$

Inserting this in (15) we get equation (14).