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FOREIGN AID AND LONG-RUN ECONOMIC GROWTH: EMPIRICAL EVIDENCE FOR A PANEL OF DEVELOPING COUNTRIES

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Abstract: This paper investigates the relationship between foreign aid and growth in per capita GDP using annual data from the 1960 to 1997 period for a sample of 71 aid-receiving developing economies. The results show that the effect of foreign aid on economic growth is positive, permanent, statistically significant, and sizable: raising foreign aid by $20 per person of the receiving country results in a permanent increase in the growth rate of real GDP per capita by approximately 0.16 per cent. Using an alternative foreign-aid measure, a permanent increase in aid by 1 per cent of the receiving economy's GDP permanently raises the per capita growth rate by 0.14 to 0.26 per cent. Copyright © 2006 John Wiley & Sons, Ltd.

Keywords: Foreign aid; economic growth; long-run effects

1 INTRODUCTION

The effectiveness of foreign aid has been the subject of extensive investigation, which is hardly surprising given the importance of the topic. More recently, however, the growing realization that a large number of developing countries have had only limited success with their convergence experience has given the issue a new urgency as foreign aid, at least in theory, can facilitate growth and thus convergence.[1]

Theoretically, however, as Burnside and Dollar (2000) point out, the effects of foreign aid on growth are easily shown to be ambiguous.[2] In the context of a standard neoclassical growth model, for example, any steady-state effects will not just depend on the amount and type of the aid, but also on how productively it is used by the receiving country and

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[1]While 'conditional' convergence is very strongly supported by the data (see Barro and Sala-i-Martin, 2004), in absolute terms, convergence in per capita income has been far from universal. See Pritchett (1997) and Sala-i-Martin (2002).

[2]It is not only the size but also the sign of the theoretical effect that is ambiguous when the possible effects on corruption and other growth-retarding policies are taken into account. For evidence and the literature on the aid-corruption link see Tavares (2003).

what other distortions, if any, it introduces. Using such a model, Obstfeld (1999) shows that lump-sum foreign aid should have no effect on the economy's steady-state capital stock or output level, but that it will speed up the dynamic adjustment to the steady state for an economy that starts below it. Obstfeld (1999) suggests several ways in which the model can be modified to produce non-zero steady-state output effects, and Dalgaard *et al.* (2004) pursue one of them to show that in a simple overlapping-generations model, the effect of aid on the steady-state capital stock is theoretically ambiguous. Modeling additional factors such as the labor-leisure choice, terms-of-trade effects, and possible changes in the tax structure, will most likely only deepen the theoretical ambiguities.

The question, therefore, has to be resolved empirically and a consensus seems to have been emerging in the last few years. First, a number of studies, such as Boone (1996), found no systematic relationship between foreign aid and growth, investment, or human development indicators in the receiving country, concluding that foreign aid is largely ineffective. More recently, the influential study of Burnside and Dollar (2000), has qualified this conclusion by showing that foreign aid has positive effects but only in economies in which it is combined with good fiscal, monetary, and trade policies. This reasonable finding, so consistent with our theoretical priors, has become the consensus view. Disagreements, however, persist, as in Hansen and Tarp's (2000) exhaustive evaluation of the empirical literature, which concludes that a positive aid-growth link can be shown to exist 'even in countries hampered by an unfavourable policy environment'.[3] Dalgaard *et al.* (2004) update these results, while Hudson (2004) provides a careful review of the issues considered in the recent literature.

The goal of the present paper is to contribute to the empirical side of the question using a panel methodology that analyzes annual data from the 1960 to 1997 period for 71 developing economies. Thus, contrary to the overwhelming majority of the empirical literature, which consists of cross-sectional studies, the time dimension of the data will be fully utilized here.[4] The results show not only that the use of time-series data substantially clarifies the issue, enabling us to arrive at sharper estimates of the growth effects of foreign aid; but also that ignoring the time dimension of the series and relying on cross-sectional data can mask the true relationship and leave the researcher with weak and misleadingly insignificant results.

The results show that the effect of foreign aid on economic growth is positive, permanent, statistically significant and economically sizable. Additionally, the effect is robust across our two measures of foreign aid: aid per capita and aid as a fraction of GDP. On average, the empirical findings support the conclusion that a permanent increase in foreign aid by $20 per person of the receiving country results in a permanent increase in the growth rate of real GDP per capita by approximately 0.16 per cent, while a permanent increase in aid by 1 per cent of the receiving economy's GDP permanently raises the per capita growth rate by approximately 0.14 to 0.26 per cent.

The rest of the paper is organized as follows. Section 2 discusses the sources of the data, defines the variables to be used in the estimation, and presents simple cross-sectional regressions in order to illustrate the limitations of that approach. Section 3 proposes the estimation methodology, derives the main empirical results, and implements several robustness checks. Section 4 discusses the findings and some policy implications, and concludes.

[3]But see also Easterly (2003) and Easterly *et al.* (2004). A somewhat related branch of the literature has looked at the determinants, rather than the effects, of foreign aid, focusing on the behavior of donor countries. Alesina and Dollar (2000) is the most prominent example.
[4]Though still in the minority, influential panel studies have been emerging. See for example Hansen and Tarp (2001) who find that the growth effects of aid are not conditional on 'good' policies.

2 DATA SOURCES AND SIMPLE CROSS-SECTIONAL REGRESSIONS

The data cover 71 developing countries and are obtained from the Penn World Table (PWT, Mark 6.1), documented in Heston, Summers, and Aden (2001; see also Summers and Heston, 1991), and the OECD's Net Geographical Distribution of Financial Flows database, included in the OECD Statistical Compendium on CD-ROM.

The variable *growth* measures the growth rate of real GDP per capita, *y*, in constant dollars. Specifically, for country *i* and year *t*,

$$growth_{i,t} = \frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}}.$$

Foreign aid for each country is captured by that country's total net Official Development Assistance (ODA) receipts from all donors. This is reported by the OECD in current U.S. dollars. In order to express it in constant (PPP) dollars, the variable is divided by the dollar deflator implied for each country by the PWT's measures of GDP in current and constant dollars.

Two measures of 'foreign aid' are computed. The first divides real ODA, *oda*, by population, *N*, to express it on a per capita basis; the second divides *oda* by real *GDP* to quantify it as a fraction of output:

$$(oda/pop)_{i,t} = \frac{oda_{i,t}}{N_{i,t}}$$

and

$$(oda/gdp)_{i,t} = \frac{oda_{i,t}}{GDP_{i,t}}.$$

To put the ODA numbers in additional perspective, two similar measures of total financial flows, *total*, are constructed in a similar way. In addition to the ODA aid components, *total* also includes non-aid flows such as direct investment and portfolio investment, but it is again defined as net receipts from all donors. This measure is also expressed on a per capita basis (*total/pop*), and as a fraction of GDP (*total/gdp*), using the transformations described above.

The rest of the variables to be used in the empirical section below are those predicted to have steady-state effects by the standard neoclassical growth model: (i) *inv* is investment as a fraction of *GDP*, (ii) *pop* is the population growth rate, and (iii) *gov* is government purchases as a fraction of *GDP*.

The data set consists of the 71 developing economies for which data on all series exist for each year of the 1960–1997 period. The Appendix provides a list of these 71 economies together with country averages over 1960–1997 for the *growth*, *oda/pop*, *oda/gdp*, *total/pop*, and *total/gdp* series.[5] Average annual growth of real *GDP* per capita has ranged from −2.97 per cent in Zaire to 5.50 per cent in Botswana. Over the same time period, annual foreign aid measured by *oda/pop* has varied from $2.75 per person in

[5]Country selection is dictated by data availability only. Sample means for the rest of the variables (*inv*, *pop*, and *gov*) are not reported in the Appendix in order to preserve space, but are available on request.

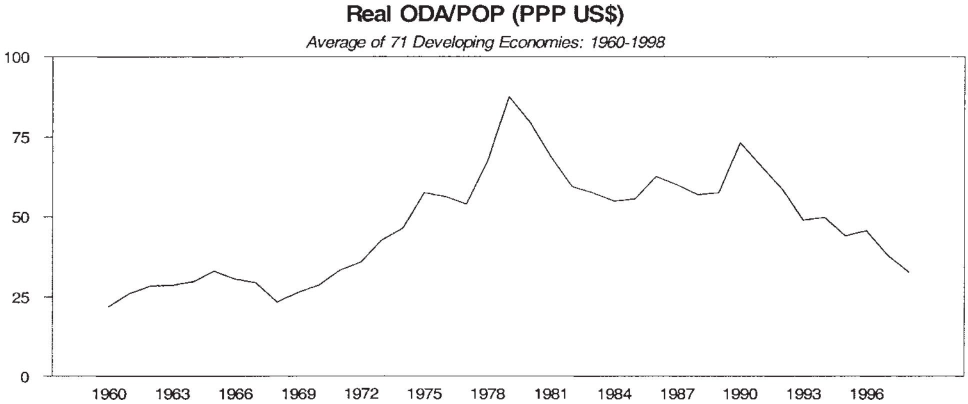

Figure 1. Average foreign aid per Capita, 1960–98

Mexico to \$375.26 per person in Jordan; while measured by *oda/gdp*, annual foreign aid has varied from 0.03 per cent of GDP in Argentina to 11.98 per cent of GDP in Jordan. It is interesting to compare these statistics on aid flows to the corresponding numbers on total flows, which measured by *total/pop* have varied from \$5.57 per person in India to \$625.82 per person in Panama, while measured by *total/gdp* have varied from 0.36 per cent of GDP in Iran to 13.40 per cent of GDP in Jordan.

Figures 1–3 add a time dimension to these numbers. Figure 1 reports the average ODA per capita over 1960–98. This measure of foreign aid grew from around \$22 in 1960 to almost \$88 in 1979, but declined again to \$32 by 1998. ODA as a fraction of the receiving country's GDP follows a similar pattern, illustrated in Figure 2: from a low value of 1 per cent, this measure of aid grew to 3.3 per cent in 1979, declined in the early 1980s, resumed growth in the second half of that decade to reach 3.5 per cent in 1990, and has been declining since, falling to 1.7 per cent in 1998. Finally, Figure 3 presents the average real GDP growth rate over the 1960–98 period, clearly showing the post-1970s slowdown, and the developing-world recessions of 1980, 1982–83, 1990, 1992, and 1994.

Table 1 reports six simple cross sectional (sometimes referred to as 'Barro-type') regressions. The top panel employs the growth rate as the dependent variable.

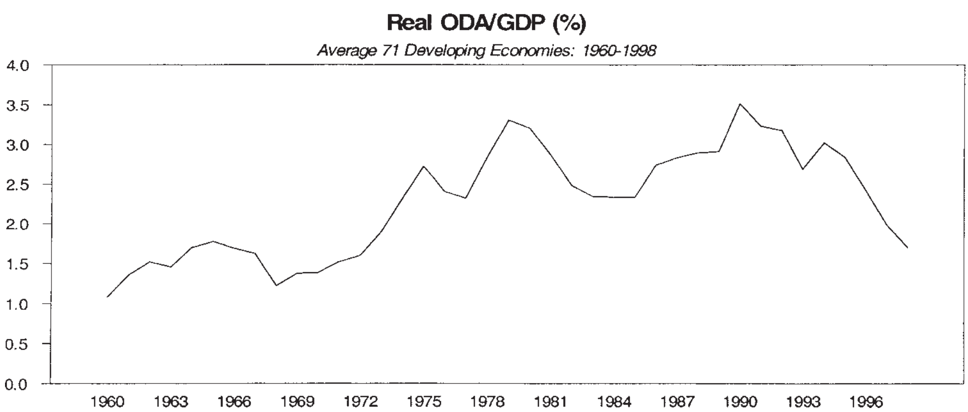

Figure 2. Average foreign aid as fraction of receiving economy's GDP, 1960–98

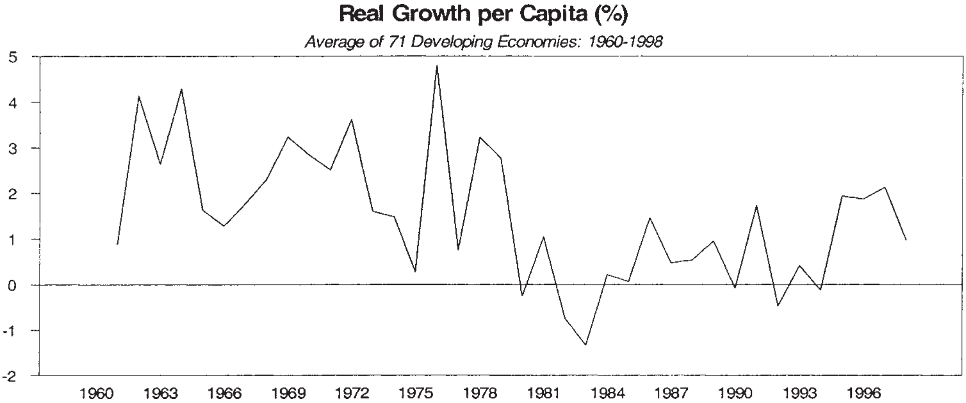

Figure 3. Average growth rate of real GDP per Capita, 1960–98

Specification (a) is the benchmark regression, similar to the models estimated in Mankiw *et al.* (1992), Barro and Sala-i-Martin (1995), and numerous other studies. This benchmark regression's estimates for the present sample of 71 developing countries are largely as expected. First, the coefficient of initial (1960) income is statistically significantly negative, indicating that there is convergence: the richer a country was in 1960, the less rapid its growth rate during 1960–97 (controlling for the effects of the other variables, which implies *conditional* convergence). Second, the estimated coefficients of *pop* and *gov* are negative (though not statistically significant), while that of *inv* is positive (and statistically significant).

Specification (b) of the top panel of Table 1 adds the variable *oda/pop* to the growth regression in order to investigate whether foreign aid per capita is a determinant of the steady state. The results are not encouraging. The point estimate of the effect of aid is

Table 1. Cross-sectional regressions.

	(a)	(b)	(c)
Dependent Variable: *growth*			
$\ln(y_{1960})$	−0.508* (0.246)	−0.520* (0.244)	−0.645* (0.270)
ln(*pop*	−0.865 (0.486)	−0.900 (0.503)	−0.805 (0.481)
ln(*inv*)	1.689** (0.322)	1.697** (0.328)	1.612** (0.344)
ln(*gov*)	−0.139 (0.358)	−0.245 (0.414)	0.015 (0.392)
ln(*oda/pop*)		0.124 (0.156)	
ln(*oda/gdp*)			−0.175 (0.167)
R^2	0.382	0.387	0.392
Dependent Variable: $\ln(y_{1997})$			
ln(*pop*)	−0.862** (0.305)	−0.876** (0.312)	−0.616* (0.244)
ln(*inv*)	0.892** (0.160)	0.895** (0.161)	0.702** (0.175)
ln(*gov*)	−0.344 (0.185)	−0.396* (0.186)	0.031 (0.177)
ln(*oda/pop*)		0.063 (0.088)	
ln(*oda/gdp*)			−0.285** (0.076)
R^2	0.472	0.476	0.569

Notes: For the cross-sectional regressions, variables are as defined in Section 2, averaged over 1960–1997 for each country. All regressions include a constant term (not reported here). Estimated standard errors in parentheses.
** and * denote statistical significance at the 1 and 5 per cent significance levels.

positive but statistically insignificant. Specification (c) includes the variable *oda/gdp* instead, but fails to clarify things. The coefficient of aid is now negative, while still statistically insignificant.

The bottom panel uses the level of income per capita (in logarithms) as the dependent variable, using the alternative specification of Mankiw *et al.* (1992). Specification (a) is again the benchmark regression. Once more, as expected, the estimated coefficient of *pop* is negative (and now statistically significant), that of *inv* is positive (and statistically significant), while the coefficient of *gov* is negative or statistically insignificant.

Specification (b) of the bottom panel of Table 1 adds again the variable *oda/pop* to the income-level regression, but once again the effect of aid is positive but statistically insignificant. Specification (c) includes the variable *oda/gdp* instead, and finds the coefficient to be negative (−0.285) and highly significant. This last coefficient of course may not indicate a causal relationship from foreign aid to growth, but may simply capture the fact that poorer economies will attract more aid.[6] It is evident that using a simple cross-sectional approach on the present data set does not produce convincing evidence.

3 LONG-RUN EFFECTS OF FOREIGN AID ON GROWTH

3.1 The Benchmark Model

A shortcoming of cross-sectional models, such as those of the last section and much of the literature reviewed in the Introduction, is that they largely give up the time dimension of the data, sacrificing a lot of information. Following the methodology of Jones (1995) in his study of investment and growth, the present paper will investigate whether changes in foreign aid permanently affect growth by estimating a dynamic time-series model. We start with the general specification

$$growth_{i,t} = w_i + v_t + C(L)growth_{i,t-1} + A(L)aid_{i,t} + u_{i,t}$$

where, once again, *growth* is the growth rate of real *GDP* per capita, *aid* is one of our two measures of foreign aid (*oda/pop* or *oda/gdp*), the *w*s and *v*s are parameters, $A(L)$ and $C(L)$ are p^{th}-order polynomials in the lag operator L with roots outside the unit circle, u is a spherical error term, and i and t index over countries and time, respectively.[7]
This specification can be rewritten as

$$growth_{i,t} = w_i + v_t + C(L)growth_{i,t-1} + b \cdot aid_{i,t} + B(L)\Delta aid_{i,t} + u_{i,t}, \tag{1}$$

where $b = A(1)$ is a parameter equal to the sum of the coefficients of the $A(L)$ polynomial, $\Delta = 1 - L$ is the difference operator, and $B(L)$ is a $(p-1)^{th}$-order polynomial whose coefficients are related to those of $A(L)$ according to $\beta_k = -\sum_{j=k+1}^{p} \alpha_j$. It follows that estimating b in model (1) can be used to examine whether changes in foreign aid have a permanent effect on the rate of economic growth, as well as the sign and magnitude of this effect.

[6]Many cross-country studies have used instrumental-variable estimation in order to address such endogeneity problems. This is not attempted here because the cross-sectional regressions are offered only as an example and basis of comparison.
[7]In all the empirical specifications that follow, the *w*s and *v*s are modelled as country and time fixed effects, respectively.

Table 2. Long-run effects of openness on growth: b and implied ℓ in model (1)

		oda/pop		*oda/gdp*	
p		OLS	Fixed Effects	OLS	Fixed Effects
1	b	0.0027 (0.0015)	0.0072** (0.0026)	−0.0798 (0.0454)	0.1420** (0.0697)
	ℓ	0.0028	0.0071	−0.0845	0.1394
	ρ	0.0037 (0.0312)	0.0046 (0.0046)	0.0043 (0.0302)	0.0059 (0.0296)
2	b	0.0032* (0.0015)	0.0094** (0.0027)	−0.0587 (0.0457)	0.1957** (0.0721)
	ℓ	0.0035	0.0089	−0.0653	0.1863
	ρ	0.0079 (0.0330)	0.0081 (0.0320)	0.0077 (0.0319)	0.0077 (0.0308)
3	b	0.0025 (0.0015)	0.0091** (0.0029)	−0.0644 (0.0467)	0.2014** (0.0760)
	ℓ	0.0029	0.0084	−0.0756	0.1896
	ρ	−0.0156 (0.0312)	−0.0154 (0.0302)	−0.0147 (0.0298)	−0.0146 (0.0285)
4	b	0.0027 (0.0015)	0.0103** (0.0030)	−0.0508 (0.0473)	0.2648** (0.0794)
	ℓ	0.0032	0.0093	−0.0609	0.2415
	ρ	0.0008 (0.0326)	−0.0069 (0.0305)	0.0029 (0.0312)	−0.0058 (0.0285)

Notes: Estimated standard errors in parentheses. p is the number of lags in the $C(L)$ and $B(L)$ polynomials in equation (1). ρ is the estimated AR(1) parameter in the regression $u_{i,t} = \rho u_{i,t-1} + e_{i,t}$.
** and * denote statistical significance at the 1 and 5 per cent significance levels.

Table 2 estimates equation (1) for the two ODA measures of aid and various lag lengths. In addition to the estimated b's, Table 2 also reports the estimated long-run effects of aid on growth, defined as $\ell = \sum_{j=1}^{p} \alpha_j / \left(1 - \sum_{j=1}^{p} c_j\right)$.[8] Focusing on $aid = oda/pop$ first, the first column ('OLS') of Table 2 reports the results for the model without fixed effects, effectively imposing the restrictions $w_i = \bar{w}$ for all i, and $v_t = 0$ for all t. These restrictions are imposed not because they are thought to be plausible, but in order to compare the specifications with and without fixed effects. The estimated bs have a positive sign, but are statistically insignificant and rather small in magnitude, as are the implied ℓs. These results are not sensitive to the number of lags included in the model.

The 'Fixed effects' column for *oda/pop* in Table 2 repeats the estimation of equation (1), but now including country- and year-specific fixed effects. Formal statistical testing shows that these are the appropriate specifications, as the null hypotheses of $w_i = \bar{w}$ for all i, and $v_t = 0$ for all t, are comfortably rejected in every specification. The results are now much more favorable for the aid-growth link. In particular, the estimated bs are all positive, highly statistically significant, and of an economically meaningful size. Using a rough average of the $p = 1$ and $p = 2$ specifications, an estimate of $\ell \simeq 0.008$ implies that the growth effects of foreign aid are sizable: an increase in aid by \$20 per person of the receiving country results in a *permanent* increase in the real growth rate by approximately 0.16 per cent. This estimate is not very sensitive to lag length, the point estimates of the b's ranging from $b = 0.0072$ to $b = 0.0103$, while those of the ℓs from $\ell = 0.0071$ to $\ell = 0.0093$.

The last two columns of Table 2 repeat the exercise for *oda/gdp*. The 'OLS' results here (unlike those for *oda/pop*) imply that aid has a negative growth effect, but all of the OLS estimates lack statistical significance. Once again, however, fixed effects can be shown to belong in the regression, so the 'OLS' model is mis-specified. Including the fixed effects gives the results of the last column of Table 2. As was the case for *oda/pop*, all estimated bs

[8]These long-run 'multipliers' can also be expressed as $\ell = A(1)/(1 - C(1)) = b/(1 - C(1))$. Table 2 also tests for serial correlation using ρ, the estimated AR(1) parameter for the residuals, as proposed by Wooldridge (2002).

for *oda/gdp* have a positive sign, are quite precisely estimated, and their magnitude is economically important. Point estimates range from $b = 0.1420$ to $b = 0.2648$, and from $\ell = 0.1394$ to $\ell = 0.2415$, leading to similar implications for the quantitative importance of foreign aid for growth: a permanent increase in aid by 1 per cent of the receiving economy's *GDP* is associated with a *permanent* increase in the growth rate of real *GDP* by approximately 0.14 to 0.26 per cent. Once again, the results are quite robust to the number of lags included in the model.

Overall, Table 2 shows that the effect of foreign aid on economic growth has been positive, permanent, statistically significant, and sizable. Moreover, the effect is shown to be robust across both measures of aid and a number of different lag lengths. The remainder of this section extends the investigation of robustness along two additional dimensions: (i) two different estimation methods, and (ii) controlling for a number of other steady-state determinants.

3.2 Two Additional Robustness Extensions

First, as Evans (1997) has pointed out in his study of government consumption and long-run growth, consistent estimation of an equation like (1) may not be straightforward. If *growth* and *aid* are both $I(1)$ processes, the OLS estimator of b is superconsistent, but inference based on the OLS standard errors will be generally invalid. Hamilton (1994) proves that the problem can be dealt with by including n leads and lags of the differenced right-hand side variable, where n is large enough for the correlation between $u_{i,t}$ and $\Delta aid_{i,t\pm s}$ to be zero for $s > n \geq 0$.

Following Hamilton's correction procedure, the model is actually estimated as:

$$growth_{i,t} = w_i + v_t + b \cdot aid_{i,t} + \sum_{j=-n}^{n} \zeta_j \Delta aid_{i,t-j} + u_{i,t}. \tag{2}$$

Then, estimating an auxiliary AR(p) process for the residuals of (2), $\hat{u}_{i,t} = \sum_{j=1}^{p} c_j \hat{u}_{i,t-j} + e_{i,t}$ can be used to obtain asymptotically consistent t-ratios. Hamilton (1994, section 19.3) shows that the OLS t-ratios need to be adjusted as follows for their asymptotic distribution to be standard normal:

$$adj \cdot T - ratio \equiv (OLS \cdot t - ratio)\left(\frac{\hat{\sigma}_u}{\hat{\sigma}_e}\right)\left(1 - \sum_{j=1}^{p} \hat{c}_j\right) \xrightarrow{d} N(0, 1).$$

Alternatively, as proposed by Evans (1997), the estimated cs can transform equation (2) to

$$\hat{c}(L)growth_{i,t} = w_i + v_t + b \cdot \hat{c}(L)aid_{i,t} + \sum_{j=-n}^{n} \zeta_j \hat{c}(L)\Delta aid_{i,t-j} + z_{i,t} \tag{3}$$

where z is asymptotically equivalent to e. It follows that estimating (3) with OLS (including fixed effects) using White's (1980) heteroskedasticity correction will produce a consistent estimate of b, and consistent estimates of its standard error and t-statistic.

Table 3. Adjusting with the Evans and Hamilton procedures: *b* in models (2) and (3)

	oda/pop		*oda/gdp*	
n	Evans adj.	Hamilton adj.	Evans adj.	Hamilton adj.
0	0.0093** (0.0021)	0.0078** (0.0020)	0.2507** (0.0852)	0.1862** (0.0529)
1	0.0081** (0.0031)	0.0066** (0.0023)	0.1972* (0.0966)	0.0775 (0.0608)
2	0.0091** (0.0033)	0.0083* (0.0025)	0.2233* (0.1091)	0.0102 (0.0670)
3	0.0083* (0.0038)	0.0077** (0.0028)	0.2134 (0.1219)	0.2007** (0.0850)

Notes: All models estimated with fixed effects. The Hamilton and Evans adjustments have been implemented as described in Section 3. Estimated adjusted standard errors in parentheses. n is the number of lags and leads included in equations (2) and (3). An AR(5) process is estimated for u in all cases ($p=5$).
** and * denote statistical significance at the 1 and 5 per cent significance levels. The critical values used are $N_{0.005}(0,1)=t_{0.005}(\infty)=2.576$ and $N_{0.025}(0,1)=t_{0.025}(\infty)=1.960$.

The results from the estimation of models (2) and (3) for both aid measures, *aid/pop* and *aid/gdp*, are reported in Table 3 for various lag lengths. Table 3 reports only the specifications with country and time fixed effects.[9] Note that all the estimated *b*s are positive and (with three exceptions) statistically significant. The results of Table 3, therefore, confirm that there is a positive, sizable, permanent, and statistically significant relationship between foreign aid and economic growth, and that the growth effects of aid are quantitatively similar to those obtained from the unadjusted models of Table 2.

The second robustness check considered in this subsection involves the possibility that the results obtained so far are biased because other steady-state determinants have been omitted from the estimated regressions. Suppose, for example, that foreign aid does not affect economic growth directly, but instead through some other variable, such as investment. If this is the case, omitting investment may generate a positive estimated relationship between aid and growth, but only because of the mis-specification. To settle the issue, investment should be included in the regression in order to test whether foreign aid has growth effects even when those of investment are controlled for.

As mentioned in Section 2, we will consider three variables predicted to have steady-state effects by the standard neoclassical growth model: *inv*, the investment-to-*GDP* ratio; *pop*, the population growth rate; and *gov*, the government-purchases-to-*GDP* ratio. For empirical evidence on the relevance of these variables, see Mankiw *et al*. (1992) and Barro and Sala-i-Martin (1995).

To take these variables into account, we generalize the original time-series specification to

$$growth_{i,t} = w_i + v_t + C(L)growth_{i,t-1} + A_{inv}(L)inv_{i,t} + A_{pop}(L)pop_{i,t} + A_{gov}(L)gov_{i,t} + A_{aid}(L)aid_{i,t} + u_{i,t}\ ,$$

where the notation is straightforward. This model then can be rewritten as

$$\begin{aligned} growth_{i,t} = {} & w_i + v_t + C(L)growth_{i,t-1} + b_{inv}\cdot inv_{i,t} + b_{pop}\cdot pop_{i,t} + b_{gov}\cdot gov_{i,t} \\ & + b_{aid}\cdot aid_{i,t} + B_{inv}(L)\Delta inv_{i,t} + B_{pop}(L)\Delta pop_{i,t} + B_{gov}(L)\Delta gov_{i,t} \\ & + B_{aid}(L)\Delta aid_{i,t} + u_{i,t} \end{aligned} \tag{4}$$

[9]All models were estimated with and without fixed effects. As the fixed effects were jointly statistically significant in each case, the models without fixed effects are not reported to preserve space.

Table 4. Controlling for *inv*, *pop*, and *gov*: b_{inv}, b_{pop}, b_{gov}, and b_{aid} in model (4)

n	b_{inv}	b_{pop}	b_{gov}	b_{aid}
aid = oda/pop				
0	0.1650** (0.0205)	−0.3170* (0.1559)	−0.0301 (0.0169)	0.0080** (0.0020)
1	0.1683** (0.0228)	−0.8271** (0.203)	−0.0160 (0.0189)	0.0079** (0.0022)
2	0.1556** (0.0245)	−0.7148** (0.2357)	−0.0141 (0.0205)	0.0083** (0.0024)
3	0.1534** (0.0266)	−0.8801** (0.2653)	−0.0539* (0.0225)	0.0090** (0.0027)
aid = oda/gdp				
0	0.1615** (0.0207)	−0.5192** (0.1566)	−0.0181 (0.0169)	0.2028** (0.0547)
1	0.1575** (0.0231)	−1.0552** (0.2097)	−0.0081 (0.0190)	0.1727** (0.0606)
2	0.1440** (0.0247)	−1.0163** (0.2354)	−0.0070 (0.0205)	0.1679* (0.0655)
3	0.1374** (0.0267)	−1.1440** (0.2619)	0.0540* (0.0224)	0.2053** (0.0728)

Notes: All models estimated with fixed effects and the Hamilton adjustment, as described in section 3. Estimated adjusted standard errors in parentheses. n is the number of lags and leads included, as in equation (2). An AR(5) process is estimated for u in all cases ($p = 5$).
** and * denote statistical significance at the 1 and 5 per cent significance levels. The critical values are as in Table 3.

where once again $b_{\text{inv}} = A_{\text{inv}}(1)$, $b_{pop} = A_{pop}(1)$, $b_{gov} = A_{gov}(1)$, and $b_{aid} = A_{aid}(1)$ are parameters, each of them equal to the sum of the coefficients of the respective $A(L)$ polynomial, and the precise relationship between the coefficients of the $B(L)$ and $A(L)$ polynomials is as described for equation (1).

Estimation of equation (4) can proceed along the lines described above for equation (1). Because of space considerations, however, Table 4 reports only specifications of model (4) that use the Hamilton adjustment and include country and time fixed effects.[10] The top panel measures aid by *oda/pop*, while the bottom panel relies on *oda/gdp*.

Starting with the three variables other than foreign aid, the results of Table 3 are largely as expected and consistent with the theoretical predictions. First, b_{inv}, the estimated growth effect of the investment ratio, is positive and highly statistically significant, consistent with the theory's prediction that a higher investment rate raises the economy's steady-state. This result holds for both aid measures and all lag lengths tried.

Second, b_{pop}, the estimated coefficient of *pop* is negative and statistically significant, again consistent with the model's prediction that a higher population growth rate leads to a lower steady state.

Third, b_{gov}, the coefficient of government size, is neither unambiguously nor (with a single exception) statistically significantly estimated, suggesting that a higher government size has an ambiguous effect on the steady state. This is not surprising or even disappointing, since the theoretical steady-state effect of *gov* is ambiguous, as the inefficiencies and distortions of taxation may or may not outweigh the productivity of government activities.

For the purposes of the present paper, of course, the most important estimates are those of b_{aid} in the last column of Table 4. These are not only positive and statistically significant, but also little different from those reported by Tables 2 and 3 (with fixed effects), leading to similar conclusions. It follows that controlling for additional steady-state

[10]As we noted above, the Hamilton adjustment generally gives lower estimates for the growth effects of foreign aid than the Evans adjustment, so Table 4 cannot be accused of overstating the effect. All results are available on request.

determinants alters neither the size nor the statistical significance of the growth effects of foreign aid.

4 DISCUSSION AND CONCLUSIONS

This paper investigated the relationship between foreign aid and growth in per capita GDP using annual data from the 1960 to 1997 period for a sample of 71 aid-receiving developing economies. Two measures of foreign aid were used: (i) total net ODA receipts per capita and (ii) total net ODA receipts as a fraction of GDP.

The empirical findings show that the effect of foreign aid on economic growth is positive, permanent, statistically significant, and not negligible in size: raising foreign aid by $20 per person of the receiving country results in a permanent increase in the growth rate of real GDP per capita by approximately 0.16 per cent. Using the paper's alternative measure, a permanent increase in aid by 1 per cent of the receiving economy's GDP permanently raises the per capita growth rate by approximately 0.14 to 0.26 per cent.

It is worth emphasizing that these results are obtained without conditioning the estimates to the effects of policies. This does not mean that good policies should not be expected to make better use of aid resources—but it does mean that the positive growth effects foreign aid are identifiable even when the policies are not controlled for.

An extremely interesting subject for future research is whether differences can be identified between the effects of transitory and permanent, increases in foreign aid. One of the theoretical implications of many poverty-trap models, for example, is that temporary flows of aid can have permanent effects if they are large enough to help the receiving economy escape the poverty trap and start converging towards a higher steady state. Determining whether this is the case in practice will shed additional light into how to optimally allocate scarce foreign-aid resources among competing uses.

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APPENDIX: COUNTRY AVERAGES OVER 1960–98

		ODA		TOTAL	
Country	*growth* (%)	*oda/pop* ($)	*oda/gdp* (%)	*total/pop* ($)	*total/gdp* (%)
1 ARG	1.37	3.48	0.03	74.24	0.72
2 BDI	0.70	29.31	3.91	30.00	4.01
3 BEN	0.23	34.09	3.23	39.20	3.75
4 BFA	0.64	32.34	4.03	32.96	4.11
5 BOL	0.46	54.72	2.09	70.12	2.66
6 BRA	2.83	4.21	0.12	40.17	0.75
7 BWA	5.50	113.08	4.72	134.88	5.65
8 CAF	−1.81	49.55	3.20	50.62	3.26
9 CHL	2.66	17.72	0.38	69.26	1.17
10 CIV	0.70	34.44	1.59	56.35	2.40
11 CMR	0.57	31.80	1.58	47.23	2.28
12 COG	4.38	61.29	4.29	103.28	7.39
13 COL	2.12	8.47	0.25	29.63	0.74
14 CRI	1.23	47.47	1.03	86.89	1.82
15 DOM	2.76	22.98	0.97	32.89	1.29
16 DZA	1.83	34.58	1.18	81.37	2.39
17 ECU	1.85	16.30	0.51	39.76	1.13
18 EGY	2.71	46.13	1.97	59.52	2.54
19 ETH	0.26	10.57	1.89	11.04	1.97
20 FJI	1.73	68.44	1.69	93.47	2.27
21 GAB	3.34	107.33	1.44	283.89	3.76
22 GHA	1.39	23.22	1.96	27.73	2.35
23 GIN	0.13	27.39	1.08	30.46	1.21
24 GMB	0.43	63.09	5.08	69.74	5.62
25 GTM	1.30	18.16	0.53	26.73	0.76
26 GUY	2.07	80.04	3.19	93.92	3.73
27 HND	0.72	48.56	2.26	58.00	2.70
28 IDN	3.56	9.88	0.64	24.01	1.30
29 IND	2.73	4.60	0.42	5.57	0.48
30 IRN	2.30	3.24	0.09	15.72	0.36
31 ISR	3.07	289.39	2.64	566.10	4.90
32 JAM	0.99	63.44	1.76	137.06	3.76
33 JOR	1.65	375.26	11.98	429.35	13.40
34 KEN	1.45	29.05	2.57	38.00	3.36
35 LKA	2.22	27.34	1.31	29.82	1.42
36 LSO	2.18	67.36	5.48	76.43	6.15
37 MAR	2.99	33.47	1.26	54.89	1.98
38 MDG	−1.01	25.23	2.55	29.63	2.98
39 MEX	1.86	2.75	0.04	53.24	0.74
40 MLI	−0.12	40.23	4.84	41.21	4.96

Continues

APPENDIX: CONTINUED

Country	*growth* (%)	*ODA*		*TOTAL*	
		oda/pop ($)	*oda/gdp* (%)	*total/pop* ($)	*total/gdp* (%)
41 MOZ	−0.84	28.03	3.04	29.61	3.15
42 MRT	1.08	116.01	7.22	131.04	8.44
43 MUS	3.95	45.62	0.76	78.28	1.17
44 MWI	1.90	32.66	5.41	35.92	5.93
45 MYS	4.00	11.74	0.29	67.36	1.25
46 NER	−1.54	41.57	3.90	46.04	4.24
47 NGA	0.31	3.25	0.31	10.90	1.05
48 NIC	−1.18	65.97	2.80	71.28	2.86
49 NPL	1.52	14.55	1.45	14.96	1.48
50 PAK	3.00	15.91	1.60	19.45	1.85
51 PAN	2.58	38.58	0.97	625.82	12.46
52 PER	1.16	15.13	0.34	43.12	0.93
53 PHL	1.27	11.76	0.42	29.32	1.00
54 PRY	2.03	27.29	0.76	38.22	1.02
55 RWA	0.26	40.37	4.44	40.51	4.44
56 SEN	−0.36	64.14	4.21	73.63	4.83
57 SLV	0.78	45.97	1.21	55.10	1.43
58 SYC	3.40	373.00	5.99	559.42	8.60
59 SYR	3.62	60.64	2.21	64.82	2.37
60 TCD	0.18	30.07	2.91	31.63	3.08
61 TGO	0.45	40.17	3.45	49.16	4.24
62 THA	4.70	9.52	0.33	36.93	0.93
63 TTO	2.33	17.27	0.25	66.32	0.81
64 TUR	2.54	14.46	0.38	40.78	0.88
65 TZA	0.92	29.37	5.52	32.02	5.96
66 UGA	1.57	19.25	2.87	19.96	2.97
67 URY	1.57	12.95	0.18	36.40	0.51
68 VEN	−0.24	4.92	0.05	57.93	0.70
69 ZAR	−2.97	18.93	2.46	29.45	3.71
70 ZMB	−0.61	48.53	4.70	62.66	5.79
71 ZWE	2.54	21.58	0.80	34.28	1.28

Notes: *growth* is the average annual growth rate of GDP per capita; *ODA* indicates net ODA/OA receipts from all donors; *Total* denotes total net receipts from all donors; *oda/pop* is average *ODA* per capita in constant dollars; *oda/gdp* is average *ODA* as a fraction of GDP; *total/pop* is average *TOTAL* per capita in constant dollars; *total/gdp* is average *TOTAL* as a fraction of GDP; All averages are over 1960–98.

