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The Impact of Foreign Aid on Economic Growth: Volatility of Disbursements and Distribution of Receipts

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Abstract

This paper is concerned with the effects of aid transfers and their degree of volatility on economic growth. We develop a theoretical framework that distinguishes the allocation of foreign aid between productive and non-productive uses. On the one hand, devoting aid inflows into productive public spending promotes growth while the related volatility has a damaging effect. On the other hand, the non-productive use of aid transfers has an adverse effect on growth while their volatility is growth-enhancing. The theoretical implications are supported by an empirical specification, formulated on similar grounds, for a panel of 74 aid-recipient countries over the time period from 1972 to 1998. The empirical results are found to be robust in a variety of sensitivity tests.

1. Introduction

Recent years have witnessed a resurgence on the interest of how foreign aid can affect economic growth – both by academic economists and policy makers alike. This renewed interest has been translated in a substantial number of both theoretical and empirical analyses, seeking to promote our understanding of the conditions under which aid could be effective (in terms of long-run macroeconomic performance) for recipient economies.[1]

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1 See World Bank 1998, Drazen 2000, Hansen and Tarp 2000, and Easterly 2003 for an overview of the issue.

Empirically, aid effectiveness has been shown to depend crucially upon the characteristics of recipient countries – most notably on the degree of political and civil liberties (e.g., Svensson 1999), on the quality of policy making and institutions (e.g., Burnside and Dollar 2000; Collier and Dollar 2002), and on environmental factors (e.g., Guillamont and Chauvet 2001). At the theoretical level, authors have only recently begun to analyse the long-term effects of foreign aid in the context of endogenous growth models. Obstfeld (1999) finds that foreign aid given in the form of lump-sum transfers (i.e., non-productive aid) does not affect steady-state growth but increases the speed of convergence towards the balanced-growth path. Similar results, concerning this particular form of aid, are reached by Chatterjee *et al.* (2003) and Chatterjee and Turnovsky (2005). They argue, however, that when aid is tied to public investment projects (i.e., productive aid) then it is likely to stimulate steady-state growth. By including elastic labour supply, Chatterjee and Turnovsky (2004) find that non-productive aid has adverse effects on economic growth.[2]

All the above analyses share a common feature – mainly, their silence on the issue of variability in foreign aid transfers and the implications that may arise from it. Nevertheless, in recent empirical studies, Palage and Robe (2001) and Bulir and Hamann (2003) have documented that aid is highly volatile. Furthermore, Lensink and Morrissey (2000) show evidence that the variability of aid transfers is damaging for the growth prospects of recipient economies. Indeed, in light of recent stochastic, dynamic general equilibrium models (e.g., Blackburn and Galindev 2003; Blackburn and Pelloni 2004; Canton 2002; de Hek 1999) and empirical analyses (e.g., Ramey and Ramey 1995; Kneller and Young 2001;

[2] Other theoretical analyses link foreign aid with the macroeconomic environment, without focusing on the issue of long-run growth. Boone (1996) argues that, depending on the prevailing political regime, foreign aid can induce the government to either reduce domestic taxation or increase lump-sum transfers. Svensson (2000) shows that, by inducing an increase in rent-extracting activities (associated with the presence of corruption in the recipient economy), higher aid receipts can actually reduce the provision of productive public goods and services. Asiedu and Villamil (2002) show how different kinds of foreign assistance may alleviate the underinvestment problem that may arise when the enforcement of debt contracts in international financial markets is imperfect.

Martin and Rogers 2000), that show how and why different kinds of variability may affect long-run growth, there is no reason to preclude the possibility that foreign aid volatility may be an additional and important factor on the determination of aid effectiveness.

The present analysis is concerned with highlighting, both theoretically and empirically, the additional repercussions emerging for the foreign aid-economic growth nexus when variability in foreign assistance is taken under consideration – an issue that, so far, has eluded the attention of researchers. The novelty of our approach on examining the growth effects of foreign aid is twofold. It lies on explicitly taking account of both the provision of foreign financial assistance and its volatility, and on considering how these effects can be qualified in relation to the allocation of aid transfers between productive and non-productive uses. Another innovation of our paper is that our empirical specification is based upon and guided by results derived from a dynamic general equilibrium model.

Our theoretical framework is described by an analytically-tractable, stochastic growth model in which the accumulation of human capital provides the underlying source of endogenous productivity improvements (e.g., Lucas 1988; Razin 1972; Uzawa 1965).[3] The dynamic process for human capital depends on the resources the individuals devote for this purpose and on the provision of productive public goods by the government. In this environment, the government receives an inflow of foreign transfers which allocates between productive (i.e., augmentation of productive public goods provision) and non-productive (i.e., lump-sum income transfers) uses. However, these transfers are not stable through time. Instead, they are characterised by some degree of variability.

As it turns out, taking account of aid variability results in additional and important implications for the determination of the relative effectiveness (in terms of growth performance) of foreign aid. Specifically, the results we obtain indicate that the impact of aid on long-run growth depends critically on the use

[3] Obstfeld (1999) argued that the education sector is one of the most important channels through which the impact of foreign aid can be translated into substantial growth effects. To the best of our knowledge, our study is the first to examine the aid induced growth dynamics when aid augments the process of human capital accumulation.

of these inflows by recipient governments and on how volatile is their supply by the donors. Our results are classified in two different scenarios. When aid is used unproductively, it has, *on average*, a negative effect on growth as a result of an income effect that distorts human capital investment decisions and discourages individuals from engaging in productivity-promoting activities.[4] At the same time, however, aid volatility induces a precautionary motive, leading individuals to increase the resources they devote for human capital investment – an effect that stimulates growth. When aid is used productively, it promotes growth, *on average*, by increasing the amount of productivity-enhancing public spending. In this case, however, aid volatility dampens growth due to the diminishing returns of public spending in the technology describing human capital improvements.

Our empirical specification is formulated, with this background in mind, in order to assess the predictions of our theoretical model. For this purpose, we utilise a panel of 74 aid-recipient countries over the sample period from 1972 to 1998, by considering three nine-year periods that correspond to three different decades. Our regressions include interaction terms in order to distinguish the effects of productive versus unproductive aid in relation to both its mean and its volatility. In addition, we test whether our results are sensitive to the inclusion of control variables that previous growth regressions have qualified as empirically important. The results are strongly in support of the implications of the theoretical model. Furthermore, these results are robust to a wide range of sensitivity tests, including panels of different period.

The rest of the paper is organised as follows: Section 2 lays out the theoretical framework and derives the results concerning the impact of foreign aid, and its volatility, on the rate of output growth. Section 3 discusses the empirical

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[4] In our model, crucial for the result that non-productive aid affects growth is the assumption of leisure-education choice by individuals. In this respect, we obtain the result of Chatterjee and Turnovsky (2004) through a different mechanism – i.e., the impact on human capital accumulation. In their model there is no human capital, however they obtain a negative effect by allowing to individuals a leisure-labour choice. Unproductive aid induces individuals to reduce their labour supply, an effect that dampens growth due to the scale effect that labour has in the class of "AK" type production functions – a class to which the production function they use in their model effectively reduces to.

methodology and describes the data. In Section 4, we present our basic results and conduct the robustness testing. Section 5 concludes.

2. Theory

In this section, we build a simple stochastic growth model, the results of which will provide the basic assumptions that we test in the empirical analysis of our paper. We use a representative agent framework in which individuals produce a perishable commodity and spend resources for improving human capital (or productivity in general), and the government spends resources with the purpose of providing productivity-enhancing public goods and services. Besides domestic resources (i.e., through income taxation), each period the government receives (random) foreign aid stipends which it allocates between lump-sum income transfers and the provision of productive public spending.

2.1 The Basic Framework

Time is measured in discrete intervals, i.e., $t = 0,1...\infty$. We consider an artificial economy populated by a large number of homogeneous producers-consumers. For simplicity, population growth is assumed to be zero and, without loss of generality, the total population size is normalised to unity. At the beginning of each period, a representative agent is endowed with $N > 1$ units of time. She utilises a constant returns production technology through which she produces y_t units of the economy's single commodity by combining a fixed amount of time, normalised to unity, together with her human capital stock, denoted by h_t.[5] Formally,

$$y_t = h_t. \qquad [1]$$

[5] The assumption that human capital is the only variable input in output production has been used by Glomm and Ravikumar (1992), Palivos (2001) and Cardak (2004) among others.

The remaining $T = N - 1$ units of time are allocated between activities that increase the agent's human capital (formal education, research, training etc.), denoted by e_t, and leisure, denoted by l_t. Therefore,

$$e_t + l_t = T. \qquad [2]$$

The process governing human capital accumulation is given by

$$h_{t+1} = \Xi(e_t h_t)^{\xi} g_t^{1-\xi}, \ \Xi > 0, \ \xi \in (0,1). \qquad [3]$$

The above expression illustrates the two underlying sources of endogenous productivity improvements in the economy. On the one hand, an agent can combine e_t units of her available time together with her existing level of knowledge, h_t, to increase her future human capital. On the other hand, publicly provided goods and services (e.g., on education, infrastructure, transportation etc.), denoted by g_t, can enhance the process of learning by increasing the efficiency through which private inputs are transformed into human capital. In this context, g_t represents aggregate public spending on goods and services that are non-rival and non-excludable. It is also assumed that when the agent maximises her utility she does not internalise the benefits accrued from the provision of public spending.

The individual derives lifetime utility according to the following

$$U = \sum_{t=0}^{\infty} \beta^t \left[\log(c_t) + \delta l_t\right], \ \delta > 0, \qquad [4]$$

where c_t denotes consumption and $\beta \in (0,1)$ is a discount factor.[6]

[6] In this model, logarithmic preferences for consumption are essential for the derivation of closed-form solutions. The assumption of linearity in the preferences for leisure follows Hansen (1985). It is innocuous for the results of the paper, however, and used purely for computational simplicity. It can be shown that, qualitatively, the same results apply for any increasing and concave function of leisure.

With the purpose of introducing foreign aid in our model, we assume that each period a foreign donor (a country, a group of countries or an international organisation) provides an income transfer to the economy equal to A_t, measured in units of domestic output.[7] Following Chatterjee *et al* (2003) and Chatterjee and Turnovsky (2005), it is further assumed that a fraction $\zeta \in [0,1]$ of this aid inflow is provided to the private sector of the economy in the form of lump-sum income transfers (*non-productive, or pure, aid*) while the remaining fraction $(1-\zeta) \in [0,1]$ is used to enhance the provision of productive public goods and services, together with domestic resources available through income taxation (*productive, or tied, aid*). Without any loss of generality, we will assume that revenues from income taxation are used exclusively for the production of public goods, while the only source for financing lump-sum transfers comes from foreign aid inflows.[8] Given these assumptions, the private sector's and the public sector's budget constraints are given, respectively, by the following expressions

$$c_t = (1-\tau)y_t + \zeta A_t, \qquad [5]$$

$$g_t = \tau y_t + (1-\zeta)A_t, \qquad [6]$$

where $\tau \in (0,1)$ denotes the constant, marginal tax rate imposed by the government on the private sector's income.

Our focus is to examine the effects of foreign aid along an equilibrium path with sustainable long-run growth. Such an equilibrium requires that the total aid disbursements are proportional to the recipient's GDP. Hence, we assume that

[7] A valid criticism to such an assumption has to do with the unlikelihood that, in reality, foreign aid inflows will remain permanent. However, this assumption has been used in the vast majority of dynamic models assessing the macroeconomic effects of foreign aid (e.g., Boone 1996; Chatterjee *et al* 2003; Chatterjee and Turnovsky 2005; Obstfeld 1999; Svensson 1999).

[8] Qualitatively, the results would be identical had we taken a more general approach by allowing both sources of government revenues to finance lump-sum transfers, i.e., by assuming that $TRANSFERS_t = \eta(\tau y_t + A_t)$ and $g_t = (1-\eta)(\tau y_t + A_t)$ where $\eta\,(1-\eta)$ is the share of government resources provided to the private sector as lump-sum income transfers (enhancement of productive goods and services). The reason for not following this assumption is that our focus is solely on the composition of foreign aid receipts.

$$A_t = \alpha_t y_t. \quad [7]$$

Our point of departure from other analyses is that, in order to introduce aid volatility, we assume that $\{\alpha_t\}_{t=0}^{\infty}$ is a sequence of identically and independently distributed random variables. In order to maintain analytical tractability, we specify a simple probability distribution whereby

$$prob\{\alpha_t = \widehat{\alpha} - \sigma\} = prob\{\alpha_t = \widehat{\alpha} + \sigma\} = 0.5, \quad [8]$$

where $\widehat{\alpha}$ is used as a measure of the expected or average level of foreign aid inflows and σ is an indicator of foreign aid volatility.[9] We impose the restriction $\widehat{\alpha} \geq \sigma$ to ensure that aid receipts are nonnegative.

2.2 Dynamic General Equilibrium

The general equilibrium in this economy can be obtained by combining the assumptions of the previous section together with the first order conditions associated with the maximisation problem of the individual, whose objective is to choose sequences for $\{c_t\}_{t=0}^{\infty}$, $\{e_t\}_{t=0}^{\infty}$ and $\{h_{t+1}\}_{t=0}^{\infty}$ as to maximise the expected value of her lifetime utility, given in [4], subject to sequences for [1], [2], [3] and [5]. When maximising her lifetime utility, the representative agent takes the sequences of $\{g_t\}_{t=0}^{\infty}$ and $\{A_t\}_{t=0}^{\infty}$ as given.

The first order conditions for the above problem are given as follows

$$\lambda_t = \frac{1}{c_t}, \quad [9]$$

$$\delta = \psi_t \xi \Xi (e_t h_t)^{\xi - 1} h_t g_t^{1-\xi}, \quad [10]$$

[9] We use $\widehat{\alpha}$ and σ as measures for average aid and aid volatility, respectively, as in equilibrium the long-run rate of output growth depends solely on the foreign aid to output ratio, α_t, rather than on the actual level of aid inflows, A_t. The randomness in α_t is meant to capture the empirically observed fact that in many instances, the variability in foreign aid provision is higher than the variability on the recipient economy's GDP (e.g., Pallage and Robe 2001).

$$\psi_t = \beta\xi\Xi E_t\left[\psi_{t+1}(e_{t+1}h_{t+1})^{\xi-1}e_{t+1}g_{t+1}^{1-\xi}\right] + \beta(1-\tau)E_t(\lambda_{t+1}), \quad [11]$$

where λ_t and ψ_t are the Lagrange multipliers associated with [5] and [3] respectively and E_t is the conditional expectations operator. Equation [9] is the familiar condition equating the shadow value of wealth with the marginal utility of consumption. Equation [10] is the static optimality condition, equating the marginal cost with the marginal benefit of an increase in the amount of time the individual devotes to activities that increase her human capital. Finally, equation [11] is the dynamic optimality condition, equating the marginal cost with the marginal benefit of an increase in the levels of human capital.

We begin the solution to the model by multiplying both sides of equation [11] by h_{t+1} and substituting equations [1] and [9]. It yields

$$\psi_t h_{t+1} = \beta\xi E_t(\psi_{t+1}h_{t+2}) + \beta(1-\tau)E_t\left(\frac{y_{t+1}}{c_{t+1}}\right). \quad [12]$$

Substituting [7] in the private sector's budget constraint, given in [5], and dividing both sides with y_t yields

$$\frac{c_t}{y_t} = 1 - \tau + \zeta\alpha_t. \quad [13]$$

Now, substitute [13] in [12] to get

$$\psi_t h_{t+1} = \beta\xi E_t(\psi_{t+1}h_{t+2}) + \beta(1-\tau)E_t\left(\frac{1}{1-\tau+\zeta\alpha_{t+1}}\right). \quad [14]$$

The expression in [14] reveals that the provision of aid in the form of pure transfers affects the private sector's incentives relative to its human capital accumulation decisions, as it is clear by the presence of α_{t+1} inside the second expectations term on the right hand side of [14].

Recall that given [8], the sequence of random variables $\{\alpha_t\}_{t=0}^{\infty}$ generate constant mean and variance. Therefore, the second term on the right hand side of

[14] is a constant. Given this, let $\beta(1-\tau)E_t[1/(1-\tau+\zeta\alpha_{t+1})]\equiv\Theta$. As the random variables have the i.i.d. property, we can substitute Θ back in [14] which then takes the form of a stochastic difference equation which can be solved with the method of repeated substitution. A solution consistent with the transversality condition on human capital, $\lim_{\mathrm{T}\to\infty}(\beta\xi)^{\mathrm{T}}E_t(\psi_{t+\mathrm{T}}h_{t+\mathrm{T}+1})=0$, is given by

$$\psi_t h_{t+1}=\frac{\Theta}{1-\beta\xi}, \tag{15}$$

recalling that $\Theta=\beta(1-\tau)E_t[1/(1-\tau+\zeta\alpha_{t+1})]$. The solution in [15] can be verified by direct substitution back in equation [14].

Given [3], the first order condition in [10] can be written as

$$\delta=\frac{\xi\psi_t h_{t+1}}{e_t}. \tag{16}$$

Substituting [15] in [16], solving for e_t and using the expression for Θ yields

$$e_t=\frac{\beta\xi(1-\tau)}{\delta(1-\beta\xi)}E_t\left(\frac{1}{1-\tau+\zeta\alpha_{t+1}}\right). \tag{17}$$

Using the properties of the specified probability distribution for $\{\alpha_t\}_{t=0}^{\infty}$ we can write the expectations term inside the brackets as

$$E_t\left(\frac{1}{1-\tau+\zeta\alpha_{t+1}}\right)=\frac{1-\tau+\zeta\widehat{\alpha}}{(1-\tau+\zeta\widehat{\alpha})^2-(\zeta\sigma)^2}. \tag{18}$$

Substitution back in [17] yields the equilibrium solution for learning activities, e_t, as

$$e_t=\frac{\beta\xi(1-\tau)(1-\tau+\zeta\widehat{\alpha})}{\delta(1-\beta\xi)[(1-\tau+\zeta\widehat{\alpha})^2-(\zeta\sigma)^2]}\equiv e(\widehat{\alpha};\sigma). \tag{19}$$

From the above equation we can establish that $e_1(\cdot)<0$ and $e_2(\cdot)>0$. *Ceteris paribus*, an increase on the average level of foreign aid reduces the time individuals spend for learning activities while an increase in foreign aid volatility increases the time resources spent for this purpose. The intuition behind these results is the following: current learning decisions yield benefits in the future as they affect next period's human capital and output. As these benefits include, among other factors, the future income transfers the individual receives, a crucial aspect on learning decisions are the expectations individuals form about future outcomes. Consider an increase in $\widehat{\alpha}$. For the individual, this corresponds to an increase in the income transfer she expects to receive in the next period. When deciding her learning activities today, she understands that her consumption next period, when the benefits from higher human capital are reaped, will be higher because of the expected increase in her available resources. As a result, the marginal utility of her future consumption will be lower. The individual finds optimal to act as to increase her future marginal utility back to the level dictated by her optimal decisions. She can achieve this by reducing the time she spends in learning activities, as such a response will lead to lower human capital accumulation and, consequently, lower output and consumption in the future.

Now consider an increase in σ. From equations [5], [9] and [14] we can see that the future marginal utility of consumption, which partially determines the marginal benefits of higher human capital, depends on the expected value of a convex function of the random variable α_{t+1}. Therefore, it is increasing in a mean-preserving spread (higher σ) in the distribution of this random variable.[10] The individual will act as to decrease her future marginal utility of consumption back to her optimising choice. This can be achieved by devoting more time in education, a decision that will enhance the accumulation of human capital and, subsequently, will lead to increased output and consumption. Intuitively, an increase in σ is associated with higher income uncertainty, to which individuals respond by resorting to "precautionary" investment in human capital.

[10] We appeal to the well known result whereby the expected value of a concave (convex) function of a random variable is decreased (increased) by a mean-preserving spread in the distribution of the random variable (Jensen's inequality).

2.3 Trend Growth

In this section we obtain the long-run growth rate of output and show how this is affected by different aspects of foreign aid, i.e., its mean and volatility. We begin by substituting [7] in [6] and factorising with y_t to get

$$g_t = [\tau + (1-\zeta)\alpha_t]y_t. \qquad [20]$$

Now, we can substitute [1] and [20] in [3] and divide both sides with y_t in order to get the following growth rate for output

$$\frac{y_{t+1}}{y_t} = \Xi e_t^{\xi}[\tau + (1-\zeta)\alpha_t]^{1-\xi} \equiv \gamma_{t+1}, \qquad [21]$$

where e_t is actually constant in equilibrium as obtained in equation [19]. It is evident, from equation [21], that the growth rate will vary with different realisations of α_t. As this model includes a stochastic element, the *actual* growth rate becomes effectively a random variable with different realisations each period according to different realisations of α_t. To obtain the long-run, or *trend*, growth rate of output, $\widehat{\gamma}$, we need to take account of the statistical properties for the distribution of α_t, given in [8], to compute the mean value of the growth rate. Taking expectations on [21] and substituting [19] yields

$$\widehat{\gamma} = \mathrm{Z}\left[\frac{1-\tau+\zeta\widehat{\alpha}}{(1-\tau+\zeta\widehat{\alpha})^2-(\zeta\sigma)^2}\right]^{\xi}\left\{[\tau+(1-\zeta)(\widehat{\alpha}-\sigma)]^{1-\xi}+[\tau+(1-\zeta)(\widehat{\alpha}+\sigma)]^{1-\xi}\right\}, [22]$$

where $\mathrm{Z} = \Xi[\beta\xi(1-\tau)]^{\xi} / 2[\delta(1-\beta\xi)]^{\xi}$. Clearly, the growth trend in the recipient economy is affected by both the expected value, $\widehat{\alpha}$, and the volatility, σ, of foreign aid inflows as measured by the aid-to-output ratio.

The growth rate in [22] reveals that, *ceteris paribus*, the impact of an increase in both the average level of aid inflows and in the degree of aid volatility depends crucially on the parameter ζ which determines the composition of foreign aid, i.e., whether aid disbursements are distributed to agents in the form of income transfers or used to expand the level of productive spending. To make the argument more transparent, we can treat ζ as a binary (or indicator) parameter and consider the two extremes in which either $\zeta = 1$ (*unproductive aid*) or $\zeta = 0$ (*productive aid*). In the first scenario ($\zeta = 1$), we have $\frac{\partial \widehat{\gamma}}{\partial \widehat{\alpha}} < 0$ and $\frac{\partial \widehat{\gamma}}{\partial \sigma} > 0$ meaning that a lower average value and a higher volatility for the aid to GDP ratio will lead to higher trend growth. In this case, the effects of foreign aid, with respect to both its mean and volatility, do not have any impact through the provision of public spending as the entire amount of aid receipts are distributed to individuals as lump-sum transfers. Instead, the effects of foreign aid are derived solely through its effect on the learning decisions of individuals. Given this, the intuition of why the mean and the volatility of aid affect trend growth in such a direction can be readily provided by appealing to the analysis and arguments of the previous section which shows the effects of aid inflows on the time resources that the private sector's agents spend on accumulating human capital.

Now consider the second scenario ($\zeta = 0$). In that case one gets $\frac{\partial \widehat{\gamma}}{\partial \widehat{\alpha}} > 0$ and $\frac{\partial \widehat{\gamma}}{\partial \sigma} < 0$ meaning that a higher average value and a lower volatility for the aid to GDP ratio will lead to increased trend growth. Contrary to the previous case, when foreign aid is used solely as to expand the productive capacity of the recipient economy by enhancing public spending, then the time resources individual's devote to human capital accumulation remain unresponsive to both changes on average aid provision and to the degree of its variability.[11] In this case, foreign aid impinges on trend growth solely by affecting productive spending. Intuitively, the positive growth effect of $\widehat{\alpha}$ is merely a result of the increase on the average level of productive spending that results from an increase on average aid inflows. The negative growth effect of σ is the result of the concavity of the temporary growth rate, in [21], with respect to the random

[11] Check that for $\zeta = 0$, the optimal solution for learning in [19] becomes $\hat{e} = \frac{\beta\xi}{\delta(1-\beta\xi)}$.

variable α_t.[12] Diminishing returns with respect to public inputs in [3], imply that the increase in knowledge (and growth) resulting from a temporary increase of productive aid is less pronounced than the decrease in human capital (and growth) from a temporary decrease of productive aid. This means that, *on average*, higher aid volatility will be associated with lower trend output growth.

3. Methodology and Data

Summarising the results of the previous section, our model provides a link between the utilisation of aid in productive versus unproductive purposes and its respective volatility, providing clear implications regarding the growth process. Our focus now turns to the issue of examining these theoretical predictions with empirical testing.

To test the effect of aid and its volatility on economic growth, first we need to classify the use of aid flows by the recipient government into productive and unproductive. This distinction is based upon the type of expenditures which are partially financed by aid inflows. This, in turn, requires the classification of government spending into productive and unproductive. In this framework, we empirically assess the effects of productive and unproductive aid and aid volatility on economic growth, through the interaction effects of productive and unproductive government spending with aid and its volatility, respectively. The grouping of government spending follows the taxonomy used by Bleaney *et al.* (2001) and Kneller *et al.* (1999) who consider spending to be productive when it incorporates "a substantial (physical or human) capital component" (Kneller *et al.* 1999, page 178). The classification of government expenditures into these two categories is presented in Table A1.

We begin our empirical specification by examining a simple regression, in the spirit of Lensink and Morrissey (2000), which involves the effect of aid and its volatility on the rate of economic growth

$$g_{it} = \alpha + \beta_0 \log gdp_{it} + \gamma_1 aid_{it} + \delta_1 volaid_{it} + \varepsilon_{it}, \qquad [23]$$

[12] See footnote 6.

where g_{it} denotes the average rate of growth of per capita GDP in country i at time t, $\log gdp_{it}$ represents the log of initial level of per capita GDP, aid_{it} describes the aid-to-GDP ratio, and $volaid_{it}$ measures the volatility of aid as the standard deviation of the aid-to-GDP ratio at each time interval.[13]

The next step is to test the implications of our theoretical framework and assess the link between productive and unproductive aid with growth, and the volatility of productive and unproductive aid with growth through interaction effects:

$$g_{it} = \alpha + \beta_0 \log gdp_{it} + \sum_{k=1}^{2} \gamma_k (aid * \exp_k)_{it} + \sum_{k=1}^{2} \delta_k (volaid * \exp_k)_{it} + \sum_{k=1}^{2} \lambda_k \exp_{kit} + \varepsilon_{it}, \qquad [24]$$

where $\exp_k$ represents the vector of the two types of government spending.

In the final step, we expand the set of control variables with the vector X, which consists of variables that have been identified in previous studies as important conditioning variables in growth regressions:

$$g_{it} = \alpha + \beta_0 \log gdp_{it} + \sum_{k=1}^{2} \gamma_k (aid * \exp_k)_{it} + \sum_{k=1}^{2} \delta_k (volaid * \exp_k)_{it} + \sum_{k=1}^{2} \lambda_k \exp_{kit} + \sum_{j=1}^{m} \beta_j X_{jt} + \varepsilon_{it}, \qquad [25]$$

These variables are the budget deficit, trade, dummies for East Asian countries and countries that are located in the tropics, and the log of initial life expectancy. In addition, all regressions account for common deterministic trends by incorporating dummies for the different time periods. The above specifications are estimated originally with OLS, and then with GMM in order to account for possible endogeneity of the regressors. With the latter method, the validity of the instruments is tested with Hansen's J-statistic of over-identifying restrictions and

[13] The standard deviation of a variable is commonly used as a measure of its volatility. See, among others, Ramey and Ramey (1995), Beck, Lundberg, and Majnoni (2001), and Aghion, Angeletos, Banerjee, and Manova (2005) for studies that calculate the volatility of output. In a later section, we examine alternative aid volatility measures to examine the current measure's robustness.

the difference C-statistic of additional moment conditions, whenever these are incorporated.[14]

Our data set comprises panel data for 74 aid recipient countries over the period 1972-1998.[15] Most of the data are drawn from two different sources. Government expenditure data come from the International Monetary Fund's (IMF) *Government Finance Statistics*, while the majority of the data are from the World Bank's *World Development Indicators*. The sample is chosen as the longest time period for which all variables are available for the widest selection of countries. Details on the description and the sources of the variables can be found in the Appendix. Although the data are based on annual observations, we remove the effects of the business cycle and extract the relevant long-run information by taking three nine-year time intervals (1972-80, 1981-89, 1990-98).[16] This is a standard approach in the recent panel data growth literature which allows an easy comparison with previous studies. Summary statistics for the data set can be found in Table 1.

4. Empirical Findings

This section conducts the estimation analysis and reports the results of the relationship between the different uses of aid receipts, their volatility, and economic growth. First, we present the basic results as specified by equations [23]-[25], and then we undertake a wide range of tests to examine their robustness

[14] Hansen's J-test is preferred over the Sargan test of over-identifying restrictions, since, unlike the latter, it is consistent in the presence of autocorrelation and heteroscedasticity (Roodman 2004).

[15] The countries involved are listed in the Appendix.

[16] Later we test the validity of our results for different periodizations. We use nine-year intervals as our benchmark, however, because we want to strike a balance between a shorter period appropriate to capture the growth effect of some types of aid-financed government spending (such as infrastructure and public services), and a longer period which is likely to capture the effects of the remaining productive spending (e.g., health and education), and to better assess the impact of aid volatility on growth.

for different specifications, definitions, time periodizations, and expenditure classifications.

4.1 Basic Results

Table 2 summarizes the basic findings. The first column depicts the homogeneous effects of aid and aid volatility on growth, thus verifying the result first illustrated by Lensink and Morrissey (2000) – mainly, that aid significantly influences growth in a positive way while the volatility of aid inhibits growth.[17] Column 2 allows the empirical link between aid, aid volatility, and growth to vary depending on the use of aid by the recipient governments. These heterogeneous effects are captured by the multiplicative terms between each type of government spending (productive/unproductive) with aid inflows and their respective volatility. The results exhibit a reasonably good fit, with the estimated interaction effects being in accordance with the predictions of our theoretical framework. In particular, we find that aid disbursements used for productive purposes have a positive effect on growth, while unproductive use of them reduces growth. In addition, the volatility of aid is found to hurt growth only when aid is used productively. When aid is used unproductively, higher volatility of aid disbursements is associated with higher growth.

Column 3 adds a set of conditioning variables found by many studies to be important determinants of growth. These consist of the budget deficit and trade as indicators of fiscal and trade policy (e.g., Hansen and Tarp 2000; Dalgaard *et al.* 2004), an intercept indicating the idiosyncrasy of tropical locations (e.g., Daalgard *et al.* 2004; Clemens *et al.* 2004), a dummy representing the fast-growing East Asian countries, and the log of initial life expectancy to proxy for health conditions (e.g., Clemens *et al.* 2004). The interaction effects of aid, aid volatility, and growth remain intact, while the signs of the additional controls are as expected. Specifically, larger budget deficits and location in the tropics adversely affect growth, whereas economies that are more open, with higher life

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[17] Pallage and Robe (2001) have raised a similar argument regarding the volatility of aid. They find the pattern of aid disbursements to be highly procyclical. This, by intensifying the volatility of output, may result in lower growth.

expectancy, and located in East Asia are related with higher growth rates. In addition, initial GDP per capita now implies income convergence effects.

The results presented so far, although consistent with our theoretical illustration, may be biased by the possible endogeneity of foreign aid. To overcome such a problem, we make use of an instrumental variable approach and estimate the growth equation with GMM. The list of instruments we employ for the multiplicative terms incorporating aid and volatility of aid are provided in the table notes.[18]

Column 4 shows that the results already obtained with OLS are not due to reverse causation running from growth to aid. The Hansen J-statistic supports this result since it does not reject the hypothesis that the instruments are uncorrelated with the error term. In addition, the reported p-values for the standard errors are robust to heteroscedasticity and autocorrelation, as they are clustered by country, giving more confidence to our results. Finally, to account for possible endogeneity of the remaining conditioning variables – namely, the budget deficit, trade, productive and unproductive expenditures, and initial per capita GDP – we augment the instruments set with one-period lagged values of trade and initial GDP per capita, and GDP squared interacted with both productive and unproductive public expenditures. The results remain intact, with the conditioning variables jointly explaining 69% of the growth variability, while both the Hansen J-test and the C-statistic are strongly satisfied. Therefore, we can conclude that the estimated coefficients are not due to reverse causation, weak instruments, omitted variables, or an artifact of heteroscedasticity and autocorrelation.

[18] The choice of instruments follows the related literature and draws largely from Hansen and Tarp (2001), Dalgaard *et al.* (2004), and Clemens *et al.* (2004). However, to ensure that the number of instruments is not too large, we follow Roodman (2004) and restrict the number of instruments not to be greater than the number of countries in the regression. Otherwise, the instruments may overfit the instrumented variables and bias the results towards those obtained with OLS.

4.2 Robustness Tests

Until recently, very few studies exploring the impact of aid on growth have examined the broader applicability of their results by means of robustness testing. However, the studies of Easterly (2003), Easterly *et al.* (2004), and Roodman (2004) have demonstrated that most of the recent empirical results are susceptible to changes in specification, definition of variables, alternative periodizations, dataset expansion, and influential observations. To account for such considerations, we investigate in this section the sensitivity of our results to a number of alterations along these proposed lines.

4.2.1 Testing the specification

Table 3 shows the regression results when we expand the vector X by alternate inclusion of a number of additional control variables. These variables include ethnic fractionalization indicating political instability (e.g., Burnside and Dollar 2000), civil war and its lag representing the disruption of normal life and the return to it (e.g., Clemens *et al.* 2004), population growth rate, money as an indicator of financial depth (e.g., Dalgaard and Hansen 2001), initial fertility rate, an intercept for Latin American countries, and, finally, aid squared to examine whether aid exhibits diminishing returns (e.g., Hansen and Tarp 2000, 2001).

Controlling for these additional factors does not alter the observed conditional relationships between aid, aid volatility, and growth (the only insignificance seems to appear with the interaction effects of unproductive spending when money is added into the regression). All the additional controls have the expected sign, with the last regression showing that aid does not have a declining effect on growth. Finally, note that Hansen's J-statistic, the C-statistic, and Shea's partial R^2 confirm the validity of the instruments set.

4.2.2 Testing the volatility measure

The volatility measure we use to examine the pattern of aid disbursements although widely acceptable, is not unique. Palage and Robe (2001) and Bulíř and

Hamann (2003) have calculated the volatility of aid as the standard deviation of its cyclical component, where the latter has been obtained by de-trending the aid series with the Hodrick-Prescott filter. To examine the sensitivity of our results to alternative aid volatility measures, we use three additional definitions. Their description and measurement can be found in the Appendix. Table 4 reports estimates based on these alternative definitions of the volatility of aid. Column 1 reproduces the regression with our original volatility measure from Table 2 to ease comparison, while the remaining columns adopt the new definitions. It becomes apparent that the multiplicative terms entailing the volatility of aid are sensitive in the choice of definition, in terms of both size and significance, although they retain the predicted sign. The results, however, remain largely robust for the two preferred volatility measures found in the literature and portrayed here in Columns 1 and 2.

4.2.3 Testing the periodization

It has become a standard procedure in cross-country growth regressions to use time period averages to capture the long-run effects of the conditioning variables on economic growth. In the aid-growth literature, almost all of the studies use either four-year or five-year periods, with the exception of Guillamont and Chauvet (2001), who use twelve-year averages. Recently, however, Easterly (2003) and Roodman (2004) have shown that different periodizations can significantly alter the results of the most prominent empirical studies (e.g., Burnside and Dollar 2000; Collier and Dehn 2001; Collier and Hoeffler 2002; Collier and Dollar 2002). To encounter such an issue in this study, we consider two alternative time period averages, 4-year and 27-year (pure cross-section).

Table 5 shows that our results remain unchanged by altering the periodization of the regression implying that increasing or decreasing the period averaging does not affect statistical significance. However, we observe that both the statistical power and the magnitude of the interaction effects differ across periodizations. In particular, the cross-section regression depicts the strongest significance (one percent) and the highest absolute values in the interaction aid effects, while the 4-year panel reports the lowest significance (ten percent) and the highest values in the multiplicative aid-volatility effects. Our benchmark 9-year period results lie in between these two extremes, making us more confident of their validity.

4.2.4 Testing the sample of recipients

The next test we undertake is to re-examine the basic results for two country sub-samples, based on the fact that the country sample we use cannot be regarded as a homogeneous country grouping. Therefore, it is possible the effect of aid on growth to differ in magnitude and significance for different sub-samples. Table 6 evaluates our econometric specification for a sub-sample of 35 low-income countries and 37 low-aid recipient countries, respectively. The first sub-sample is comprised by countries that are grouped as low-income and low-upper income by the World Bank, while the second sub-sample consists of the countries that have aid receipts smaller than the sample average. Both columns in Table 6 show that neither the sign nor the significance of the interaction effects change. However, although the magnitude of the effects remains unchanged for the low-income sample, it uniformly rises by a scale of ten for the low-aid recipient's sample. This result could imply the greater marginal effect aid has on growth if it is received in small amounts, representing possible coordination difficulties or the presence of corruption related with bigger amounts of aid receipts.[19]

4.2.5 Testing the expenditures classification

Finally, we need to acknowledge that the types of expenditure we have aggregated as being productive, do not necessarily have the same impact on economic growth when they are partially financed with aid. To address this point, we separate education expenditures, health expenditures, and transportation and communication expenditures from the rest of productive expenditures to examine whether there is a particular type of aid-financed spending that is most influential for growth.

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[19] The second link is empirically supported by Alesina and Weder (2002) and Svensson (2000) who find that increases in aid cause more corruption.

The results in Table 7, and in particular the instrumented regressions, suggest that the only category of productive government spending financed with aid that significantly promotes growth is expenditures in education. This result accords well with our theoretical illustration and with the findings of Miller and Russek (1997), Bleaney *et al.* (2001) and Bose *et al.* (2003), who report positive growth effects of government expenditures in education (the first two studies for developed countries and the third for developing countries). Furthermore, the volatility of aid flows used in the education sector have a negative effect on growth – a result consistent with our previous findings. The remaining categories of productive spending financed with aid, show either a zero (transportation and communication) or a negative correlation with growth (health and rest of spending).[20]

5. Conclusion

The objective of this paper has been to evaluate the relationship between foreign aid and economic growth. Our contribution lies on identifying, *both* theoretically *and* empirically, the volatility of aid inflows – documented by the studies of Palage and Robe (2001) and Bulir and Hamann (2003) – as an additional factor on the determination of the growth effects generated by the provision of aid. Moreover, we distinguish the effects of aid transfers and their volatility according to whether foreign resource inflows are utilised for financing productive or non-productive public spending.

The general conclusion emerging from our analysis can be summarised as follows: when aid is used productively (unproductively) it has, *on average*, a positive (negative) effect on growth while its respective volatility has a negative (positive) growth effect. From a policy perspective, our results seem to suggest that the scope for a higher effectiveness of aid on stimulating growth is a

[20] Although these results strike surprising, both of them have been reported by past studies that examined the impact of various government spending categories on growth for low-income countries. Both results are supported by Miller and Russek (1997), with the first result also found in Bose *et al.* (2003), and the second in Devarajan *et al.* (1996).

responsibility that lies with all sides from the wide spectrum encompassing the process of resource transfers, i.e., both recipients and donors. Taking them literally, our results propose that recipient countries should allocate the aid they receive on the most productive uses, while donors should make sure that aid provision is the least erratic possible.

Nevertheless, although suggestive, our analysis, together with the previous studies on the foreign aid-economic growth nexus (e.g., Chatterjee et al 2003; Chatterjee and Turnovsky 2004, 2005; Obstfeld 1999), shares a fair number of limitations that make us cautious on claiming definite policy conclusions. One such restriction is that our analysis abstracts from the important issue of poverty reduction. Insofar as income transfers can alleviate, to some extent, the severely adverse effects resulting from situations of extreme poverty (i.e., high mortality rates, restrictions on undertaking costly activities that promote future productivity) then even aid given in the form of transfers may have beneficial growth and welfare effects. Another shortcoming – once more dictated by the need to keep the analysis tractable – is that we have considered the provision of aid and its distribution on different uses as exogenously given, without specifying any kind of preferences for either donors or recipients. To the extent that the inclusion of such preferences may result in strategic interactions in the decisions between donors and recipients, then the possibility of multiple equilibria may actually provide an explanation of why aid disbursements are volatile. Although these issues are not considered in our analysis, they may constitute a promising avenue for future research.

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Table 1
Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
GDP p.c. growth rate	1.42	2.92	-8.65	11.97
Initial p.c. GDP (log)	7.10	1.20	4.60	10.32
Aid	5.81	7.11	-0.007	34.64
Volatility of aid	2.07	3.07	0.007	27.53
Productive expenditures	14.76	7.03	4.04	49.8
Unproductive expenditures	12.47	7.87	2.18	52.2
Budget deficit	3.55	6.03	-30.45	41.69
Trade	69.75	44.82	12.55	329.75
Tropical	0.53	0.50	0	1
East Asia & Pacific	0.09	0.28	0	1
Initial life expectancy (log)	4.09	0.17	3.61	4.33

Notes: All variables are based on 9-year averages of the data. The variables aid, productive and unproductive expenditures, budget deficit, and trade are expressed as fractions of GDP. Initial GDP, and initial life expectancy enter in log form, while East Asia & Pacific and Tropical enter as 0/1 dummies.

Table 2
Basic Results

	(1) OLS	(2) OLS	(3) OLS	(4) GMM	(5) GMM
Initial GDP per capita (log)	0.248	0.097	-0.884	-1.09	**-1.34**
	(0.339)	(0.743)	(0.028)	(0.001)	**(0.001)**
Aid	0.086				
	(0.093)				
Aid volatility	-0.300				
	(0.005)				
Aid * Productive expenditures		0.015	0.022	**0.022**	**0.022**
		(0.000)	(0.000)	**(0.025)**	**(0.019)**
Aid * Unproductive		-0.018	-0.036	**-0.031**	**-0.034**
expenditures		(0.051)	(0.003)	**(0.056)**	**(0.030)**
Aid volatility * Productive		-0.074	-0.067	**-0.060**	**-0.070**
expenditures		(0.000)	(0.000)	**(0.024)**	**(0.004)**
Aid volatility * Unproductive		0.087	0.096	**0.068**	**0.080**
expenditures		(0.000)	(0.000)	**(0.044)**	**(0.011)**
Productive expenditures		0.001	-0.042	-0.133	**-0.084**
		(0.977)	(0.444)	(0.005)	**(0.114)**
Unproductive expenditures		-0.073	-0.080	0.017	**-0.009**
		(0.141)	(0.167)	(0.635)	**(0.816)**
Budget deficit			-0.104	-0.065	**-0.077**
			(0.099)	(0.191)	**(0.202)**
Trade			0.010	0.019	**0.016**
			(0.151)	(0.002)	**(0.008)**
Tropical			-0.886	-1.37	-1.34
			(0.035)	(0.000)	(0.000)
East Asia & Pacific			2.79	2.94	3.03
			(0.000)	(0.000)	(0.000)
Initial life expectancy (log)			8.63	7.73	10.69
			(0.002)	(0.000)	(0.000)
Countries / Observations	74 / 190	70 / 137	67 / 126	52 / 107	49 / 99
R^2	0.130	0.149	0.418	0.668	0.686
Hansen J-statistic (p-value)				0.654	0.676
C-statistic (p-value)					0.857
Shea partial R^2					
Aid * Productive expenditures				0.668	0.668
Aid * Unproductive expenditures				0.624	0.652
Aid volatility * Productive expenditures				0.607	0.615
Aid volatility * Unproductive expenditures				0.637	0.679
Initial GDP per capita (log)					0.719
Productive expenditures					0.805
Unproductive expenditures					0.782
Budget deficit					0.610
Trade					0.822

Notes: p-values in parentheses based on robust standard errors. Aid volatility measured as the standard deviation of aid. Constant term and time dummies not reported. Instrumented variables are in bold type. Instruments in regression (4): dummies for Central America, African Franc Zone countries, and Egypt, lagged arms imports as a fraction of total imports, lagged aid and aid volatility and their interaction with lagged productive and unproductive expenditures, GDP interacted with productive and unproductive expenditures, population and its interaction with productive and unproductive expenditures, and population squared. Regression (5) adds as instruments: trade and initial GDP per capita, both lagged one period, and GDP squared interacted with productive and unproductive expenditures.

Table 3
Testing the specification: additional controls

	(1) GMM	(2) GMM	(3) GMM	(4) GMM	(5) GMM	(6) GMM	(7) GMM
Initial GDP per capita (log)	-1.37	-1.07	-1.08	-1.00	-1.14	-0.903	-1.03
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.011)	(0.001)
Aid * Productive expenditures	**0.021**	**0.021**	**0.021**	**0.019**	**0.019**	**0.022**	**0.016**
	(0.026)	**(0.038)**	**(0.011)**	**(0.082)**	**(0.032)**	**(0.031)**	**(0.049)**
Aid * Unproductive expenditures	**-0.035**	**-0.029**	**-0.035**	**-0.019**	**-0.029**	**-0.025**	**-0.025**
	(0.035)	**(0.093)**	**(0.025)**	**(0.246)**	**(0.059)**	**(0.120)**	**(0.105)**
Aid volatility * Productive expenditures	**-0.058**	**-0.058**	**-0.056**	**-0.050**	**-0.050**	**-0.057**	**-0.046**
	(0.030)	**(0.032)**	**(0.011)**	**(0.115)**	**(0.043)**	**(0.049)**	**(0.067)**
Aid volatility * Unproductive expenditures	**0.066**	**0.065**	**0.174**	**0.040**	**0.060**	**0.059**	**0.052**
	(0.059)	**(0.068)**	**(0.023)**	**(0.278)**	**(0.057)**	**(0.073)**	**(0.090)**
Productive expenditures	-0.129	-0.134	-0.117	-0.135	-0.129	-0.157	-0.135
	(0.008)	(0.005)	(0.010)	(0.003)	(0.005)	(0.001)	(0.026)
Unproductive expenditures	0.021	0.015	-0.0003	-0.001	0.0008	0.011	0.020
	(0.600)	(0.691)	(0.991)	(0.973)	(0.978)	(0.747)	(0.585)
Budget deficit	-0.091	-0.064	-0.055	-0.067	-0.046	-0.060	-0.055
	(0.076)	(0.194)	(0.209)	(0.154)	(0.321)	(0.229)	(0.265)
Trade	0.021	0.018	0.018	0.010	0.018	0.014	0.020
	(0.001)	(0.003)	(0.001)	(0.076)	(0.001)	(0.025)	(0.001)
Tropical	-1.39	-1.35	-1.34	-1.09	-1.38	-0.940	-1.41
	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)	(0.026)	(0.000)
East Asia & Pacific	3.22	2.93	2.80	2.80	2.41	2.42	2.91
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Initial life expectancy (log)	7.49	7.66	6.55	7.76	4.12	9.81	7.14
	(0.000)	(0.000)	(0.001)	(0.000)	(0.125)	(0.000)	(0.000)
Ethnic fractionalization	-0.013						
	(0.112)						
Civil war		-0.200					
		(0.770)					
Lagged civil war		0.174					
		(0.802)					
Population growth rate			-0.474				
			(0.034)				
Money				0.025			
				(0.039)			
Initial fertility rate					-0.573		
					(0.024)		
Latin America & Caribbean						-1.03	
						(0.091)	
Aid squared							**-0.0008**
							(0.858)
Countries / Observations	52 / 105	52 / 107	52 / 107	52 / 107	52 / 107	52 / 107	52 / 107
R^2	0.672	0.670	0.685	0.685	0.690	0.668	0.669
Hansen J-statistic (p-value)	0.627	0.654	0.827	0.573	0.731	0.694	0.549
C-statistic (p-value)	0.466	0.686	0.879	0.996	0.824	0.917	0.205
Shea partial R^2							
Aid * Productive expenditures	0.672	0.658	0.665	0.676	0.668	0.671	0.702
Aid * Unproductive expenditures	0.607	0.611	0.632	0.613	0.626	0.606	0.617
Aid volatility * Productive expenditures	0.624	0.600	0.607	0.618	0.605	0.602	0.569
Aid volatility * Unproductive expenditures	0.635	0.622	0.648	0.637	0.639	0.624	0.658
Aid squared							0.330

Notes: p-values in parentheses based on robust standard errors. Aid volatility measured as the standard deviation of aid. Constant term and time dummies not reported. Instrumented variables are in bold type. Instruments in regressions (1)-(7): as in Table 2 regression (4). Regression (7) also adds as instrument: lagged aid squared.

Table 4
Testing the volatility measure: alternative definitions

	(1) Volatility1	(2) Volatility2	(3) Volatility3	(4) Volatility4
Initial GDP per capita (log)	-1.09	-1.20	-1.05	-1.07
	(0.001)	(0.001)	(0.001)	(0.000)
Aid * Productive expenditures	**0.022**	**0.003**	**0.021**	**0.012**
	(0.025)	**(0.433)**	**(0.085)**	**(0.037)**
Aid * Unproductive expenditures	**-0.031**	**-0.016**	**-0.032**	**-0.020**
	(0.056)	**(0.018)**	**(0.141)**	**(0.093)**
Aid volatility * Productive expenditures	**-0.060**	**-0.667**	**-0.155**	**-0.058**
	(0.024)	**(0.019)**	**(0.233)**	**(0.848)**
Aid volatility * Unproductive expenditures	**0.068**	**0.704**	**0.179**	**0.259**
	(0.044)	**(0.002)**	**(0.187)**	**(0.367)**
Productive expenditures	-0.133	0.085	-0.123	-0.169
	(0.005)	(0.361)	(0.091)	(0.033)
Unproductive expenditures	0.017	-0.180	0.007	0.018
	(0.635)	(0.044)	(0.870)	(0.740)
Budget deficit	-0.065	-0.101	-0.058	-0.042
	(0.191)	(0.013)	(0.300)	(0.458)
Trade	0.019	0.021	0.019	0.016
	(0.002)	(0.000)	(0.002)	(0.003)
Tropical	-1.37	-1.26	-1.44	-1.39
	(0.000)	(0.000)	(0.000)	(0.000)
East Asia & Pacific	2.94	2.24	2.90	3.09
	(0.000)	(0.000)	(0.000)	(0.000)
Initial life expectancy (log)	7.73	7.85	8.00	9.06
	(0.000)	(0.000)	(0.001)	(0.000)
Countries / Observations	52 / 107	48 / 96	52 / 107	52 / 107
R^2	0.668	0.652	0.655	0.665
Hansen J-statistic (p-value)	0.654	0.546	0.624	0.714
Shea partial R^2				
Aid * Productive expenditures	0.668	0.709	0.409	0.569
Aid * Unproductive expenditures	0.624	0.798	0.422	0.508
Aid volatility * Productive expenditures	0.607	0.228	0.372	0.325
Aid volatility * Unproductive expenditures	0.637	0.365	0.430	0.397

Notes: p-values in parentheses based on robust standard errors. Aid volatility measured as the standard deviation of aid in regression (1), the standard deviation of the detrended aid series in logarithm, using the Hodrick and Prescott filter in regression (2), the log[1+sd(aid)] in regression (3), the standard deviation of log(1+aid) in regression (4). Constant term and time dummies not reported. Instrumented variables are in bold type. Instruments in regressions (1)-(4): as in Table 2 regression (4).

Table 5
Testing the time intervals: alternative period averages

	(1) Cross section	(2) Panel (9 year averages)	(4) Panel (4 year averages)
Initial GDP per capita (log)	**-1.23**	**-1.34**	**0.350**
	(0.000)	**(0.001)**	**(0.691)**
Aid * Productive	**0.051**	**0.022**	**0.034**
expenditures	**(0.000)**	**(0.019)**	**(0.089)**
Aid * Unproductive	**-0.110**	**-0.034**	**-0.042**
expenditures	**(0.000)**	**(0.030)**	**(0.093)**
Aid volatility * Productive	**-0.100**	**-0.070**	**-0.189**
expenditures	**(0.000)**	**(0.004)**	**(0.090)**
Aid volatility *	**0.178**	**0.080**	**0.290**
Unproductive expenditures	**(0.000)**	**(0.011)**	**(0.091)**
Productive expenditures	**-0.042**	**-0.084**	**-0.163**
	(0.019)	**(0.114)**	**(0.028)**
Unproductive expenditures	**0.027**	**-0.009**	**-0.198**
	(0.193)	**(0.816)**	**(0.178)**
Budget deficit	**-0.090**	**-0.077**	**-0.406**
	(0.000)	**(0.202)**	**(0.070)**
Trade	**0.014**	**0.016**	**0.023**
	(0.000)	**(0.008)**	**(0.003)**
Tropical	-0.371	-1.34	-1.60
	(0.002)	(0.000)	(0.001)
East Asia & Pacific	2.14	3.03	2.71
	(0.000)	(0.000)	(0.000)
Initial life expectancy (log)	5.14	10.69	3.55
	(0.000)	(0.000)	(0.368)
Countries / Observations	23 / 23	49 / 99	70 / 269
R^2	0.960	0.686	0.167
Hansen J-statistic (p-value)	0.348	0.676	0.289
C-statistic (p-value)	0.501	0.857	0.412
Shea partial R^2			
Aid * Productive expenditures	0.826	0.668	0.142
Aid * Unproductive expenditures	0.993	0.652	0.170
Aid volatility * Productive expenditures	0.915	0.615	0.080
Aid volatility * Unproductive expenditures	0.999	0.679	0.073
Initial GDP per capita (log)	0.983	0.719	0.220
Productive expenditures	0.997	0.805	0.623
Unproductive expenditures	0.999	0.782	0.177
Budget deficit	0.993	0.610	0.055
Trade	0.994	0.822	0.809

Notes: p-values in parentheses based on robust standard errors. Aid volatility measured as the standard deviation of aid. Constant term and time dummies not reported. Instrumented variables are in bold type. Instruments in regressions (1)-(3): as in Table 2 regression (5).

Table 6
Testing the recipients: sub-sample analysis

	(1) Low-income	(2) Low-aid recipients
Initial GDP per capita (log)	-0.821	-1.10
	(0.126)	(0.008)
Aid * Productive expenditures	**0.021**	**0.300**
	(0.028)	**(0.000)**
Aid * Unproductive expenditures	**-0.035**	**-0.379**
	(0.064)	**(0.000)**
Aid volatility * Productive expenditures	**-0.056**	**-0.510**
	(0.012)	**(0.004)**
Aid volatility * Unproductive expenditures	**0.069**	**0.643**
	(0.053)	**(0.001)**
Productive expenditures	-0.135	-0.127
	(0.124)	(0.091)
Unproductive expenditures	0.112	-0.037
	(0.287)	(0.508)
Budget deficit	0.055	-0.145
	(0.344)	(0.002)
Trade	0.017	0.008
	(0.232)	(0.056)
Tropical	-1.12	-1.29
	(0.021)	(0.001)
East Asia & Pacific	3.00	3.15
	(0.000)	(0.000)
Initial life expectancy (log)	5.11	11.52
	(0.045)	(0.003)
Countries / Observations	35 / 71	37 / 73
R^2	0.620	0.756
Hansen J-statistic (p-value)	0.715	0.477
Shea partial R^2		
Aid * Productive expenditures	0.562	0.198
Aid * Unproductive expenditures	0.558	0.285
Aid volatility * Productive expenditures	0.645	0.171
Aid volatility * Unproductive expenditures	0.662	0.257

Notes: p-values in parentheses based on robust standard errors. Aid volatility measured as the standard deviation of aid. Constant term and time dummies not reported. Instrumented variables are in bold type. Instruments in regressions (1)-(2): as in Table 2 regression (4).

Table 7
Testing the expenditures classification: disaggregating productive spending

	(1) OLS	(2) OLS	(3) GMM	(4) GMM
Initial GDP per capita (log)	-0.124	-1.13	-1.48	**-1.52**
	(0.783)	(0.046)	(0.000)	**(0.000)**
Aid * Education expenditures	0.082	0.113	**0.395**	**0.412**
	(0.037)	(0.358)	**(0.000)**	**(0.001)**
Aid * Health expenditures	-0.064	-0.038	**-0.339**	**-0.279**
	(0.445)	(0.718)	**(0.000)**	**(0.006)**
Aid * Transp. & com. expenditures	0.043	0.025	**-0.002**	**-0.089**
	(0.253)	(0.668)	**(0.985)**	**(0.487)**
Aid * Other productive expenditures	-0.001	-0.016	**-0.138**	**-0.135**
	(0.894)	(0.704)	**(0.000)**	**(0.001)**
Aid * Unproductive expenditures	-0.026	-0.032	**0.009**	**0.004**
	(0.017)	(0.022)	**(0.376)**	**(0.735)**
Aid volatility * Education expenditures	-0.656	-0.466	**-1.04**	**-0.930**
	(0.010)	(0.203)	**(0.002)**	**(0.036)**
Aid volatility * Health expenditures	0.117	0.368	**1.17**	**0.816**
	(0.648)	(0.240)	**(0.000)**	**(0.018)**
Aid volatility * Transp. & com. expenditures	0.030	-0.150	**-0.153**	**0.084**
	(0.822)	(0.400)	**(0.525)**	**(0.760)**
Aid volatility * Other productive expenditures	0.047	0.092	**0.403**	**0.307**
	(0.491)	(0.437)	**(0.000)**	**(0.017)**
Aid volatility * Unproductive expenditures	0.142	0.066	**-0.077**	**-0.037**
	(0.002)	(0.220)	**(0.015)**	**(0.493)**
Education expenditures	0.315	0.250	-0.128	**-0.194**
	(0.399)	(0.363)	(0.350)	**(0.276)**
Health expenditures	0.279	0.030	-0.001	**0.127**
	(0.364)	(0.914)	(0.992)	**(0.596)**
Transp. & com. expenditures	-0.148	-0.425	-0.222	**-0.238**
	(0.622)	(0.059)	(0.053)	**(0.158)**
Other productive expenditures	-0.083	-0.110	-0.169	**-0.027**
	(0.545)	(0.312)	(0.009)	**(0.801)**
Rest expenditures	-0.120	-0.062	0.021	**-0.019**
	(0.051)	(0.411)	(0.544)	**(0.718)**
Budget deficit		-0.105	-0.117	**-0.128**
		(0.126)	(0.001)	**(0.020)**
Trade		0.011	0.019	**0.016**
		(0.172)	(0.000)	**(0.030)**
Tropical		-0.416	-0.991	-1.10
		(0.416)	(0.001)	(0.001)
East Asia & Pacific		3.00	2.99	3.25
		(0.000)	(0.000)	(0.000)
Initial life expectancy (log)		9.95	12.15	12.94
		(0.009)	(0.000)	(0.000)
Countries / Observations	58 / 105	55 / 96	46 / 82	42 / 76
R^2	0.222	0.492	0.683	0.683
Hansen J-statistic (p-value)			0.655	0.554
Shea partial R^2				
Aid * Education expenditures			0.623	0.452
Aid * Health expenditures			0.716	0.704
Aid * Transp. and com. expenditures			0.744	0.558
Aid * Other productive			0.661	0.534

expenditures		
Aid * Unproductive expenditures	0.829	0.763
Aid volatility * Education expenditures	0.534	0.430
Aid volatility * Health expenditures	0.681	0.561
Aid volatility * Transp. And com. expenditures	0.708	0.548
Aid volatility * Other productive expenditures	0.640	0.560
Aid volatility * Unproductive expenditures	0.788	0.500
Initial GDP per capita (log)		0.780
Education expenditures		0.890
Health expenditures		0.888
Transp. and com. expenditures		0.806
Other productive expenditures		0.679
Unproductive expenditures		0.768
Budget deficit		0.636
Trade		0.797

Notes: p-values in parentheses based on robust standard errors. Aid volatility measured as the standard deviation of aid. Constant term and time dummies not reported. Instrumented variables are in bold type. Instruments in regression (3): dummies for Central America, African Franc Zone countries, and Egypt, lagged aid and aid volatility and their interaction with lagged categories of productive and unproductive expenditures, population and its interaction with categories of productive and unproductive expenditures, population squared, GDP and its square interacted with categories of productive and unproductive expenditures. Regression (4) adds as instruments: trade and initial GDP per capita, both lagged one period.

Country and Data Appendix

Country Sample (74)

Argentina, Bahamas, Bahrain, Barbados, Belarus, Belize, Bhutan, Bolivia, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Chile, Colombia, Congo Dem. Rep., Congo Rep., Costa Rica, Cote d'Ivoire, Cyprus, Czech Rep., Dominican Rep., Egypt, Estonia, Ethiopia, Gambia, Guatemala, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iran, Israel, Korea Rep., Kuwait, Lesotho, Liberia, Madagascar, Malaysia, Mali, Malta, Mauritius, Mexico, Mongolia, Morocco, Nepal, Nicaragua, Pakistan, Panama, Paraguay, Peru, Poland, Romania, Rwanda, Senegal, Seychelles, Singapore, Slovenia, Sri Lanka, Suriname, Syrian Arab Rep., Tanzania, Thailand, Togo, Tonga, Tunisia, Turkey, Uruguay, Venezuela, Yemen Rep., Zambia, Zimbabwe.

Table A1
Variables Description and Sources

Variable	Definition	Source
Basic Set		
GDP p.c. growth rate	Annual percentage growth rate of GDP per capita based on constant local currency.	World Bank, *WDI* (2003)
Initial p.c. GDP	GDP per capita in constant 1995 US dollars.	World Bank, *WDI* (2003)
Aid	Official development assistance and net official aid (% of GDP).	World Bank, *WDI* (2003)
Volatility of aid	Standard deviation of aid flows.	World Bank, *WDI* (2003)
Productive expenditures	Sum of educational expenditures, health expenditures, transportation and communication expenditures, defense expenditures, housing expenditures, and general public services expenditures (% of GDP).	International Monetary Fund, *GFS*
Unproductive expenditures	Sum of social security and welfare expenditures, recreation expenditures, economic services expenditures, and other unclassified expenditures (% of GDP).	International Monetary Fund, *GFS*
Budget deficit	Overall budget balance for central government (% of GDP).	World Bank, *WDI* (2003)
Trade	Sum of exports and imports of goods and services (% of GDP).	World Bank, *WDI* (2003)
Tropical	Dummy indicating tropical location.	World Bank, Global Development Network
East Asia & Pacific	Dummy indicating region.	World Bank
Initial life expectancy	Life expectancy at birth, total.	World Bank, *WDI* (2003)
Instruments Set		
Central America	Dummy for Central American countries.	World Bank
Franc Zone	Dummy for African Franc Zone countries.	World Bank
Egypt	Dummy for Egypt.	
Lagged arms imports	Lagged arms imports as a fraction of total imports.	Roodman, D. (2004)
Population	Population, total.	World Bank, *WDI* (2003)
Sensitivity Set		
Ethnic fractionalization	Probability that two individuals belong to different ethnic groups.	World Bank, Global Development Network
Civil war	Dummy for civil war.	Clemens *et al.* (2004) and Collier and Hoeffler (2002)
Population growth rate	Annual population growth rate.	World Bank, *WDI* (2003)
Money	Money and quasi-money, M2 (% of GDP).	World Bank, *WDI* (2003)
Initial fertility rate	Fertility rate (births per woman), total.	World Bank, *WDI* (2003)
Latin America & Caribbean	Dummy indicating region.	World Bank
Volatility2	Standard deviation of logarithmic aid flows' cyclical component, calculated using the Hodrick-Prescott filter ($\lambda = 100$). Using $\lambda = 10$ does not alter the results.	Author's calculations
Volatility3	Logarithm of one plus the standard deviation of aid.	Author's calculations
Volatility4	Standard deviation of the logarithm of one plus aid.	Author's calculations
Low-income countries	Low-income and low-middle-income countries.	World Bank
Low aid-recipients	Recipients with lower than average aid.	Author's calculations
Low aid-volatility-recipients	Recipients with lower than average volatility of aid.	Author's calculations

Notes: The classification of the productive and unproductive expenditures follow Kneller *et al.* (1999) and Bleaney *et al.* (2001). These expenditure data are consolidated and cover all levels of government.