THE WORLD BANK ECONOMIC REVIEW, VOL. 12, NO. 1: 29-58

# A Panel Data Analysis of the Fungibility of Foreign Aid

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*The donor community has been increasingly concerned that development assistance intended for crucial social and economic sectors might be used directly or indirectly to fund unproductive military and other expenditures. The link between foreign aid and public spending is not straightforward because some aid may be "fungible." This article empirically examines the impact of foreign aid on the recipient's public expenditures, using cross-country samples of annual observations for 1971–90.*

*For the base sample of 14 developing countries, it finds that aid is not fungible at the aggregate level and there is no associated tax relief. Increasing the number of countries, however, makes aid fungible. Moreover, results based on the main sample indicate that aid is fungible in three out of five sectors examined. Developing-country governments receiving earmarked concessionary loans for agriculture, education, and energy reduce their own resources going to these sectors and use them elsewhere; only loans to the transport and communication sector are fully spent on the purposes intended by donors. Because most aid appears to be fungible, the rate of return on a specific donor-funded project tells little about the impact of that assistance; a better approach may be to tie foreign aid to an overall public expenditure program that provides adequate resources to crucial sectors.*

With the end of the Cold War and many rich countries facing their own fiscal problems, foreign aid budgets are being squeezed. Donor governments and aid agencies are asking new questions about the effectiveness of aid in promoting economic growth and reducing poverty, the two oft-stated objectives of development policy. Much of this attention is focused on the impact of foreign aid on the recipient's public expenditures, one of the main channels through which aid influences development outcomes. While an extensive literature has studied the growth effects of foreign aid programs, because of lack of data, many questions about the impact of foreign aid on public expenditures have not been systematically studied. (See White and Luttik 1994 and Obstfeld 1995 for a survey of foreign aid work.)

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Public Disclosure Authorized

This article studies the relationship between foreign aid and aggregate as well as sectoral public spending in recipient countries. In particular, it focuses on the relationship between aid and components of public expenditure: current and capital expenditures as well as education, health, infrastructure, and defense expenditures. The article also analyzes the impact of foreign aid on some human development indicators.

The link between foreign aid and public spending is not straightforward because some aid may be "fungible." An aid-recipient country could render earmarked aid fungible by reducing its own resources in the sector that receives aid and transferring them to other sectors of the budget. Some analysts claim that aid dollars are intrinsically more effective because they come as part of a package that includes the technical expertise and superior management skills of donor agencies. However, the crowding out of public spending and the use of aid at the margin have been contentious issues. The donor community has been increasingly concerned that development assistance intended for crucial social and economic sectors might be used directly or indirectly to fund unproductive military expenditures. (See UNDP 1994 for an analysis of the human development cost of arms imports in developing countries.) Given that donor agencies provide a significant portion of aid for specific projects or sectors (for example, projects in agriculture, health, and transport), they would like to know whether the aid increases net expenditures in those sectors or whether specific-purpose aid merely substitutes for expenditures that governments would have undertaken anyway. In this context, this article analyzes the fungibility of foreign aid across public expenditure categories.

Section I explains the concept of fungibility by means of a graphical analysis. Section II develops an analytical framework that links foreign aid with various components of public expenditure. Section III empirically examines the link between foreign aid and public spending. Section IV presents concluding remarks.

## I. A Graphical Analysis of Aid Fungibility among Public Spending Categories

Assessing the impact of aid on the recipient country's budgetary allocation requires examining the fungibility of aid. It is important to define this term because the concept of fungibility has been used in several ways in the aid literature (see Pack and Pack 1993). We first postulate a model and then use it to define precisely the term aid fungibility among public spending categories.

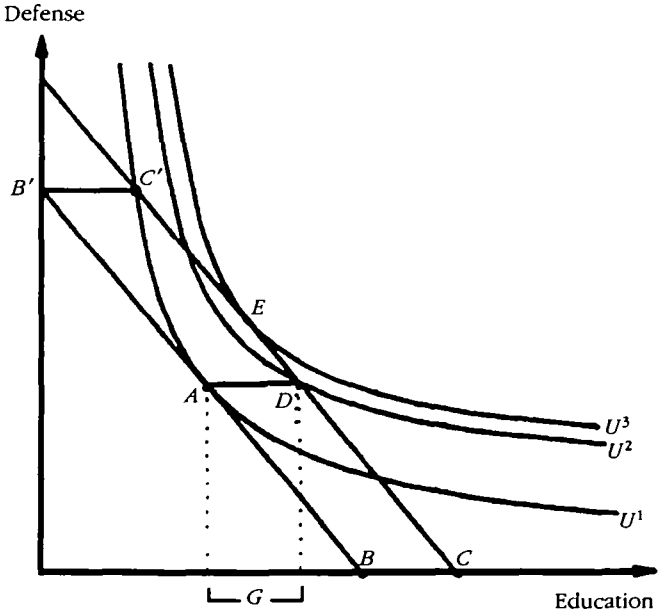
Suppose that a developing-country government buys two public goods (defense and education), both normal (noninferior), in the market to provide to its citizens. It pays for these goods by means of domestically generated resources. In addition, foreign donor agencies provide assistance toward the purchase of education. Figure 1 captures this scenario. The budget line $B'B$ represents public spending choices that can be financed by domestic resources. Given the prefer-

ences of the recipient-country government, point *A* represents the optimal mix of the two goods, defense and education, in the absence of aid. A foreign donor agency gives an amount *G* of earmarked aid to education. For simplicity, we assume that aid does not affect the relative price of the two goods. The post-aid budget line is *B'C'C*. To our knowledge, the only study that models the impact of aid on price changes is the seminal contribution by McGuire (1978). In his analysis, the fungible amount of aid shifts the budget constraint out, and the nonfungible amount rotates the budget constraint as the price of the nonaided good changes in relation to that of the aided good.

Given the pre-aid budget constraint, if the recipient country can treat a portion $\phi$ ($0 \leq \phi \leq 1$) of the earmarked aid as if it were a pure revenue supplement, then the aid is fungible. Cases 1–3 define the degrees of aid fungibility:

- *Case 1.* Aid is *fully fungible* if $\phi = 1$ and the post-aid optimal mix of the two goods, chosen by the country, is an interior solution. The latter requires that the country spend at least some of its own resources besides the aid in the targeted sector. $\phi = 1$ implies that the budget constraint shifts outward by the full amount of aid with a kink indicating the aid conditionality. If the solution is interior, the country moves to a new optimal point associated with a higher level of utility. In figure 1 this is indicated by a move from point *A* to point *E*.
- *Case 2.* Aid is *fully nonfungible* if $\phi = 0$. In this case, the country is not able to manipulate its resources and is forced by the donor agency to spend all

Figure 1. *Impact of Aid on a Country's Budgetary Allocations*



the aid money in the targeted sector. Given the preferences of the country, such a move is suboptimal, as shown by a move from point *A* to point *D* in figure 1.

- *Case 3.* Aid is *partially fungible* if $0 < \phi < 1$. In this case, the country's budget constraint shifts outward by the amount of fungible aid. A kink in the new budget line (not shown in figure 1) indicates that the education spending chosen by the country plus the nonfungible part of the aid has to be greater than (or equal to) the amount of aid. The country chooses an optimal point (if the solution is interior) on its new budget line and adds the nonfungible part of the aid to its education spending. Partial fungibility implies that the country is not able to transfer resources from education to defense as much as it would like to. This case would be given by a point that lies between *E* and *D* on the post-aid budget line in figure 1 and would be suboptimal (although it would be associated with a higher level of utility than in the case with full nonfungibility).

When they target aid to particular sectors, donor agencies often use a proxy of what the recipient country would have spent in the absence of aid. To ensure that the recipient country spends aid funds in the targeted sector and to preclude any switching of funds at the margin, donors often impose carefully chosen conditions. Restricting the switching of funds, at least on paper, seems simple; donor agencies only need to figure out the pre-aid levels of spending of the recipient country based on its previous years' budget documents. Using this as an (imperfect) indicator of what the country would have spent in the absence of aid, donor agencies can compel the recipient country to spend the aid funds at the margin in the targeted sector. For example, in figure 1, if the pre-aid composition of education and defense spending is known to be at point *A*, the recipient country could be asked to spend in addition the aid resources, *G*, on education. The post-aid composition of spending would then be at point *D*, and aid would be completely nonfungible at the margin.

In practice, however, several reasons make such monitoring difficult, if not impossible. First, domestic resources in developing countries fluctuate by significant amounts from year to year. Treating past years' composition of spending as the pre-aid composition may not be meaningful if the change in domestic resources is large relative to foreign aid. In such situations, recipient countries can easily switch aid funds among expenditure categories. Second, when there are several sources of aid in a country and donor coordination is not good, monitoring aid becomes extremely difficult. Finally, not all aid goes through the recipient country's budget. In many developing countries, particularly in Sub-Saharan Africa, a portion of foreign aid bypasses the government budget. In such cases, it might be difficult to pinpoint the spending requirement for the government. All in all, monitoring foreign aid is difficult in practice, and therefore aid fungibility is essentially an empirical issue.

## II. A Model of Aid Fungibility

McGuire (1978) has done seminal work on modeling aid fungibility in his studies of the local government response to federal grants for education in the United States. He proposes an indirect statistical method to determine the shape of the post-aid budget constraint of the recipient government. In McGuire's model, an unknown portion, $\phi$, of the grant is a pure revenue supplement to the recipient and is completely fungible along with the recipient's own fungible resources. The nonfungible portion, $1 - \phi$, of the grant changes the price of the subsidized good. Using a utility maximization framework, McGuire derives a system of equations with which to estimate the fungibility parameter, $\phi$. One drawback of this model is that the aid recipient is always at an optimal point. In our view, unless the aid is fully fungible, the recipient is constrained by the aid conditionality and government spending is not at the optimal level.

In this article, we postulate a variant of the McGuire model that allows the aid recipient's spending to be at suboptimal levels. In our model, which is close in spirit to the framework adopted by Pack and Pack (1993), the aid recipient government buys $S$ public goods $(g_1, g_2, \ldots, g_S)$ in the market to provide them to its citizens. It pays for these goods with the fungible portion of the foreign assistance and all other sources, $R$ (both domestic and foreign), at its disposal. A portion, $\phi$ $(0 \leq \phi \leq 1)$, of the earmarked aid is fungible if it can be treated as a revenue supplement. Citizens also consume goods that the government has to purchase from the nonfungible portion, $1 - \phi$, of the foreign aid. We assume that, by design, all foreign assistance is earmarked by purpose toward the purchase of $K$ $(\leq S)$ specific public goods so that $\phi_k$ is the fungible portion of aid earmarked for good $k$. This assumption is not far from the actual pattern of aid disbursement. Even the policy-based lending of multilateral institutions specifies a negative list of goods on which the aid may not be spent. We also assume that $a_k$ $(k = 1, \ldots, K)$ is the amount of aid for good $k$. Public spending on good $k$ has to be at least $a_k$. Further, let the representative agent's utility function, $W$, defined on these $S$ public goods and a single private good, $c_p$, be given by:

$$W = U[c_p, g_1, g_1^{NF}, \ldots, g_K, g_K^{NF}, g_{K+1}, \ldots, g_S] \tag{1}$$

$$\text{where } g_k^{NF} = \frac{(1-\phi_k)a_k}{p_k} \quad k = 1, \ldots, K$$

where $g_k^{NF}$ is the quantity of the $k$th good that the government has to purchase from the nonfungible portion of the aid earmarked for good $k$, and $p_s$ $(s = 1, \ldots, S)$ is the price of the $s$th public good.

We take the fungibility coefficient, $\phi$ $(\phi_1, \phi_2, \ldots, \phi_K)$, as given, rather than deriving it from a game-theoretic framework. Such a derivation would require specifying some strategic behavior on the part of the government that takes into account the penalty of being "caught" redirecting funds. Although this may be a

fruitful extension of the research, we do not attempt such an exercise here. Instead, we simply assume that the government once and for all decides on some number, $\phi_k$, for each $k$, which we estimate from data.

Moreover, by the definition of fungibility, aid affects the government's choice of $S$ goods ($g_1, g_2, \ldots, g_S$) only through the fungible portion; public goods purchased from the nonfungible part do not affect this choice. This assumption is crucial for modeling fungibility. If the nonfungible components ($g_1^{NF}, g_2^{NF}, \ldots, g_S^{NF}$) are taken into account in making the government's choice of $S$ goods ($g_1, g_2, \ldots, g_S$), then $G_1, G_2, \ldots, G_S$, where $G_k = g_k + g_k^{NF}$, is always optimal. In other words, irrespective of the size of $\phi$, ($G_1, G_2, \ldots, G_S$) will be the same as the set chosen optimally by the government if all aid came as a pure lump-sum revenue supplement. In such a case, aid is always fully fungible (unless we have corner solutions). As a matter of fact, if the nonfungible component of aid is not taken as a separable argument in the utility function, the fungibility coefficient, $\phi$, drops out of the analytical solution of the maximization problem. By making this assumption, we allow the government to have suboptimal $G_k$. For example, as seen in figure 1, the government's optimal choice of the two goods is given by $E$ (in this case $\phi = 1$) and the suboptimal choices (which involve purchases from the nonfungible part of the aid, essentially a constraint on the recipient government) are given by the points that lie between the interval ($E$, $D$). In real life, we believe that policymakers ignore a certain portion of the aid, which they regard as nonfungible, in their decisionmaking analysis.

The budget constraint faced by the government is:

$$p_1 g_1 + p_2 g_2 + \ldots + p_S g_S = R + \sum_{k=1}^{K} \phi_k a_k. \tag{2}$$

Taking $p_s$, $R$, $\phi_k$, and $a_k$ as given, the government chooses $S$ goods ($g_1, g_2, \ldots, g_S$) to maximize equation 1 with respect to equation 2. To get analytical solutions, let the utility function be of the Stone-Geary form (Stone 1954):

$$U[c_p, g_1, g_1^{NF}, \ldots, g_K, g_K^{NF}, g_{K+1}, \ldots, g_S] = F(c_p) + H\left(\sum_{k=1}^{K} g_k^{NF}\right) + \prod_{s=1}^{S} (g_s - \gamma_s)^{\beta_s}, \tag{3}$$

where $\gamma_s$ are the subsistence quantities of the public goods and are positive; and $\beta_s$ satisfy the condition $\Sigma \beta_S = 1$. Maximizing equation 3 subject to the budget constraint in equation 2 yields, if the solution exists and is interior, the following system of linear expenditure equations:

$$p_s g_s = p_s \gamma_s + \beta_s \left( R + \sum_{k=1}^{K} \phi_k a_k - \sum_{j=1}^{S} p_j \gamma_j \right) \quad s = 1, \ldots, S. \tag{4}$$

Empirically, however, we observe the total spending on any particular good rather than the spending that is financed by fungible or nonfungible resources. Simple manipulation of equation 4 leads to:

$$(5)\quad p_s\bar{g}_s = p_s\gamma_s + (1-\phi_s+\beta_s\phi_s)a_s + \beta_s\left(R + \sum_{k\neq s}^{K}\phi_k a_k - \sum_{j=1}^{S} p_j\gamma_j\right) \quad s = 1,\ldots,S;$$

$$\text{where } \bar{g}_s = g_s + g_s^{NF} = g_s + (1/p_s)((1-\phi_s)a_s).$$

Because $R$ is all sources of finance—domestic and foreign—except foreign aid, it can be measured by $G^N$, which is total government spending net of foreign aid:

$$(6)\quad R = G^N = G - A$$

$$\text{where } G = \sum_{s=1}^{S} p_s g_s + \sum_{k=1}^{K} p_k g_k^{NF} \text{ and } A = \sum_{k=1}^{K} a_k.$$

By substituting $G^N$ for $R$, equation 5 becomes

$$(7)\quad p_s\bar{g}_s = p_s\gamma_s + (1-\phi_s+\beta_s\phi_s)a_s + \beta_s\left(G^N + \sum_{k\neq s}^{K}\phi_k a_k - \sum_{j=1}^{S} p_j\gamma_j\right) \quad s = 1,\ldots,S.$$

Using data, we can analyze the effect of foreign aid on various components of public spending by estimating equation 7. Following McGuire (1978), we proxy the parameter $\gamma_s$ ($s = 1, \ldots, S$)—the subsistence quantities of various public goods—by social and other economic variables. These variables also capture the underlying differences in preferences across countries. Alternatively, we can estimate the parameter $\gamma_s$. In our analysis, we do it both ways, that is, we proxy $\gamma_s$ by social and economic variables (the so-called control variables) as well as estimate the parameter directly. In both cases, however, the coefficient and the significance of the aid variable—the key explanatory variable in our analysis—are not very different. For considerations of space, therefore, we only report the regressions with the control variables.

In equation 7, if the estimated coefficient of $G^N$ is the same as the coefficient of $a_s$, then aid earmarked for good $s$ is fully fungible and $\phi_s = 1$. (Provided $\beta_s$, the coefficient of $G^N$, is not equal to 1 for any sector $s$, in which case the concept of fungibility is not meaningful because it indicates a complete matching of the donor's and the recipient's preferences for that sector.) If the coefficient of $a_s$ is 1, then aid for good $s$ is fully nonfungible and $\phi = 0$. A coefficient of $a_s$ less than 1 but greater than the coefficient of $G^N$ would indicate partial fungibility of aid, that is, $0 < \phi_s < 1$. Finally, the coefficient of $a_k (k \neq s)$ indicates how much of aid earmarked for good $k$ is spent on good $s$.

## III. Empirical Analysis

The focus of our empirical analysis is the link between foreign aid and government spending. While the literature on the effectiveness of aid is replete with studies linking foreign aid with consumption, investment (both public and private), taxation, and other macro variables, very few studies analyze the impact of foreign aid on different components of government expenditure. (For a comprehensive review of the foreign aid literature, see Mosley, Hudson, and Horrell 1987, White and Luttik 1994, and Obstfeld 1995.) As a result, the interesting issues concerning the fungibility of foreign aid among public expenditure categories such as agriculture, health, education, transport and communication, and other sectors have not been fully researched. One reason for this has been the difficulty in obtaining data on aid by sector. For example, while Cashel-Cordo and Craig (1990) claim to have determined whether foreign aid changes the composition of government expenditure in a sample of 46 developing countries, the expenditure components in their analysis are limited to defense and nondefense spending. Similarly, in examining the fungibility of U.S. aid among eight major aid-recipient countries, Khilji and Zampelli (1994) look at defense and nondefense expenditures.

Researchers have used time-series data in individual countries to analyze the question of aid fungibility across the sectoral classification of expenditures (Gupta 1993, McGuire 1978, and Pack and Pack 1990, 1993). In a study of foreign aid to Indonesia, Pack and Pack (1990) do not find any evidence of fungibility across sectoral expenditures. By contrast, in their analysis of the Dominican Republic, Pack and Pack (1993) find evidence of substantial diversion of foreign aid away from its intended purposes. The evidence for a single country, while important, does not allow any cross-country generalization that could be useful to the donor community. For example, donors would like to know the sectors across countries in which aid resources are likely to be more or less fungible. In this context, the question of the impact of aid on government expenditure in general, and the fungibility of aid resources in particular, needs to be addressed in a cross-country, time-series framework.

### *Data*

Our empirical analysis uses annual data on developing countries from 1971 through 1990 (see appendix A). We constructed a panel database with information along three dimensions: the aid variable, the public spending variable, and control variables.

Data on foreign aid. We use two variables for foreign aid—official development assistance (ODA) and concessionary loans. For total aid to a country, we use the series on annual net disbursement of ODA that is put together by the Organisation of Economic Co-operation and Development (OECD 1994). For sectoral aid, we would have liked to have had data on

disbursement of ODA over time and across countries. However, such data only exist on aid commitments, not disbursements. We did not want to use data on sectoral aid commitments for two reasons. First, the mapping between aid commitment and disbursement is far from one-to-one; the disbursement data have a very disparate time profile. The data on aid commitment are discontinuous, with large swings from year to year, while the data on aid disbursement are relatively smooth. Second, the disbursement data, being predetermined in most part, are much less prone to the simultaneity problem with government spending data.

In the empirical analysis, we use the net disbursement of concessionary loans from all bilateral and multilateral sources—a component of ODA—by sector, over time, and across countries. (We put together this series from the World Bank database.) Thus, for our analysis of sectoral aid fungibility, we use concessional lending to developing countries. This data constraint may, however, introduce a bias in our results. If concessionary loans and grants are correlated, the absence of grants could lead to a bias in the estimate of the concessionary loan variable. Despite our laborious search, similar information on grants—the remaining component of ODA—was not available. Although we strongly believe that it would be useful to have data on grants by sector, such data could be obtained only by collecting information from each country's budget over the years, but the search would likely involve prohibitively high costs.

DATA ON PUBLIC SPENDING. Our database on public spending consists of data on the functional classification of public expenditure from two sources: the International Monetary Fund's *Government Finance Statistics* (GFS; IMF various years) and a database created by Easterly and Rebelo (1993).[1] Among the available data on public spending, the coverage of GFS is comprehensive for central government accounts but is quite restricted for the accounts of general (central plus subnational) government. In addition, GFS data do not include spending by public sector enterprises. Easterly and Rebelo's database is not as rich and comprehensive as GFS, but it does have information on public investment of the consolidated general government (which includes spending by all levels of government as well as investments by public enterprises).

DATA ON CONTROL VARIABLES. The database includes information on per capita real gross domestic product (GDP), infant mortality rates, average years of

1. As part of this research, we also collected public spending data from various issues of the IMF's *Recent Economic Developments* (various years), a document prepared annually by the IMF for all its member countries. The data reported in *Recent Economic Developments* are said to reflect a more accurate description of public spending in developing countries because they are based on detailed analyses of country budgets by the IMF staff missions. Our results from these data, however, were not very different from our results using the other two sources (GFS and Easterly and Rebelo 1993), and hence we do not report them.

schooling in the labor force, military expenditures of neighboring countries, and the share of agriculture in national income (see appendix A for data sources).

### *Choice of Variables*

The model in section II developed links between foreign aid and public spending assuming that the observed mix of public expenditures results from a combination of the government's utility maximizing choice using fungible (domestic and foreign) resources and the purchase of goods from the nonfungible portion of aid. In the empirical analysis, first, we estimate the impact of aggregate foreign aid on total government spending to examine whether foreign aid is associated with any effort to mobilize resources on the part of the recipient country. Second, we estimate the effect of foreign aid on the government's investment and consumption spending. Third, we estimate the impact of earmarked sector-specific aid on components of government spending. Finally, we analyze the fungibility hypothesis (whether aid is fungible).

The key explanatory variable in our analysis is the share of foreign aid (aggregate as well as sector-specific) in GDP. By including a few social and other economic variables in our set of explanatory variables, we attempt to capture the effect of the variable $\gamma_s$—the minimum quantity of various public goods—and at the same time reduce the problem of simultaneity. Because a neighboring country's military expenditure is an important determinant of a country's own defense spending (Landau 1994), we include this variable with a single-period lag. Another control variable, the past year's infant mortality rate, is included because it is an important determinant of a country's health sector spending. Similarly, one-period lagged values of average schooling in the labor force and the share of agricultural output are included because these factors influence education and agricultural spending, respectively. Finally, countries at different levels of development tend to have different sizes of government (Wagner's law). In an effort to control for this effect, we include per capita GDP at 1987 constant prices measured in U.S. dollars for each sample country. Because the per capita GDP variable is correlated with infant mortality, school enrollment, and the share of agriculture in GDP, the estimates of the coefficients on the latter variables are likely to be affected. In our empirical analysis, however, the resulting increase in variance of the coefficients is not big enough to influence the hypothesis testing results.

Could our analysis be subject to a simultaneity problem of the expenditure and foreign aid variables? In deciding the level and composition of foreign aid, donor agencies look at, among other things, the economic, political, and social indicators of the recipient country. Although the problem of simultaneity exists in principle in our analysis, we attempt to minimize it by using aid disbursement numbers that are largely predetermined and by including lagged values of a few economic and social indicators of the recipient country as explanatory variables in the regression analysis. The latter is consistent with the approaches of Boone (1994), Gang and Khan (1990), and McGuire (1978).

### *Regression Analysis*

We use the method of least squares to estimate equations 8, 9, and 10.

$$(8) \qquad G_{i,t} = \alpha_{0,i} + \alpha_1 \, Aid_{i,t} + \sum_{c=1}^{C} \alpha_{c+1} Z_{c,i,t-1} + \varepsilon_{i,t}$$

for country $i$ ($i = 1, \ldots, I$) at time $t$ ($t = 1, \ldots, T$).

$$(9) \qquad G_{i,t}^{E_j} = \delta_{0,i} + \delta_1 \, G_{i,t}^{N} + \delta_2 \, Aid_{i,t} + \sum_{c=1}^{C} \delta_{c+2} Z_{c,i,t-1} + \nu_{i,t}$$

where $E_j$ $\{j = 1,2\}$ are current and capital expenditures.

$$(10) \; G_{i,s,t} = \lambda_{0,i,s} + \lambda_{1,s} \, G_{i,t}^{N} + \lambda_{2,s} \, Aid_{i,s,t} + \sum_{k \neq s}^{S} \lambda_{3,k} \, Aid_{i,k,t} + \sum_{c=1}^{C} \lambda_{c+3,s} Z_{c,i,t} + \eta_{i,s,t}$$

$$\text{where } \lambda_{1,s} = \beta_s; \lambda_{2,s} = (1 - \phi_s + \beta_s \phi_s); \text{ and } \lambda_{3,k} = \beta_s \phi_k \text{ for } k \neq s$$

for each sector $s$ ($s = 1, \ldots, S$). Equation 10 is the system of sectoral expenditure equations (see equation 7). Equation 8 is derived by applying the Stone-Geary utility function for the case when there is only one variable—aggregate government spending. Equation 9 treats current and capital government expenditures (see appendix B for the derivation). The regressions include the following variables for country $i$, sector $s$, and time $t$.

| | | |
|---|---|---|
| $G_{i,t}$ | = | The share of total government expenditure (including foreign aid) in GDP |
| $G_{i,t}^{E_j}$ | = | The share of government expenditure for current or capital purposes (including foreign aid) in GDP, where $E_j\{j = 1,2\}$ denotes current or capital expenditure, respectively |
| $Aid_{i,t}$ | = | The share of net disbursement of total foreign aid in GDP |
| $G_{i,s,t}$ | = | The share of government expenditure (including foreign aid) in sector $s$ in GDP |
| $G_{i,t}^{N}$ | = | The share of total government expenditure (net of foreign aid) in GDP |
| $Aid_{i,k,t}$ | = | The share of net disbursement of foreign aid to sector $k$ in GDP |
| $Z_{i,t-1}$ | = | A vector of other control variables (infant mortality rate, average years of schooling in the labor force, average ratio of a neighboring country's military expenditure to GDP, ratio of agricultural output to GDP) |
| $\varepsilon_{i,t}$, $\nu_{i,t}$, and $\eta_{i,s,t}$ | = | White-noise error terms for the three equations. |

Table 1 presents the estimates for equation 8, which is estimated under the null hypothesis that the coefficient of the country dummy variable, $\alpha_{0,i}$, is a fixed

Table 1. *The Impact of Foreign Aid on Government Expenditure, 38-Country Sample, 1971–90*

| Variable | Equation 1-1 | Equation 1-2 |
|---|---|---|
| Constant | 31.20 | 32.77 |
| | (6.51) | (6.86) |
| Share of official development assistance in GDP | 0.33 | |
| | (3.29) | |
| Share of concessionary loans in GDP | | 0.63 |
| | | (3.13) |
| Real per capita GDP | –0.001 | –0.001 |
| | (–0.61) | (–0.91) |
| Neighboring country's military expenditure in GDP, lag (–1) | –0.03 | 0.02 |
| | (–0.29) | (0.11) |
| Average schooling in labor force, lag (–1) | –0.12 | –0.18 |
| | (–0.20) | (–0.31) |
| Infant mortality rate, lag (–1) | 0.02 | 0.006 |
| | (0.58) | (0.21) |
| Share of agriculture output in GDP, lag (–1) | –0.39 | –0.39 |
| | (–6.53) | (–6.50) |
| Adjusted $R^2$ | 0.25 | 0.22 |
| Number of observations | 309 | 309 |
| Type of model[a] | Random | Random |

*Note*: The results reported here are for estimation of equation 8 in the text. The dependent variable is government expenditure expressed as a share of gross domestic product (GDP). Z-values are in parentheses. The 38 countries in the sample are listed in appendix A.

a. Indicates whether the country dummies in the regression represent a fixed effects or a random effects model. The test is based on Hausman (1978).

*Source*: Authors' calculations. Government expenditure data are from the IMF's *Government Finance Statistics* (IMF various years).

parameter. If the Hausman test rejects the null hypothesis that the fixed effects model is appropriate, then the random effects model is estimated.[2]

The aggregate fungibility results presented in table 1 are based on a sample of 309 observations: annual time-series data from 1971 through 1990 on 38 countries (see appendix A for the list of countries). When we chose this sample, we included a country if at least 35 percent of the annual observations were available on each of the variables used in the regression. This was the largest sample size available that satisfied our data requirement.

Equation 1-1 in table 1 shows a positive and statistically significant relationship between the share of total government expenditure in GDP and the share of the net disbursement of ODA. The regression shows that an increase of $1.00 in foreign aid leads to an increase of $0.33 in total government spending; the re-

2. In the fixed effects model $\alpha_{0,i}$, the country dummy parameter, is a fixed coefficient. In the random effects model, these parameters are assumed to be independent random variables with a fixed mean and variance, that is, $\alpha_{0,i} = \alpha_0 + e_i$. Hausman has developed a test that shows that under the null hypothesis the fixed effects model is appropriate and the preferred estimator is least squares with dummy variables. However, if the fixed effects model is rejected in favor of the random effects model, then the preferred estimator is generalized least squares. For details, see Hausman (1978).

maining aid is used for tax relief. Increases in the net disbursement of concessional loans are far more stimulative of total government expenditures; equation 1-2 in table 1 shows that a dollar increase in concessionary loans leads to a $0.63 increase in government expenditures.

The likely reason why concessionary loans have a relatively larger impact on government expenditures than ODA is that a portion of such loans have matching requirements, that is, for every dollar that a government spends on a specified activity, it gets a matching amount in concessionary loans. Among the control variables, the share of agricultural output in GDP—a measure of the level of development in a country—is the only variable that is statistically significant in both equations. The negative coefficient suggests that countries that receive a larger share of their GDP from agriculture and are therefore relatively less developed have relatively lower government spending. The evidence from these two equations suggests aid fungibility at the aggregate level. We could argue, however, that the associated tax relief may not be necessarily bad because in most developing countries the distortionary cost of taxation is quite high. Tax relief, therefore, may carry, at least in the short run, a very high rate of return.

The public spending variable used in the regression in table 1 is from GFS (IMF various years). As discussed earlier, public investment data reported in GFS do not include spending by public sector enterprises. Easterly and Rebelo (1993) have information on the public investment of the consolidated general government (which includes spending by all levels of government as well as investments by public enterprises). In view of the potential data bias, we did not want to rely on the GFS public investment variable to analyze the link with foreign aid.

To be able to check for any bias due to the definition of the public investment variable, therefore, we modified our sample. Starting with the Easterly and Rebelo database, we included a country in our sample if at least 35 percent of the annual observations were available on each variable used in the regression analysis. From a total of 166 countries, 27 were chosen. Four of these 27 countries were dropped because they did not have related GFS expenditure data on the same variables. The objective was to have the same set of countries from all three databases: GFS, Easterly and Rebelo, and the IMF's *Recent Economic Developments* (various years). Based on this criterion, we chose only 14 of the 23 countries because they had the required information on all the relevant variables (including the control variables) in the regression. See appendix A for details.

Table 2 reports the estimates for equations 8 and 9 based on the modified sample of 14 countries. Equation 2-1 in table 2 shows that a dollar increase in foreign aid leads to an increase of $0.95 in total government spending. There is no tax relief effect in this sample of 14 countries. Rather, increases in the net disbursement of concessional loans stimulate total government expenditures; equation 2-2 shows that a $1.00 increase in concessionary loans leads to a $1.24 increase in government expenditures. Thus, unlike for the larger group of countries, we do not find evidence of foreign aid fungibility at the aggregate level. Our findings seem to be consistent with the available evidence on the tax relief

Table 2. *Impact of Foreign Aid on Total, Current, and Capital Public Expenditures, 1971–90*

| | *Dependent variable*[a] | | | | | |
|---|---|---|---|---|---|---|
| | *Total government spending* | | *Public current expenditures* | | *Public capital expenditures* | |
| *Variable* | *Eq. 2-1* | *Eq. 2-2* | *Eq. 2-3* | *Eq. 2-4* | *Eq. 2-5* | *Eq. 2-6* |
| Constant | | | | | | 1.80 |
| | | | | | | (0.29) |
| Government expenditure net of aid in GDP | | | 0.63 | 0.65 | 0.35 | 0.35 |
| | | | (15.33) | (14.44) | (9.15) | (8.80) |
| Share of official development assistance in GDP | 0.95 | | 0.72 | | 0.29 | |
| | (5.82) | | (10.59) | | (4.65) | |
| Share of concessionary loans in GDP | | 1.24 | | 1.22 | | 0.27 |
| | | (4.08) | | (8.97) | | (1.19) |
| Real per capita GDP | 0.01 | 0.01 | –0.002 | –0.004 | 0.002 | 0.002 |
| | (1.67) | (1.10) | (–0.43) | (–1.05) | (0.59) | (0.80) |
| Neighboring country's military expenditure in GDP, lag (–1) | 0.33 | 0.43 | –0.10 | –0.53 | 0.08 | 0.04 |
| | (1.04) | (1.26) | (–0.76) | (–0.37) | (0.64) | (0.30) |
| Average schooling in labor force, lag (–1) | –1.78 | –1.12 | 3.74 | 2.92 | –3.58 | –1.95 |
| | (–1.04) | (–0.61) | (4.19) | (2.90) | (–4.27) | (–2.66) |
| Infant mortality rate, lag (–1) | 0.09 | 0.06 | 0.06 | 0.01 | –0.05 | –0.02 |
| | (1.51) | (0.94) | (2.19) | (0.26) | (–1.91) | (–0.89) |
| Share of agriculture output in GDP, lag (–1) | –0.63 | –0.53 | –0.12 | –0.09 | 0.07 | 0.15 |
| | (–2.69) | (–2.09) | (–0.94) | (–0.63) | (0.59) | (1.55) |
| Adjusted $R^2$ | 0.87 | 0.84 | 0.97 | 0.97 | 0.79 | 0.19 |
| Number of observations | 128 | 128 | 89 | 89 | 89 | 89 |
| Type of model[b] | Fixed | Fixed | Fixed | Fixed | Fixed | Random |

*Note*: The results reported here are for estimation of equations 8 and 9 in the text. *t*-statistics are in parentheses for the fixed effects models; Z-values are in parentheses for the random effects model. The 14 countries in the sample are listed in appendix A.

a. Dependent variables are expressed as a share of gross domestic product (GDP).

b. Indicates whether the country dummies in the regression represent a fixed effects or a random effects model. The test is based on Hausman (1978).

*Source*: Authors' calculations. Government expenditure data are from the IMF's *Government Finance Statistics* (IMF various years).

effect of aid, which shows a lot of heterogeneity depending on the sample (see White and Luttik 1994).

Equation 2-3 in table 2, which includes expenditure shares according to the economic classification of GFS, indicates that roughly three-quarters of ODA are spent on government's current expenditure. This may not be bad because several components of current expenditure, such as operations and maintenance, may have higher rates of return than capital expenditure. In a study of 43 developing countries over 20 years, Devarajan, Swaroop, and Zou (1996) show that current expenditure is the only broad category of public expenditure that is associated with higher economic growth. The coefficient of ODA in equation 2-5 shows that the remaining one-quarter of aid (after accounting for current expenditure) goes for capital expenditure. Comparing the coefficients on the aid vari-

able with the coefficients on total spending net of aid, however, suggests that at the margin more money is spent on current expenditure if the financing is from aid sources (equation 2-3).

In order to determine whether the measure of capital spending from GFS qualitatively or quantitatively affects our results, we employ the measure of public investment from the Easterly and Rebelo database. The relationship between foreign aid and public investment of the consolidated general government is also positive and significant, as illustrated in equations 3-1 and 3-2 in table 3. These regressions show that net concessionary loans stimulate public investment far more than ODA. Out of $1.00 in ODA and concessionary loans, $0.20 and $0.32 go for public investment purposes, respectively. The remaining aid presumably funds either government consumption or private investment and/or consumption. This outcome of foreign aid may not be unintended for two reasons. First, ODA funds are given to promote development and welfare and, therefore, by design, public investment may not be their sole purpose. Levy (1987) has argued that aid transfers include very heterogeneous components (drought-related food transfers, for example) and therefore are likely to have different marginal propensities to consume and invest. Second, the standard definition of public in-

Table 3. *The Impact of Foreign Aid on Public and Total Investment, 1971–90*

| | *Dependent variable*[a] | | | | | |
|---|---|---|---|---|---|---|
| | *Public investment* | | *Total investment* | | | |
| *Variable* | *Eq. 3-1* | *Eq. 3-2* | *Eq. 3-3* | *Eq. 3-4* | *Eq. 3-5* | *Eq. 3-6* |
| Share of official development assistance in GDP | 0.20 (2.81) | | 0.81 (5.05) | | 0.30 (6.82) | |
| Share of concessionary loans in GDP | | 0.32 (2.55) | | 1.18 (4.05) | | 0.58 (7.46) |
| Real per capita GDP | 0.02 (4.92) | 0.02 (4.70) | 0.03 (3.56) | 0.02 (3.06) | 0.01 (5.73) | 0.01 (5.94) |
| Neighboring country's military expenditure in GDP, lag (–1) | 0.51 (3.69) | 0.52 (3.73) | 0.49 (1.57) | 0.55 (1.69) | –0.22 (–1.66) | –0.14 (–1.21) |
| Average schooling in labor force, lag (–1) | –0.36 (–0.47) | –0.33 (–0.44) | –1.73 (–1.02) | –1.40 (–0.79) | –2.17 (–1.37) | –1.38 (–1.71) |
| Infant mortality rate, lag (–1) | 0.07 (2.59) | 0.06 (2.21) | 0.13 (2.21) | 0.10 (1.64) | 0.07 (2.44) | 0.04 (1.76) |
| Share of agriculture output in GDP, lag (–1) | –0.14 (–1.37) | –0.13 (–1.29) | –0.38 (–1.64) | –0.32 (–1.33) | –0.17 (–3.29) | –0.21 (–3.93) |
| Adjusted $R^2$ | 0.85 | 0.85 | 0.66 | 0.63 | 0.25 | 0.23 |
| Number of observations | 128 | 128 | 128 | 128 | 309 | 309 |
| Type of model[b] | Fixed | Fixed | Fixed | Fixed | Fixed | Fixed |

*Note*: The results reported here are for estimation of equation 9 in the text. *t*-statistics are in parentheses. The 14 countries in the sample are listed in appendix A.

a. Dependent variables are expressed as a share of gross domestic product (GDP).

b. Indicates whether the country dummies in the regression represent a fixed effects or a random effects model. The test is based on Hausman (1978).

*Source*: Authors' calculations. Public investment data are from Easterly and Rebelo (1993), and total investment data are from national accounts.

vestment does not capture the difference between capital stock–enhancing (physical as well as human capital stock) expenditures and consumption expenditures. For example, some researchers consider spending on public education as investment (see Barro 1991). As for the other variables in the regressions, infant mortality rate and a neighboring country's military expenditure both have a positive and statistically significant relationship with public investment.

Many researchers, most notably Boone (1994), have argued that foreign aid does not increase investment and growth and, in most cases, is spent entirely on consumption. Using data on 96 countries between 1971 and 1990, Boone shows that the marginal propensity to spend foreign aid on consumption is insignificantly different from 1, and the marginal propensity to spend it on investment (public and private) is 0. Our results show that foreign aid—ODA or concessionary loans—has a positive and significant impact on public investment. To check whether the impact of aid on public investment could be crowding out private investment in our sample of countries, we regress both the aid variables on total (public and private) investment. Equations 3-3 and 3-4 in table 3 show that both ODA and concessionary loans have a positive and statistically significant relationship with total investment. In summary, our results do not support Boone's finding that foreign aid is spent entirely on consumption and not on investment.

One reason why our finding is different from that of Boone might be the difference in the method of selecting a sample. Boone uses 10-year averaged data and hence has only two data points for each country in the sample. Although his sampling procedure yields nearly 300 data points, they are based on 10 or fewer time-series observations. We use annual observations for each country in our sample, which is restricted by our decision to use the Easterly and Rebelo data set. This constraint restricts the number of observations in our sample; compared with Boone's sample, we have only 128 observations. Although compromising on the number of observations, we gain on two fronts. First, our analysis is not subject to any bias due to an underestimation of public investment in the total investment variable. Second, with the emphasis on the time dimension, we are able to capture more effectively the impact of annual net disbursement of aid on that period's government budget; we reduce the problem of reverse causality. In panel data regressions, averaging over time may lead to reverse causality if the full panel is not available. For example, in averaging data over 1971 to 1980, a data point on investment for a country could be the average of the annual observations from 1971 to 1976 and the corresponding data point on aid could be the average of years 1975 through 1978. Using such data points to regress investment on aid could introduce reverse causality. When we drop the data constraint of using the Easterly and Rebelo data set and use the larger sample of 38 countries (as in table 1), our results do change. The coefficients on the two aid variables (see equations 3-5 and 3-6) are reduced in size by more than half, although they continue to be positive and statistically significant. It is possible that the reduction in size is due to the exclusion of the investments of public enterprises.

Table 4 shows the estimates of equation 10 when GFS data on public spending are used. Regressions reported in this table examine the link between the net disbursement of concessionary loans to a particular sector and public spending in that sector. It is possible, however, that this regression could be subject to the

Table 4. *The Impact of Sectoral Concessionary Loans on Sectoral Government Expenditure, 1971–90*

| | *Dependent variable*[a] | | | | | |
|---|---|---|---|---|---|---|
| *Variable* | *Education, eq. 4-1* | *Health, eq. 4-2* | *Energy, eq. 4-3* | *Agriculture, eq. 4-4* | *Transport and communication, eq. 4-5* | *Defense, eq. 4-6* |
| Constant | 4. 12 | 1.19 | –0.63 | –2.07 | 2.08 | 3.36 |
| | (1.49) | (1.28) | (–0.51) | (–1.20) | (3.44) | (0.89) |
| Government expenditure net of aid in GDP | 0.08 | 0.02 | 0.01 | 0.03 | 0.10 | 0.11 |
| | (4.94) | (4.32) | (1.99) | (2.75) | (5.57) | (5.10) |
| *Sectoral loans (as a share of GDP)* | | | | | | |
| Education | 1.55 | 0.01 | 0.16 | 0.05 | 0.52 | 0.71 |
| | (1.08) | (0.03) | (0.27) | (0.05) | (0.31) | (0.38) |
| Health | –3.21 | –0.31 | 3.07 | 3.45 | 1.10 | 5.19 |
| | (–0.73) | (–0.23) | (1.61) | (1.29) | (0.21) | (0.91) |
| Energy | –0.71 | 0.12 | 0.36 | 0.21 | 0.17 | 0.02 |
| | (–1.21) | (1.84) | (3.82) | (1.59) | (3.75) | (0.07) |
| Agriculture | 0.56 | 0.19 | 0.09 | –0.05 | –0.01 | 0.21 |
| | (2.22) | (2.45) | (0.82) | (–0.32) | (–0.03) | (0.65) |
| Transport and communication | –0.59 | 0.14 | 0.16 | 0.21 | 0.92 | 0.36 |
| | (–3.01) | (2.44) | (1.92) | (1.77) | (3.98) | (1.44) |
| Other sectors | –0.05 | 0.02 | 0.01 | 0.06 | 0.04 | –0.01 |
| | (–1.65) | (2.30) | (0.79) | (3.25) | (1.09) | (–0.35) |
| Real per capita GDP | 0.0003 | –0.0001 | 0.001 | 0.0003 | –0.0002 | 0.0002 |
| | (0.26) | (–0.15) | (1.44) | (0.45) | (–0.17) | (0.15) |
| Neighboring country's military expenditure in GDP, lag (–1) | –0.12 | 0.003 | 0.02 | –0.004 | –0.04 | 0.01 |
| | (–1.28) | (0.17) | (0.41) | (–0.12) | (–0.67) | (0.16) |
| Average schooling in labor force, lag (–1) | –0.19 | –0.08 | –0.12 | 0.46 | –1.65 | –0.29 |
| | (–0.68) | (–0.89) | (–0.99) | (2.55) | (–4.87) | (–0.75) |
| Infant mortality rate, lag (–1) | 0.01 | –0.003 | 0.002 | 0.01 | –0.03 | –0.01 |
| | (1.37) | (–0.91) | (0.53) | (1.60) | (–2.38) | (–1.12) |
| Share of agriculture output in GDP, lag (–1) | –0.05 | 0.008 | 0.02 | –0.004 | –0.08 | –0.03 |
| | (–1.17) | (0.65) | (1.12) | (–0.18) | (–1.92) | (–0.56) |
| Adjusted $R^2$ | 0.04 | 0.24 | 0.18 | 0.09 | 0.89 | 0.34 |
| Number of observations | 128 | 128 | 128 | 128 | 128 | 128 |
| Type of model[b] | Random | Random | Random | Random | Random | Random |

*Note*: The results reported here are for estimation of equation 10 in the text. Z-values are in parentheses. The 14 countries in the sample are listed in appendix A.

a. Dependent variables are sectoral government expenditure expressed as a share of gross domestic product (GDP).

b. Indicates whether the country dummies in the regression represent a fixed effects or a random effects model. The test is based on Hausman (1978).

*Source*: Authors' calculations. Government expenditure data are from the IMF's *Government Finance Statistics* (IMF various years).

omitted-variable problem due to the omission of the grants variable. If grants and concessionary loans are positively correlated, then the estimated coefficient on the loan variable will be upwardly biased. Moreover, due to the resulting higher variance, the tests of significance on the coefficient will be conservative.

In each of the six regressions—one each for education, health, energy, agriculture, transport and communication, and defense—the coefficient on the government expenditure net of aid variable, which is statistically significant in all regressions, indicates how the government distributes an additional dollar that it gets from all resources net of concessionary loans. In the past two decades, concessionary loans—certainly in dollar value if not in numbers—have mostly funded economic infrastructure. Data from our sample countries confirm this; loans (in dollar value) to two sectors—transport and communication and energy—account for roughly 29 and 31 percent of all concessionary loans. Data on loans also show that most of the variation occurs in these two sectors.

To analyze aid fungibility, we need to look at the estimate of $\phi$—the fungibility parameter. Table 4 contains the ordinary least squares (OLS) estimates of equation 10, which does not directly give us the estimates of $\phi_k$. We solve for $\phi_k$ from the other coefficient estimates (see table 5). Our results indicate that loans to the transport and communication sector are fully nonfungible, that is, a dollar in concessionary loans given to the sector is fully spent in the sector. The coefficient for the fungibility parameter for the transport and communication sector is 0.09, which is insignificantly different from 0. This can also be seen from table 4, where equation 4-5 has a positive and statistically significant relationship between public spending in and loans to the transport and communication sector; the coefficient on the aid variable is 0.92, which is not statistically different from 1. Moreover, as indicated in table 4, loans to the transport and communication sector appear to stimulate public spending in the health and energy sectors and to dampen public spending on education. The other estimates of $\phi$ (see table 5) indicate that loans to the agriculture and energy sectors are fungible in the sample countries. However, for the education and health sectors, we can not reject any of the null hypotheses of interest (that is, $0 \leq \phi \leq 1$). Based on the available data for these sectors, the power of the test is not enough to reject any reasonable hypothesis. In recent years, the donor community has been increasingly concerned that development assistance is being used directly or indirectly to fund military expenditures. Data from our sample countries do not support the hypothesis that foreign aid is being diverted for military purposes (see table 4, equation 4-6).

The explanation of full nonfungibility of aid in the transport and communication sector is uncertain; possibly donor restrictions designed to reduce fungibility have been more effective in this sector than in others. There could be at least two reasons for this. First, concessionary loans to this sector frequently have matching requirements; the recipient country has to finance a significant part of the project from its own sources in order to receive foreign assistance.

Table 5. *Least Squares Estimates of the Foreign Aid Fungibility Parameter*

| *Sector and type of public spending* | *Fungibility parameter estimate,* $\phi_k$ | *Hypothesis testing results* | | | |
|---|---|---|---|---|---|
| | | *Full fungibility,* $\phi_k = 1$ | *Partial fungibility,* $0 < \phi_k < 1$ | *Nonfungibility,* $\phi_k = 0$ | *All*[a] |
| *Education* | | | | | |
| Total central government | –0.60 | | | | √ |
| | (–1.58) | | | | |
| Total public investment | 0.52 | | | | √ |
| | (0.39) | | | | |
| *Health* | | | | | |
| Total central government | 1.33 | | | | √ |
| | (1.18) | | | | |
| Total public investment | 0.35 | | | | √ |
| | (0.81) | | | | |
| *Energy* | | | | | |
| Total central government | 0.65 | | √ | | |
| | (0.09) | | | | |
| Total public investment | — | | | | |
| *Agriculture* | | | | | |
| Total central government | 1.08 | √ | √ | | |
| | (0.16) | | | | |
| Total public investment | 0.88 | √ | √ | | |
| | (0.10) | | | | |
| *Transport and communication* | | | | | |
| Total central government | 0.09 | | | √ | |
| | (0.24) | | | | |
| Total public investment | 0.07 | | | √ | |
| | (0.24) | | | | |

— Not available.

*Note*: √ indicates that the null hypothesis cannot be rejected at the 5 percent significance level. Standard errors are in parentheses.

a. We cannot reject any null hypothesis within a reasonable range.

*Source*: Authors' calculations based on data for total government expenditures from the IMF's *Government Finance Statistics* (IMF various years) and for total public investment from Easterly and Rebelo (1993).

Second, transport and communication investments are lumpy in nature, providing little scope for reduced government spending.

Table 6 reports the regression results when the dependent variable is taken to be sectoral public investment. Once again we find that concessionary loans to the transport and communication sector are fully nonfungible. In equation 6-4, the coefficient on the loan variable is positive and statistically not different from 1. Thus, a dollar given to the sector increases the public investment in that sector by roughly the same amount (the coefficient for the fungibility parameter for the transport and communication sector, given in table 5, is 0.07, which is not significantly different from 0). Moreover, the loan stimulates investment in the agriculture and health sectors. For considerations of space, we do not report the regression results based on public spending data from *Recent Economic Devel-*

Table 6. *The Impact of Sectoral Concessionary Loans on Sectoral Public Investment, 1971–90*

| | *Dependent variable*[a] | | | |
|---|---|---|---|---|
| *Variable* | *Education, eq. 6-1* | *Health, eq. 6-2* | *Agriculture, eq. 6-3* | *Transport and communication, eq. 6-4* |
| Constant | –0.55 | 0.75 | | 0.35 |
| | (–0.82) | (1.47) | | (0.12) |
| Government expenditure | 0.01 | 0.002 | –0.01 | 0.004 |
| net of aid in GDP | (2.07) | (0.73) | (–1.92) | (0.19) |
| *Sectoral loans (as a share of GDP)* | | | | |
| Education | 0.49 | –0.49 | –0.42 | 2.89 |
| | (1.27) | (–1.93) | (–0.68) | (1.73) |
| Health | –0.56 | 0.65 | 4.18 | –0.81 |
| | (–0.44) | (0.80) | (2.20) | (–0.15) |
| Agriculture | 0.07 | 0.007 | 0.11 | 1.29 |
| | (1.16) | (0.17) | (1.03) | (0.99) |
| Transport and | –0.01 | 0.09 | 0.31 | 1.07 |
| communication | (–0.19) | (2.50) | (3.68) | (4.57) |
| Other sectors | –0.0003 | 0.003 | 0.02 | 0.06 |
| | (–0.03) | (0.48) | (1.81) | (1.69) |
| Real per capita GDP | 0.0002 | 0.0001 | 0.003 | 0.003 |
| | (0.69) | (0.69) | (5.14) | (2.64) |
| Neighboring country's | | | | |
| military expenditure | 0.01 | 0.01 | 0.02 | 0.15 |
| in GDP, lag (–1) | (0.59) | (1.00) | (0.90) | (2.50) |
| Average schooling in | 0.09 | –0.06 | –0.34 | –0.47 |
| labor force, lag (–1) | (1.18) | (–1.18) | (–2.55) | (–1.48) |
| Infant mortality | 0.005 | –0.0003 | 0.01 | 0.005 |
| rate, lag (–1) | (2.43) | (–0.30) | (1.96) | (0.51) |
| Share of agriculture | | | | |
| output in GDP, | –0.002 | –0.004 | 0.007 | –0.02 |
| lag (–1) | (–0.23) | (–0.624) | (0.063) | (–0.55) |
| Adjusted $R^2$ | 0.13 | 0.64 | 0.84 | 0.06 |
| Number of observations | 128 | 128 | 128 | 128 |
| Type of model[b] | Random | Random | Fixed | Random |

*Note*: The results reported here are for estimation of equation 10 in the text. *t*-statistics are in parentheses for the fixed effects model; *Z*-values are in parentheses for the random effects models. The 14 countries in the sample are listed in appendix A.

a. Dependent variables are sectoral public investment expressed as a share of gross domestic product (GDP).

b. Indicates whether the country dummies in the regression represent a fixed effects or a random effects model. The test is based on Hausman (1978).

*Source*: Authors' calculations. Sectoral public investment data are from Easterly and Rebelo (1993).

*opments* (IMF various years). The results are similar to the ones reported for the other two sources (GFS and Easterly and Rebelo).

### *Joint Estimation of the Sectoral Equations*

Our model of aid fungibility outlined in section II yields a system of estimable sectoral equations that are nonlinear in the structural parameters (equation 7).

In each of these equations, there are $K$ aid fungibility parameters ($\phi_k$, $k = 1, \ldots, K$), where $K(\leq S)$ is the number of sectors that receive earmarked aid. The results reported in tables 4 and 6 are based on independent least squares estimates of each sectoral equation as given in equation 10, which is basically a modified form of equation 7. We now jointly estimate the sectoral equations and impose the cross-equation restriction that the aid fungibility parameter $\phi_k (k = 1, \ldots, K)$ is the same across all equations. The system of equations estimated is given by

$$(11) \qquad G_{i,s,t} = \lambda_{0,s} + \beta_s G^N_{i,t} + (1 - \phi_s + \beta_s \phi_s) Aid_{i,s,t} + \sum_{k \neq s}^{K} \beta_s \phi_k Aid_{i,k,t} + \sum_{c=1}^{C} \lambda_{c+3,s} Z_{c,i,t-1} + Error_{i,s,t}$$

for each sector $s$ ($s = 1, \ldots, S$), country $i$ ($i = 1, \ldots, I$), time $t$ ($t = 1, \ldots, T$).

To estimate this system of equations, we use the generalized method of moments (GMM) technique as discussed in Hansen and Singleton (1982). For estimation we use a GMM program written in the software Gauss by Hansen, Heaton, and Ogaki (1993). Coefficient estimates and other statistics are reported in table 7 (using public expenditure data from GFS) and table 8 (using public expenditure data from Easterly and Rebelo).

To eliminate fixed or random effects, we difference the foreign aid and government spending variables on the right-hand side of equation 11. The overidentification tests do not indicate any model misspecification problems; the chi-square tests reported in tables 7 and 8 indicate that the null hypothesis of no model misspecification is not rejected. The test of the hypothesis on aid fungibility is described in table 9. The coefficient for the fungibility parameter for the transport and communication sector continues to be insignificantly different from 0, which indicates that loans to the transport and communication sector are fully nonfungible. This result holds whether we use the numbers for total central government spending in the transport and communication sector from the GFS or the numbers for total public investment from Easterly and Rebelo. The results for the agriculture and energy sectors are mixed. Foreign aid to the energy sector is fungible when we use total central government spending data from the GFS; based on public investment data, however, the null hypothesis that $\phi$ is within a reasonable range ($0 \leq \phi \leq 1$) is not rejected. For the agriculture sector, we find that aid is fungible when the numbers for total public investment are used; for the central government spending data, the test suggests that only unreasonable values of $\phi$ are not rejected. In the social sectors, our results indicate that foreign aid to education is fungible when we use the numbers for total public investment.

### *Foreign Aid and Poverty Alleviation*

Lack of adequate and consistent data, particularly time-series data, on poverty indicators (for example, income by decile) in most developing countries

Table 7. *Joint Estimation of Sectoral Equations Using Government Expenditure Data from GFS, 1971–90*

| Variable | Dependent variable[a] | | | | | |
|---|---|---|---|---|---|---|
| | *Education, eq. 7-1* | *Health, eq. 7-2* | *Energy, eq. 7-3* | *Agriculture, eq. 7-4* | *Transport and communication, eq. 7-5* | *Defense, eq. 7-6* |
| Constant | –1.73 | –0.15 | –0.53 | 0.65 | –0.05 | –1.04 |
| | (–0.78) | (–0.18) | (–0.32) | (0.38) | (–0.65) | (–0.72) |
| Real per capita GDP | 0.0007 | 0.0001 | 0.0002 | –0.0003 | –0.0001 | 0.0003 |
| | (0.0003) | (0.0001) | (0.0001) | (–0.0002) | (–0.0003) | (0.0003) |
| Infant mortality rate, lag (–1) | 0.0005 | 0.0001 | 0.0014 | –0.0018 | 0.0039 | 0.0031 |
| | (0.0022) | (0.0005) | (0.0008) | (–0.0015) | (0.0022) | (0.0021) |
| Neighboring country's military expenditure in GDP, lag (–1) | 0.0587 | –0.0013 | 0.0098 | –0.0192 | –0.0135 | 0.0150 |
| | (0.0250) | (–0.0066) | (0.0103) | (–0.0116) | (–0.0233) | (0.0229) |
| Share of agriculture output in GDP, lag (–1) | 0.0274 | 0.0034 | 0.0069 | –0.0058 | –0.0060 | 0.0159 |
| | (0.0129) | (0.0036) | (0.0051) | (–0.0066) | (–0.0129) | (0.0134) |
| *Common to all equations* | | | | | | |
| Share of sectoral aid in GDP, $\beta_i$ | 0.11 | 0.02 | 0.01 | 0.03 | 0.07 | 0.09 |
| | (0.03) | (0.01) | (0.01) | (0.01) | (0.02) | (0.02) |
| Fungibility parameter, $\phi_i$ | –2.99 | –3.96 | 0.92 | 1.90 | –0.21 | |
| | (–2.61) | (–1.61) | (0.06) | (0.15) | (–0.28) | |
| Chi–square | 13.4 | | | | | |
| Probability | 0.99 | | | | | |
| Degrees of freedom | 30 | | | | | |
| Number of observations | 104 | | | | | |

*Note*: The results reported here are for estimation of equation 11 in the text. Standard errors are in parentheses. The 14 countries in the sample are listed in appendix A.

a. Dependent variables are sectoral government expenditures expressed as a percentage of gross domestic product (GDP).

*Source*: Authors' calculations. Sectoral government expenditure data are from the IMF's *Government Finance Statistics* (IMF various years).

Table 8. *Joint Estimation of Sectoral Equations Using Government Expenditure Data from Easterly and Rebelo, 1971–90*

| | *Dependent variable*[a] | | | |
|---|---|---|---|---|
| *Variable* | *Education, eq. 8-1* | *Health, eq. 8-2* | *Agriculture, eq. 8-3* | *Transport and communication, eq. 8-4* |
| Constant | –0.07 | –0.01 | 0.05 | –0.02 |
| | (–0.13) | (–0.05) | (0.11) | (–0.33) |
| Real per capita GDP | 0.0001 | –0.0002 | –0.0004 | 0.0001 |
| | (0.0006) | (–0.0004) | (–0.0006) | (0.0001) |
| Infant mortality rate, lag (–1) | 0.0002 | 0.0003 | –0.0003 | 0.0001 |
| | (0.0009) | (0.0004) | (–0.0007) | (0.0023) |
| Neighboring country's military expenditure in GDP, lag (–1) | 0.0039 | –0.0004 | –0.0008 | 0.0096 |
| | (0.0071) | (–0.0041) | (–0.0077) | (0.0377) |
| *Common to all equations* | | | | |
| Share of sectoral aid in GDP, $\beta_i$ | 0.001 | 0.0004 | 0.003 | 0.017 |
| | (0.002) | (0.001) | (0.004) | (0.024) |
| Fungibility parameter, $\phi_i$ | 1.57 | 45.44 | 0.99 | –0.25 |
| | (0.41) | (66.07) | (0.06) | (–0.13) |
| Chi-square | 14.19 | | | |
| Probability | 0.72 | | | |
| Degrees of freedom | 18 | | | |
| Number of observations | 104 | | | |

*Note*: The results reported here are for estimation of equation 11 in the text. Standard errors are in parentheses. The 14 countries in the sample are listed in appendix A.

a. Dependent variables are sectoral government expenditures expressed as a percentage of gross domestic product (GDP).

*Source*: Authors' calculations. Sectoral government expenditure data are from Easterly and Rebelo (1993).

precludes a systematic analysis of the relationship between foreign aid and poverty alleviation. It is possible, however, to measure the impact of foreign aid on a few human development indicators such as infant mortality rate and school enrollment ratios.

Equation 10-1 in table 10 reports the regression of the rate of change in infant mortality on per capita, net concessionary loans given to the health sector. Both the contemporaneous and the one-period lagged value of the concessionary loan have a negative and significant relationship with infant mortality. Together, the coefficients indicate that if the health sector received concessionary loans equal to $1.00 per capita, infant mortality would fall nearly a third. Given the mean value of the loan variable ($0.03) in the sample, this implies that doubling the existing amount of per capita concessionary loans to the health sector would reduce infant mortality 1 percent. In Bangladesh, one of our sample countries, infant mortality in 1992 was 110 deaths per 1,000 live births. A 1 percent reduction in infant mortality would save 1.1 lives (per 1,000 live births); if there are 5 million live births in a year in Bangladesh, 5,500 infants would be saved. Although concessionary loans to the health sector in developing countries have

Table 9. *Joint Estimates of the Foreign Aid Fungibility Parameter, 1971–90*

| *Sector and type of public spending* | *Fungibility parameter estimate,* $\phi_k$ | *Hypothesis testing results* | | | | |
|---|---|---|---|---|---|---|
| | | *Full fungibility,* $\phi_k = 1$ | *Partial fungibility,* $0 < \phi_k < 1$ | *Non-fungibility,* $\phi_k = 0$ | *All*[a] | *Unreasonable*[b] |
| *Education* | | | | | | |
| Total central government | –2.99 (–2.61) | | | | √ | |
| Total public investment | 1.57 (0.41) | √ | √ | | | |
| *Health* | | | | | | |
| Total central government | –3.96 (–1.61) | | | | | √ |
| Total public investment | 6.67 (2.06) | | | | | √ |
| *Energy* | | | | | | |
| Total central government | 0.92 (0.06) | √ | √ | | | |
| Total public investment | 45.44 (66.08) | | | | √ | |
| *Agriculture* | | | | | | |
| Total central government | 1.90 (0.15) | | | | | √ |
| Total public investment | 0.99 (0.06) | √ | √ | | | |
| *Transport and communication* | | | | | | |
| Total central government | –0.20 (–0.28) | | | √ | | |
| Total public investment | –0.25 (–0.13) | | | √ | | |
| *Other*[c] | | | | | | |
| Total central government | 1.68 (0.20) | | | | | √ |
| Total public investment | 8.57 (9.80) | | | | √ | |

*Note*: √ indicates that the null hypothesis cannot be rejected at the 5 percent significance level. Standard errors are in parentheses.

a. We cannot reject any null hypothesis within a reasonable range.

b. Only unreasonable parameter values are not rejected.

c. Public spending not allocated to the specified sectors.

*Source*: Authors' calculations based on data for total government expenditures from the IMF's *Government Finance Statistics* (IMF various years) and for total public investment from Easterly and Rebelo (1993).

been historically low—accounting for only one-third of a percent of all concessionary loans—the evidence suggests that the poor are receiving the benefits of these aid programs.

The other significant variable in the regression (equation 10-1 in table 10) is real per capita GDP, which has a negative relationship with infant mortality. The

sign is what would be expected: rich countries have low infant mortality. The positive but statistically insignificant relationship between infant mortality and public health spending is not necessarily surprising. Together, these results indicate that the intrasectoral allocation of public resources in the health sector does not benefit the poor. Boone (1994) reports that foreign aid does not significantly improve infant mortality. Our analysis also shows that there is no significant impact of aid on infant mortality when we regress the latter on aggregate aid. Using the aggregate aid variable, ODA, we also find no impact of aid on infant mortality (the results are not reported here). However, we find that foreign aid given to the health sector in the form of concessionary loans does improve infant mortality.

Our data do not support any significant links between aid to the education sector and primary school enrollment (see equation 10-2 in table 10). In fact, none of the independent variables in equation 10-2 is statistically significant. It

Table 10. *The Impact of Concessionary Loans on Social Indicators, 1971–90*

| *Variable* | *Rate of change in infant mortality, eq. 10-1* | *Rate of change in primary school enrollment, eq. 10-2* |
|---|---|---|
| Constant | | 0.89 |
| | | (0.20) |
| Per capita health expenditure | 0.05 | |
| | (0.35) | |
| Per capita health expenditure, lag (–1) | 0.17 | |
| | (0.91) | |
| Per capita concessionary loans to the health sector | –14.26 | |
| | (–4.75) | |
| Per capita concessionary loans to the health sector, lag (–1) | –18.48 | |
| | (–6.04) | |
| Per capita education expenditure | | –0.25 |
| | | (–0.49) |
| Per capita education expenditure, lag (–1) | | 0.31 |
| | | (0.57) |
| Per capita concessionary loans to the education sector | | –4.57 |
| | | (–0.60) |
| Per capita concessionary loans to the education sector, lag (–1) | | 3.31 |
| | | (0.44) |
| Real per capita GDP | –0.01 | –0.001 |
| | (–2.30) | (–0.61) |
| Population growth rate | –1.78 | –0.12 |
| | (–1.45) | (–0.10) |
| Adjusted $R^2$ | 0.68 | 0.04 |
| Number of observations | 105 | 105 |
| Type of model[a] | Fixed | Random |

*Note*: Per capita numbers are in real 1987 dollars. *t*-statistics are in parentheses for the fixed effects model (infant mortality); *Z*-values are in parentheses for the random effects model (primary school enrollment). The 14 countries in the sample are listed in appendix A.

a. Indicates whether the country dummies in the regression represent a fixed effects or a random effects model. The test is based on Hausman (1978).

*Source*: Authors' calculations.

is possible that either the model is misspecified or the lag structure of the independent variables is not rich enough to decipher any kind of relationship. Alternatively, the fungibility of aid to education may be part of the explanation.

## IV. Conclusion

This article empirically examined the relationship between foreign aid and public spending in developing countries. Using a model of aid fungibility, we derived an equation that could be used to estimate the effect of foreign aid on aggregate public spending as well as various components of public spending. For the empirical analysis, we put together a panel data set that includes annual time-series observations from 1971 through 1990 on 14 developing countries. This was the largest sample that satisfied our data requirements, and most of the results reported in this article are based on this sample.

At the aggregate level we did not find aid to be fungible nor any associated tax relief. However, when we used a larger sample—annual time-series data from 1970 through 1990 on 38 countries—we found that aid is fungible and part of the funds are used for tax reduction. This diversity is in line with the available results in the literature on foreign aid. Our empirical results also showed that a fraction of development assistance shows up in increased public investment.

In analyzing the impact of foreign aid on different components of public spending, we found that most aid is indeed fungible. Earmarked concessionary loans given to the agriculture, energy, and education sectors are diverted, and only loans to the transport and communication sector are fully spent on the purposes intended by the donor. The explanation for the latter is uncertain; possibly donor restrictions designed to reduce fungibility have been more effective in this sector than in others. These sectoral fungibility results were based on a sample of 14 developing countries for which aid is not fungible at the aggregate level. For the larger sample of 38 countries, we found that aid is fungible even at the aggregate level; lack of data, however, prevented the sectoral fungibility analysis. It is likely that if data had been available, the evidence on sectoral aid fungibility could have been strengthened.

Overall, our findings suggest two policy implications. First, the success of an aid program should not be judged by the proportion of assistance going to capital expenditure. Second, because most aid appears to be fungible, linking foreign aid to an overall public expenditure program that provides adequate resources to crucial sectors may be a better way of transferring resources to developing countries.

## Appendix A. The Panel Database

We constructed a panel database using annual data from 1971 through 1990 for developing countries. In the regression analysis, we used three sets of expen-

diture data: total and sectoral expenditure data at the consolidated central government level from the IMF's *Government Finance Statistics* (various years) and from the IMF's *Recent Economic Developments* (various years) and total and sectoral public investment data at the consolidated general government level from Easterly and Rebelo (1993). We used two sets of data on foreign aid: net disbursement of aggregate overseas development assistance from OECD (1994) and net disbursement of concessionary loans (overall as well as by sectors) from World Bank sources.

### *Sample Selection*

The main sample used in the empirical analysis (tables 2–10) is based on 128 observations from 14 developing countries (see the country list below). To collect our sample, we started with the database of Easterly and Rebelo (1993), which has a new measure of public investment that incorporates investment by all levels of government as well as by public enterprises. Data on public investment in GFS and *Recent Economic Developments* are incomplete in this sense. To construct a meaningful panel for the statistical analysis, we included a country from the Easterly and Rebelo database in our sample if at least 35 percent of the annual observations were available on each of the public investment variables used in the regression analysis. From a total of 166 countries, 27 met this criterion. We dropped four of these 27 countries because they did not have related GFS expenditure data on the same variables. The objective was to have the same set of countries from all three databases. In the final analysis, only 14 of the 23 countries were chosen because only these had the required information on all the relevant variables (including the control variables) in the regression.

Table 1 in the text presents aggregate fungibility results based on a sample of 309 observations—annual time-series data from 1971 through 1990 on 38 countries (see country list below). When we chose this sample, we included a country if at least 35 percent of the annual observations were available for each of the variables used in the regression. This was the largest sample size available that satisfied our data requirement.

### *Countries*

Countries are classified by regions and by income levels according to the World Bank classification of country group (World Bank 1994). The 14-country sample contains Bangladesh, Costa Rica, Ecuador, Egypt, Honduras, Kenya, Malawi, Malaysia, Mexico, Peru, Sierra Leone, Thailand, Turkey, and Zaire. The 38-country sample contains Argentina, Bangladesh, Bolivia, Brazil, Chile, Cameroon, Colombia, Costa Rica, Ecuador, Egypt, El Salvador, Ghana, Honduras, Indonesia, Jamaica, Kenya, Republic of Korea, Liberia, Malawi, Malaysia, Mali, Mexico, Pakistan, Paraguay, Peru, the Philippines, Senegal, Sierra Leone, Sri Lanka, Sudan, Thailand, Tunisia, Turkey, Uruguay, Venezuela, Zaire, Zambia, and Zimbabwe.

### *Data Sources*

- Data on public investment are from Easterly and Rebelo (1993), IMF (*Government Finance Statistics*, *International Financial Statistics*, and *Recent Economic Developments*, various years), and national accounts data from the World Bank's database
- Data on foreign aid are from *Geographical Distribution of Financial Flows to Aid Recipients* (OECD 1994) and from World Bank data
- Data on exchange rate are from International Currency Analysis, Inc. (various years)
- Data on infant mortality rate are from U.N. Social Indicators
- Data on average years of schooling in the labor force are from Barro and Lee (1993) and Nehru, Swanson, and Dubey (1993)
- Data on military expenditures of neighboring countries are from Landau (1994)
- Data for the agriculture output to GDP ratio are from United Nations.

## APPENDIX B. THE UTILITY FUNCTION

Let the utility function be of the Stone-Geary form:

$$U[c_p, g^{E_1} g^{E_2}] = F(c_p) + \prod_{j=1}^{2} (g^{E_j} - \gamma_j)^{\beta_j} \tag{B-1}$$

where $c_p$ is a private good, $g^{Ej}$ are public goods ($j = 1$ for current expenditures; $j = 2$ for capital expenditures), $E_1$ and $E_2$ represent current and capital expenditures; $\gamma_j$ are subsistence quantities of the public goods and are positive; and $\beta_j$ satisfy the condition $\Sigma\beta_j = 1$. If $A$ is the total amount of foreign aid, and $R$ is all other sources of government revenue, then the budget constraint faced by the government is:

$$p_1 g^{E_1} + p_2 g^{E_2} = R + A \tag{B-2}$$

where $p_1$ and $p_2$ are the prices of public current and capital goods, respectively. Maximizing equation B-1 subject to the budget constraint in equation B-2 yields, if the solution exists and is interior, the following system of linear expenditure equations:

$$p_j g^{E_j} = p_j \gamma_j + \beta_j \left( R + A - \sum_{j=1}^{2} p_j \gamma_j \right). \tag{B-3}$$

Since $R$ is all sources of finance—domestic and foreign—except foreign aid, it can be measured by $G^N$, which is total government spending net of foreign aid. By substituting $G^N$ for $R$ and simple manipulation, equation B-3 can be written as

$$\text{(B-4)} \qquad G^{E_i}_{i,t} = \delta_{0,i} + \delta_1 G^N_{i,t} + \delta_2\, Aid_{i,t} + \sum_{c=1}^{C} \delta_{c+2} Z_{c,i,t-1} + v_{i,t}$$

$$\text{where } G^{E_i} = p_i g^{E_i}$$

and where $Aid_{i,t}$ is the share of net disbursement of total foreign aid in GDP, $Z_{c,i,t-1}$ is a vector of control variables (see section III of the text), and v is the error term.

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