ABSTRACT

Title of dissertation: A STUDY OF PUBLIC FINANCE AND FISCAL MANAGEMENT IN DEVELOPING COUNTRIES

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This dissertation consists of three self-contained chapters, mostly with an empirical emphasis, investigating different aspects of public finance and fiscal management in developing countries. The first chapter is a study of the impact of decentralization on urban public good provision, with a focus on developing countries. This work is unlike others on the subject in at least two ways. First, it examines decentralization and pubic good provision at the city rather the country level. Second, it treats decentralization as endogenous rather than exogenous, recognizing that its extent and nature are influenced by institutional and other factors. The second and third dissertation chapters deal with the fungibility of foreign aid – the fact that aid intended for a particular purpose sometimes merely substitutes for spending the government would have undertaken anyway. The second chapter examines the fungibility of foreign aid given to states in India, while the third chapter investigates fungibility in the context of Sub-Saharan African countries.

A STUDY OF PUBLIC FINANCE AND FISCAL MANAGEMENT IN DEVELOPING COUNTRIES

by

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Chapter 1

Decentralization and the Provision of Local Public Goods: An Empirical Analysis[1]

Chapter Abstract

This is perhaps the first study to use city-level data – from many different types of cities round the world – to examine the impact of decentralization on urban public good provision. But, more importantly, it is also one of the few studies to treat decentralization as endogenous rather than exogenous, recognizing that its extent and nature are influenced by institutional and other factors that may in turn affect public good provision. The results suggest that some public good output and impact indicators are indeed higher in cities with decentralized provision than in other cities. There is some evidence, furthermore, that these increased levels – where they occur – are the result of more efficient provision in the decentralized cities. When the endogeneity of decentralization is corrected for, however, decentralization itself is found to have no impact on public good provision. This suggests that the differences between decentralized and other cities in public good provision should be attributed not to decentralization itself, but rather to other factors common to decentralized cities.

[1] The author wishes to express his sincere appreciation for all the tremendous help and guidance he has received in this and other endeavors, from his advisor Maureen Cropper. In addition, the author is indebted to Professors Roger Betancourt, Wallace Oates, Andrew Lyon, Lars Olson and Bill Evans for very helpful guidance and comments. All mistakes, omissions and failings are, of course, attributable solely to the author.

1.1 Introduction

Decentralized government – long a feature of many developed economies – is becoming increasingly popular elsewhere as well. Of the 75 developing countries with population over 5 million in the 1990s, 63 embarked on some form of decentralization (Devarajan et al., 1999). It is now common for economic reform plans to include a decentralization component, particularly when they involve the provision of public goods such as education, health care and running water (Dillinger, 1994). This trend is apparently encouraged by policy advice from aid donors; 12% of World Bank projects completed between 1993 and 1997, for example, involved decentralization (Litvack et al., 1998).

Yet, this may be an example of the cart coming before the horse. To date, there is little systematic empirical research on the impact of decentralization in developing countries (World Bank, 1997). Many case studies have been conducted (e.g. Freinkman and Yossifov, 1999; World Bank, 1996; Xie, Zou and Davoodi, 1999; Zhang and Zou, 1996). Some have made casual comparisons between countries with and without decentralized systems or sectors (e.g. Blair, 2000; Kolehmainen-Aitken, 1999; McLean and King, 1999; Parker, 1995). While these exercises are enlightening, it may be misleading to draw broad conclusions from them. To do this, rigorous research using cross-country data is needed.

The few existing examples of such research have their own shortcomings. First, they have largely dealt with decentralization at the macroeconomic level, rather than in individual sectors such as public education and public health care. The focus has typically been on the relationship between decentralization – measured as the proportion of overall public expenditure or revenue accounted for by subnational governments – and variables such as economic growth, government size and government deficits (e.g. Davoodi and Zou, 1998; Estache and Sinha, 1995; Jin and Zou, 2000; and Fornasari et al., 1998).

There are a handful of exceptions: Prawda (1992) and Humplick and Moini-Araghi (1996) analyze the impact of decentralizing the provision of education and roads respectively, while Humplick and Estache (1995) do the same for electricity and water provision. But even these suffer from a major flaw: they treat the degree of decentralization as exogenous. Yet in practice, the extent and nature of decentralization are not randomly determined; they are influenced by institutional factors such as the quality of governance and structure of government, as well as by other determinants (Dillinger, 1994; Litvack et al., 1998; Potter, 1993). But, these same factors are also likely to affect cost-efficiency, output and overall performance in public-good provision sectors. Ignoring the endogeneity of decentralization in empirical analyses can be expected to cause serious bias in the results obtained.

This paper is an attempt to address these failings in the empirical literature. Focussing on the provision of urban water services, health care and education, it uses regression analysis to estimate the impact of decentralization at the local-government level on available output and performance indicators. In each case, the endogeneity of decentralization is addressed by using a two-stage estimation technique, with decentralization as the dependent variable in the first-stage regression. The results show that decentralization has no impact on the measured indicators.

To illustrate the importance of recognizing the endogeneity of decentralization, a separate set of regressions is performed, with decentralization treated this time as exogenous. In this case of deliberate misspecification, decentralization does indeed have an apparent impact on most performance indicators. This shows that ignoring the endogeneity of decentralization – as most researchers to date have done – leads to biased results: Policy advice formulated without regard to institutional and other determinants of decentralization is likely to be misplaced. The next section contains a more thorough discussion of these issues.

The paper is structured as follows. Section 1.2 explains in greater detail the importance of taking into account the endogeneity of decentralization when studying its impact. Section 1.3 presents a simple theoretical model to motivate the empirical analysis. Section 4 describes the empirical models and data used for the analysis, paying particular attention to how the decentralization variables are constructed. Sections 1.5 to 1.7 present the results from the empirical work, and Section 1.8 provides some concluding comments.

1.2 Addressing the Right Policy Question

If the world were a test-tube, a researcher would choose the most methodologically correct approach towards studying decentralization: a sample of countries would be randomly chosen, decentralization would be implemented in these alone, and the resultant effects would be examined, using countries without decentralization as controls.

Unfortunately, such an experiment is not feasible in the real world; researchers must draw conclusions from the experiences of countries that have decentralized of their own accord. But decentralization is more likely to occur under some circumstances than others. If differences in such circumstances are not allowed for, conclusions based on the countries that have decentralized may be inapplicable in other countries. This is why "case studies" of decentralization – of which there are a growing number – may be of less value than expected.

But the typical approach used in most econometric cross-country studies of decentralization – including all those cited in the Introduction – may also be of limited value. Since they treat decentralization as a random or exogenous event, political, institutional and other determinants of this event are not taken into account. Because these same factors may have an economic impact in their own right, ignoring them may cause bias in the impacts attributed to decentralization. In other words, treating decentralization as exogenous may lead to inaccurate conclusions: The extent and nature of decentralization are really endogenous, and should be treated as such.

1.3 Using Output and Revenue as Performance Indicators in Public Good Provision: Insights From a Simple Theoretical Model

When studying the decentralization of local public goods such as running water and health care, the available data are typically limited to indicators of output, coverage, user fees if any, and taxes or government revenue – as well as impact measures such as literacy levels and infant mortality. Inferences must usually be drawn from observing changes in these variables. This section presents some insights into how this can be done, using a simple theoretical model for illustration.

Decentralization can affect public good provision in four main ways. First, it may lead to greater allocative efficiency and increased choice, by allowing people to select from a range of localities with different tax and public good characteristics (Oates, 1972; Tiebout, 1956). Second, it can affect the cost, quantity and quality of public good provision through changes in economies of scale, or in the quality of public-sector management. Third, local governments may be more in touch with local preferences than central or state governments, and may thus be better able to attain socially optimal outcomes in the provision of local public goods (Inman and Rubenfeld, 1997; Rondinelli, 1990; World Bank, 1997). Finally, lower-level governments may place a smaller – or larger – emphasis than higher-level ones on the use of public good provision for redistributive purposes.

The first of these – the impact of decentralization on allocative efficiency – is difficult to measure in practice, and is not dealt with in this paper. The other three effects could also be the result of changes other than decentralization, such as changes in the quality and nature of governance or in other institutional factors. Whatever their cause, these effects – particularly the impact on the cost, quantity and quality of public good provision – are the main focus of this paper, and will be analyzed with the help of the model to be presented now.

But before this is done, it is important to clarify the distinction, in the context of the model, between the quantity and the quality of public goods.[2] Both of these are

[2] I wish to express my thanks here to Prof. Roger Betancourt for highlighting the importance of this.

important; they both affect utility, and they can be thought of as two different dimensions of the output of a public good. It is possible to model both at the same time; a starker picture can, however, be presented by focusing on changes in one, while assuming the other is held constant. This is the approach followed below. There is only one public good in the model, and the focus is on the optimal output or consumption level of this good. "Output" or consumption can be interpreted in two ways. First, it can be thought of as quantity, with quality being held constant in the model; this is the most obvious interpretation. But alternatively, "output" can be thought of as quality, with quantity being held constant.[3] This interpretation works just as well, as long as one accepts the notion that standard techniques used to model optimal output quantity – such as the use of a constant returns-to-scale production function with output quantity as one argument – are also applicable to the modelling of optimal output quality. To be sure, more sophisticated approaches for modelling product quality have been developed in the literature (e.g. Dreze and Hagen, 1978; Leffler, 1982; Schmanlensee, 1978); integrating them into a model of public good provision may lead to useful insights, but this is not attempted here.

The framework used below could, in fact, be extended so that the optimal levels of both dimensions of public good output – rather than just one of them – have to be determined. One way of doing this would be to treat the two dimensions as if they were the output levels of two separate goods. The qualitative conclusions would then be broadly similar to those in the one-output case below, as long as the same basic

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[3] One could, for example, assume that the quantity demanded – but not the quality demanded – of a public good such as running water is completely inelastic. Then, assuming the government in charge supplies the fixed quantity demanded, the question then is how to determine the optimal quality.

model was used.[4] In the empirical section of the paper, quantity as well as quality measures of public good output are included in the analysis.

The model focuses on a jurisdiction with identical residents, in an economy where individuals are immobile across jurisdictions. The representative individual's utility U is given by:

$$U = U(C, G) \qquad \text{...(1.1)}$$

where C and G are her consumption of a composite private commodity and a local public good, respectively. The variable G could represent either the quantity (with quality held fixed) or the quantity (with quantity held fixed) of the local public good. For both types of consumption, marginal utility is positive ($U_C > 0$, $U_G > 0$) but diminishing ($U_{CC} < 0, U_{GG} < 0$). The two types of consumption are separable in the utility function.[5]

The local public good is "public" in the sense that it is supplied by the government, possibly through private-sector contracting. In other respects, however, it is similar to a private good; nonrivalrousness and nonexcludability do not apply. In the empirical analysis, the definition of a "public" good is extended to allow for partial – or in some cases full – provision by the private sector.

Local economic affairs, including provision of the local public good, are handled entirely by one level of government – either local or central – at any one

[4] The two dimensions of output – quality and quantity – would both be arguments in the utility function as well as the production function, which would exhibit constant returns to scale – as it does in the model presented below. See footnote 8 for an example of how the utility and production function in this case could be specified.

[5] This means that U_C is independent of G, and U_G is independent of C.

time.[6] Provision is funded using part of the proceeds from a lump-sum tax T on personal income. (The possibility of funding the public good through user fees is discussed later.) The rest of the tax revenue – an amount s – goes towards a budget covering administrative expenses in the public sector. The size of this budget depends on how well the public sector is managed; poor management leads to unnecessarily large expenses and corruption. The value of s is fixed; but it can change when an exogenous event occurs, such as decentralization or a change in the institutional environment.

Our representative resident supplies an amount L of labor, and owns K units of capital. Both of these are fixed in quantity; their rates of return in equilibrium are r and w respectively. The individual budget constraint is thus given by:

$$wL + rK = T + C \qquad ...(1.2)$$

where the price of the private commodity is normalized to one.

The production function exhibits constant returns to scale, and can therefore be expressed in per-capita terms:[7]

$$C + bG + s = F(K, L) \qquad ...(1.3)$$

where b is a cost parameter whose value depends partly on the quality of public-sector management. Exogenous factors that affect the latter – including decentralization and various types of institutional changes, such as changes in corruption levels – are likely

[6] The model and results would remain unchanged if the comparison were between the local government and some other higher-level government, such as the state or provincial government.

[7] In the case of centralized government with heterogenous jurisdictions, the government may cross-subsidize across jurisdictions for redistributive purposes, imposing lower tax rates and/or providing more of the public good in poorer jurisdictions. This amounts to taking some of the output in the richer jurisdictions - either of the private or public good - and giving it to consumers in the poorer jurisdictions. To model this, equation (1.3) needs to be appropriately modified; for simplicity, I abstract

to change the value of b. Similarly, b may change for technology-related reasons; it will rise under decentralization, for example, if the local government has less technical know-how than the central state government, or reduced access to some fixed factor of production.[8] [9]

1.3-I The Outcome When the Government Maximizes Utility

Assume first that the government in charge of the economy – local or central – is fully aware of the residents' preferences, and aims to maximize utility. Utility maximization does *not* preclude poor public-sector management; the quality of this management is, however, assumed to be exogenous to the maximization problem. Any changes in this quality acts through changes in the parameters b and s, which reflect the public good provision cost and the size of the administrative government budget, respectively.

A utility-maximizing government would maximize U, given by equation (1.1), subject to the production constraint given by equation (1.3). More details of the optimization procedure are given in Part 1 of Theoretical Appendix 1.1. Using equation (1.3) to substitute C out of the utility function, and maximizing with respect to G, the following is obtained:

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from such considerations in the current analysis; the question of redistributive public good provision, though within rather than across jurisdictions, is addressed below.

[8] If diseconomies of scale are introduced into the model, decentralization would automatically raise b; changing the model in this way, however, would add unnecessary complexity, and would not substantially change the qualitative results.

[9] Earlier, in Section 1.3, it was noted that this model could be extended to include two dimensions of output of the local public good (instead of one as in the present model) – quantity and quality. One way of doing this would be to use a production function such as the following: $C + h(Q_G^T Q_G^L) + s = F(K, L)$ where Q_G^T and Q_G^L are the quantity and quality of the public good, respectively; and where the function h(.) exhibits constant returns-to-scale. It can then be shown that similar conclusions would be obtained as in the present model, where there is just one dimension of output.

$$\frac{U_G}{U_C} = b \qquad \ldots(1.4)$$

This equation is merely a version of the Samuelson condition for optimal provision of public goods: the marginal willingness to pay $\frac{U_G}{U_C}$ (or *MWTP*) should be set equal to the marginal provision cost b (or *MC*) (Samuelson, 1954).[10] When expressed as functions of G, *MWTP* and *MC* can be thought of as inverse demand and supply functions, respectively, for the public good. This is illustrated diagramatically in Figure 1.1, where the optimal public good output level is G_2 – the quantity which equates *MWTP* with *MC*.

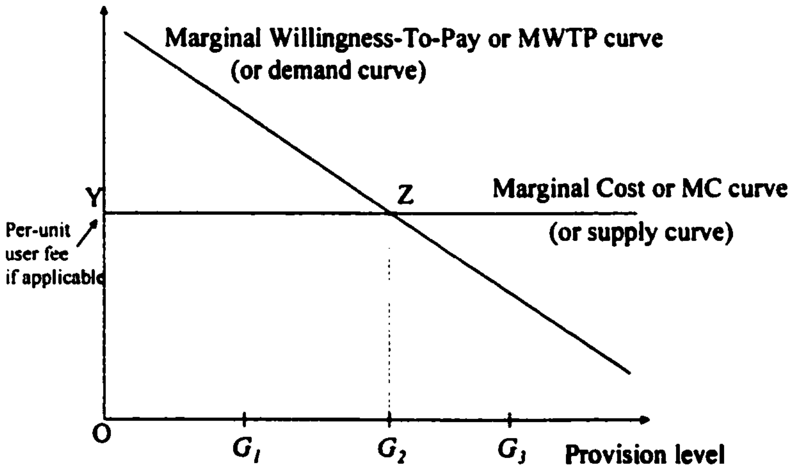

Figure 1.1

[10] The original Samuelson rule actually says that the *sum* of all individuals' marginal willingness-to-pay should be equal to the marginal provision cost. In the current context, this rule is modified since the good in this model does not have the "pure" public-good properties of nonrivalrousness and nonexcludability.

Now assume there is a fall in the marginal provision cost *b*, for technology-related reasons, or due to improved public sector management; the latter could, in turn, be caused either by decentralization or by some other political or institutional change. The parameter *s* is held constant for now. The fall in *b* amounts to a downward shift in the marginal cost curve, as shown in Figure 1.2, causing public good provision to rise from G_2^A to G_2^B. The impact of a change in *b* is analyzed in full in the Theoretical Appendix 1.1 (Part 1), and summarized in Table 1.1.

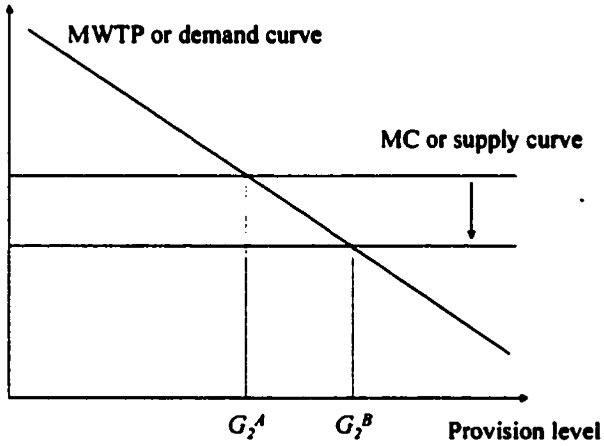

Figure 1.2

Next, consider the case of a fall in the size *s* of the administrative government budget – due either to decentralization, or to other political or institutional changes – with *b* held constant. A fall in *s* increases individuals' after-tax income, thereby raising their marginal willingness to pay for the public good; the *MWTP* (or inverse demand) curve thus shifts rightward, and the optimal provision level of the public good rises. Again, the impact of a fall in *s* is analyzed in detail in Theoretical Appendix 1.1 (Part 1), and summarized in Table 1.1.

The preceding results were derived for the case of a public good whose quantity is fixed for consumers, and chosen by the government. But local public goods are often funded through a combination of user fees and taxes; in some cases user fees are the only financing instrument employed. In the latter scenario, consumers select the quantity of the public good, rather than the government; their choice depends, of course, on the level of the per-unit user fee. The government may subsidize or tax the good, if it wishes, by selecting a fee that is different from the marginal provision cost.[11]

The outcome in the user-fee case is in fact exactly equivalent to that in the theoretical model above, where the public good is fully funded from taxes; this is shown in Part 2 of Theoretical Appendix 1.1. The per-unit user fee is set equal to the *MWTP* and the *MC* (or the inverse demand and supply curves) in equilibrium, and the quantity of public good chosen by consumers is the same as the level chosen by the government in the tax-funded case. The results obtained in the tax-funded model above are thus equally applicable to the user-fee case.

1.3-II Underprovision or Overprovision by the Government

In the preceding section, the government in charge of the economy was assumed to be utility-maximizing. In practice, of course, this may not be the case. The government may select a suboptimal output of the public good, such as G_1 in Figure 1.1; or it may choose an excessively high output level such as G_3. One reason for this is that governments may not in practice be fully aware of citizens' preferences;

[11] In general, there is no reason to do this in situations with identical consumers; utility is maximized by setting a user fee equal to the marginal provision cost, and by avoiding excess demand or supply – i.e. by supplying a quantity equal to the quantity demanded.

another is that governments may simply lack the incentive to do what is best for the people.

Underprovision could also be defined as output levels that are too low because of imperfect or badly-functioning capital markets. For example, the initial outlay needed for water piping or health facility infrastructure may be high, even if this can easily be recovered in the future through user fees or other revenue sources. Thus, if the government is credit-constrained, this infrastructure may not be built even if the total willinngess-to-pay for it exceeds the total cost, in present value terms.[12]

The government's ability or willingness to maximize utility may be altered by an exogenous event, such as decentralization or some political or institutional change. Some argue that decentralization brings an economy closer to the socially optimal outcome, because local governments are more in touch with citizens' preferences than central or state ones (Inman and Rubenfeld, 1996; World Bank, 1997).

In the current context, bringing the economy closer to the socially optimal outcome means either increasing provision (in the case of underprovision) or reducing it (in the case of overprovision). Between underprovision and overprovision, it is more likely that the former is the case, at least in developing countries – especially if one counts low provision levels due to imperfect capital markets as underprovision. To illustrate the prevalence of underprovision, consider the many cases cited in practice where people – especially in poorer areas – lack water connections even though their

[12] This argument does not apply if the restrictions on government borrowing are counted as a real cost, and are factored into the marginal provision cost b of the public good. In that case, the provision level would be optimal, but this optimal level would be low. Technically, this approach is analyzed in a different way from the one in the text, where the cost of borrowing is not included in b; the result using both approaches are, however, similar in practice.

MWTP for these exceeds the provision cost. Indeed, they often purchase water from private water vendors, although this means paying much more than they would for appropriately-priced water connections (Roth, 1987; Serageldin, 1994). The same is likely to apply for public goods such as education and health care, especially if the positive externalities associated with these are taken into account.

By contrast, it is difficult to think of good examples in practice of overprovision. It may be the case that governments are unaware of residents' preferences, which could cause overprovision; but this could also cause underprovision. Overall, the latter is more likely than the former. In sum, increased public good provision in many developing countries is likely to be welfare-enhancing, ceteris paribus, because there was probably underprovision to begin with.

1.3-III The Use of Public Good Provision for Redistributive Purposes

In the model presented above, all individuals are identical, and have the same income. Yet in practice governments often use public good provision partly to redress imbalances between the living standards of the rich and the poor. This is especially true in developing countries, where tax evasion and weak institutions can make redistributive taxation difficult to implement (Newbery, 1987).

But the model can be readily extended to include two types of individuals, one rich and poor; redistributive concerns can then be taken into account. This extended model can be used to analyze the outcome when decentralization – or some other institutional or political change – causes a change in the weight placed by the government on redistribution.

Part 4 of Theoretical Appendix 1.1 presents an extended model and an analysis along these lines. One of the results obtained is that an increased emphasis on redistribution causes – unsurprisingly – a greater amount of the public good to be provided to the poor. It also leads to an increase in the total supply of the good in the economy, and in total taxes (or total user fees collected). The converse results apply, of course, if there is a reduced emphasis on redistribution.

1.3-IV Summary of Results and Interpretation of Changes in Provision Levels, Taxes and Revenues

The main results can be summarized in the following table:

Table 1.1 Impact of Exogenous Changes in Theoretical Model

1.3-I Utility-Maximization by Government, in Identical-Individual Case				
Exogenous Change	*Variable*			
	Output of public good (*G*)	Total taxes (*T*) or total user fees	Marginal *WTP*[1] or per-unit user fee	Utility
Rise (fall) in size *s* of administrative budget	Falls (rises)	Rises (falls)	no change	Falls (rises)
Rise (fall) in public good cost parameter *b*	Falls (rises)	unclear	Rises (falls)	Falls (rises)
1.3-IIa Underprovision of Public Good, in Identical-Individual Case				
Exogenous Change	*Variable*			
	Output of public good (*G*)	Total Taxes (*T*) or total user fees	Marginal *WTP* or per-unit user fee	Utility
Fall (rise) in public good provision level chosen	Falls (rises)	falls (rises)	rises (falls)	Falls (rises)

1.3-IIb *Overprovision of Public Good, in Identical-Individual Case*				
Exogenous Change	*Variable*			
	Output of public good (G)	Total taxes (T) or total user fees	Marginal *WTP* or per-unit user fee	Utility
Fall (rise) in public good provision level chosen	Falls (rises)	falls (rises)	rises (falls)	Falls (rises)

1.3-III *Weighted Utility-Maximization, with Two Types of Individuals – Rich and Poor*						
Exogenous Change	*Variable*					
	Output of public good provided to poor (G_L)	Output of public good provided to rich (G_H)	Total supply of public good In economy (G_L+G_H)	Total taxes or user fees collected in economy (T)	Utility of poor	Utility of rich
Increase (decrease) in emphasis placed on redistribution	rises (falls)	falls (rises	rises (falls)	rises (falls)	rises (falls	falls (rises

Notes: 1. The marginal WTP here is computed at the actual consumption level of the public good, rather than its optimal level. In the cases of 3.1 and 3.3, the two are equivalent.

If the provision level G of the public good is observed to rise as a result of decentralization or some other exogenous event, what does this imply? From the various scenarios listed above, it suggests one of a number of possibilities:

(i) Public-sector management could have improved, or provision costs fallen for technological reasons, causing a fall in the administrative budget parameter s or the cost parameter b, or both. Note that these two parameters incorporate factors such as corruption and government inefficiency; rises in these cause increases in s, or b, or both.

(ii) The government could have been underproviding to begin with, and is now able to bring the provision level closer to the optimum. As discussed above, initial underprovision is more likely than initial overprovision, at least in developing countries; this point was supported using the commonly cited example of underprovision of water piping infrastructure.

(iii) The government was initially overproviding, and has now decided to provide even more. As mentioned above, however, initial overprovision is not very likely.

(iv) The government has increased the emphasis it places on redistribution.

If the first or second of these possibilities describes what in fact happened, utility has unambiguously risen. If the fourth is accurate, the poor have benefitted at the expense of the rich. This may be a positive development in many developing countries, where there are large inequalities in living standards. Only in one of these four cases – that of initial overprovision – does a rise in the provision level have unambiguously negative implications. But this case is probably not encountered often, as noted above. In summary:

- *If all that is observed is a rise in the output provided of the public good, this is more likely than not to result from a scenario that is welfare-enhancing. The opposite is true when all that is observed is a fall in the public good provision level.*

Looking at the change in total taxes T – or total user fees collected – can also provide some clues to what is happening. If this rises at the same time as the provision level G rises, then no firm conclusions can be drawn. But if T falls or stays the same when the provision level G rises, then the underlying cause of these changes is a fall in the cost parameter b – in which case utility has unambiguously risen. This is expressed in the following statement:

- *If the output provided of a public good rises, and total taxes or use fees remain the same or fall at the same time, then this must be the result of a fall in the cost parameter b, an event that is unambiguously welfare-enhancing. The opposite is true when the output provided of a public good falls, and total taxes or user fees remain the same or rise at the same time.*

Finally, a comparison of changes in the provision levels to the poor and the rich – if these can be distinguished – may be illustrative. These two provision levels will move in opposite directions, in response to any change in the emphasis placed on redistribution.

1.4 Overview of Empirical Analysis And Description of Key Variables

The empirical analysis focuses on the impact of decentralization—from the central or state to the local government—on the provision of three different local public goods in urban localities: water supply services, education, and health care. Following the model of Section 1.3, reduced-form equations are estimated to explain variation across cities in the either the quantity or quality of local public goods provided. In the case of health, I also estimate the impact of decentralization on a health outcome that is affected by public services—child mortality under the age of 5.

One of the main themes of this paper is that, when analyzing the impact of decentralization, the latter should be treated as endogenous. Empirical analysis that treats decentralization as exogenous – the standard approach to date – can produce misleading results. To highlight the potential seriousness of this problem, two sets of regressions are performed in this paper: one where decentralization is deliberately – and erroneously – modelled as an exogenous variable, and a second where its endogeneity is corrected for. In the latter case, a two-stage estimation technique is employed for each sector and each public good output measure, with decentralization modelled as the dependent variable in the first-stage equation. A brief overview of the models to be estimated is now presented, for each set of regressions.

1.4-I Model Treating Decentralization as Exogenous

1.4-Ia Basic Outline of Model

The model of Section 1.3 predicts that the output provided of a local public good will vary with factors that affect the demand for the public good—such as per-capita income and income distribution—as well as factors that affect the marginal cost of providing it. The latter include the population of the city (if there are economies of scale in provision of the public good) and population density, which may affect the cost of providing piped water and/or sewerage connections (Estache and Rossi, 1999). The rate of population growth may also affect provision; in a rapidly growing city, it may be more difficult for the government to provide a given level of services to all residents.[13] All of these factors are included as right-hand side variables in the equations to be estimated.

As suggested in Section 1.3, the output of local public good provided may also be affected by decentralization and/or changes in the quality of governance. The empirical equations include measures for these, as well as for the extent of private-sector involvement in provision, as explanatory variables.

The previous section also suggests that decentralization can, among other things, cause changes in the size of the administrative budget, the level of corruption or the cost of providing local public goods. These are mechanisms by which it can have an impact on the quantity or quality of local public good provided. It would be useful to empirically distinguish between these different mechanisms, and to determine in particular the effect of decentralization on the efficiency or cost of local public good provision. One way to do this would be to obtain a measure of the revenues collected to fund each local public good, individually, and then to insert this as a right-hand side variable in the equation explaining the provision level of the same good.

Unfortunately, the data do not permit estimation to be carried out along these lines. In particular, revenue or expenditure data specific to individual public good sectors are not available. Section 1.6 below provides indirect evidence on the impact of decentralization on public good provision cost, however, by examining the link between decentralization and revenues from taxes and user fees.

[13] This may be especially true in developing countries, where most urban immigrants are from poor rural areas, and are thus typically unable or unwilling to pay high taxes or user fees for public services.

The basic structure for the equations describing the provision levels of local public goods is:[14]

$$G_{ijk} = a_{0k} + a_{1k} y_{ij} + a_{2k} s_{ij} + a_{3k} D_{PS,ijk} + a_{4k} PP_{ijk}$$

$$+ a_{5k} E_j + a_{6k} p_{ij} + a_{7k} \dot{p}_{ij} + a_{8k} t_{ij} + \varepsilon_{ijk} \qquad ...(1.5)$$

where "i" and "j" denote the city and country; where "k" $\{k = w,e,h\}$ denotes the public good provided ("w" for water, "e" for education" or "h" for health); and where:

(i) G_{ijk} is an output measure used for public good sector "k" (see detailed explanations below);

(ii) y_{ij} is the log of the per-capita city product, the city equivalent of the national Gross Domestic Product;

(iii) s_{ij} is the proportion of housing in each city that is sub-standard, which means slum housing in particular;[15]

(iv) $D_{PS,ijk}$ is a dummy variable for countries where provision in sector "k" is fully decentralized to the local government, possibly with some involvement by the private sector (Section 1.4-III below explains in detail how this variable is constructed);

(v) PP_{ijk} is a dummy variable for countries where there is some private-sector involvement in provision, in sector "k" (see Section 1.4-III for more details);

(vi) E_j is the "ethnolinguistic fractionalization" – a measure of ethnic diversity – in the country (see Data Appendix 1 for more details on this);

[14] In this and all other equations in the paper, variables with positively skewed univariate distributions – i.e. with a long tail at the upper end – are converted to logarithmic form before estimation.
[15] The variables s_{ij} and t_{ij} are included only in the regression equations for which they are relevant.

(vii) p_{ij}, $\dot{p}_{ij}$ and t_{ij} are the log of the city population, the growth rate of the city population, and the log of the city population density,[16] respectively; and:

(viii) ε_{ijk} is an error term.

Note that in the dataset assembled for the estimation, there were originally five cities[17] with fully privatized provision (with no or minimal government involvement) in the water sector, and none with fully privatized provision in the education or health sectors. But since the main focus of the paper is on decentralization within the public sector, the five cities were dropped from the sample used for the water sector regressions before estimation. Consequently, if $D_{PS,ijk}$=0 for any one city in the final dataset, this indicates that provision of public good "k" is partially or fully centralized (see sub-Section 1.4-III for details).

Note also that $D_{PS,ijk}$ and PP_{ijk} are not mutually exclusive dummies. $D_{PS,ijk}$=1 precludes significant involvement in provision by higher-level governments, but it does not preclude significant private-sector involvement. Similarly, there may or may not be significant private-sector involvement when $D_{PS,ijk}$=0.

The proportion of sub-standard housing in each city is included as a right-hand side variable because it is the best measure available for the proportion of residents that are poor. More standard indicators of poverty or income distribution are not available at the city level. The proportion of poor people in a city is likely to be strongly correlated with public good provision indicators such as the proportion of city residents with water and/or sewerage connections.

[16] See previous footnote.

The reason for including "ethnolinguistic fractionalization" as an explanatory variable is that in highly diverse and fractionalized societies, there may be a high degree of inequality among different groups of people, in income as well as political power. The more disadvantaged groups are thus likely to enjoy less public good access than the other groups; output measures such as the proportion of city residents with water connections are again likely to be affected.

One caveat concerning the city population and population density variables is that their values are dependent on officially defined city or metropolitan area boundaries; these are based on historical and other circumstances, rather than standard criteria that are comparable across cities. As a result, there is a lot of noise in the data for these variables, and their estimated coefficients – as well as the associated t-ratios – are likely to be biased towards zero (Greene, 1997).

There are a number of other physical and geographical factors that may have an impact on public good provision. The layout of a city surely matters. For example, it can affect the cost and patterns of provision of water services. As another example, it may be easier to lay pipes beneath the surface in some types of ground than others. Unfortunately, quantitative measures for these types of physical determinants cannot easily be obtained. Omitting them from the equations does not cause bias, however, as long as they are uncorrelated with the variables of interest on the right-hand side of the equations – the decentralization measures.

Unless otherwise stated, all equations are initially estimated using ordinary least squares, with the Huber/White correction used to obtain robust variance estimates in

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[17] These five cities are Bedfordshire, Cardiff and Hertfordshire (all United Kingdom), Bouake (Cote

the case of heteroskedasticity (Huber, 1967; White, 1980). In estimating equation (1.5) in this way, the decentralization variable is being effectively treated as exogenous. As explained in the introduction, this may give biased results but is done deliberately, in order to compare regression results when decentralization is treated as exogenous with results when it is treated as endogenous.

The remainder of Section 1.4-I describes the output measures used as dependent variables in (1.5), and the child mortality equation. Next, Section 1.4-II presents the model used to estimate the impact of decentralization on the level of public good provision, when decentralization is treated as *endogenous*. Finally, Sections 1.4-III and 1.4-IV discuss the construction of the decentralization and privatization variables, and the dataset used for the analysis. The two sets of regression results for the equations explaining the level of public good provision – with decentralization first treated as exogenous, then as endogenous – are discussed in detail in Sections 1.5-I and 1.5-II respectively.

1.4-Ib Dependent Variables in the Analysis

1.4-Ibi Output in the Water Sector as the Dependent Variable

For the water sector, two different output measures are used for the dependent variable G_{ijw} in equation (1.5), with separate regressions estimated for each: the proportion of households in each city with piped water connections, and the average per-person consumption level of household water from all sources, piped and non-piped, in each city.

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d"Ivoire) and Cologne (Germany).

1.4-Ibii Output in the Education Sector as the Dependent Variable

Output in the education sector can be measured in terms of quantity or quality, or both. Commonly-used quality measures include the number of students per classroom or per teacher (e.g. Duraisamy et al., 1997; Fuller and Holsinger, 1993; Wolff et al., 1994); there is evidence that these are negatively related to examination scores and other educational performance indicators (Velez et al, 1993; Fuller and Clarke, 1994). Quantity measures include the proportion of eligible children attending school, or school enrollment rates (e.g. Filmer and Pritchett, 1998; World Bank, 1998). Both types of output measures are important, since there may be some conflict between them; higher quality may be attained at the expense of quantity, and vice versa.

In this paper, two sets of education sector regressions are estimated: one using a quality measure for the output variable G_{ije} in equation (1.5), and the other a quantity measure. The quality measure used is the inverse of the average number of students per classroom – or average classroom size – converted to log form. The quantity measure used is the school enrollment rate. The data permit equation (1.5) to be estimated separately for primary and secondary schools. Hence, for *each* of these, an average classroom size as well as an enrolment rate regression is estimated.

One caveat should be noted for the enrollment rate regressions: the available data are limited, permitting just 30 cities – disproportionately from developed countries – to be included in the estimation.[18] The results from these regressions are

[18] This is because the source for most of the city data – the United Nations Global Urban Indicators database – does not include data on enrollment rates. The enrollment rate data came from other sources, as detailed in Data Appendix 1.

nevertheless useful, since quantity and quality measures are both important for the education sector. As more city-level data become available in the future, more precise results can be obtained.

1.4-Ibiii Output in the Health Sector as the Dependent Variable

The output measure used for the health sector is the total number of hospital beds divided by the total population, in each city, converted to log form. Equation (1.5) is estimated using this measure as the dependent variable G_{ijh}, for this sector.

1.4-Ibiv Child Mortality as the Dependent Variable

A commonly-used indicator of a community's health status is the mortality rate for children under 5 years of age; this is more robust than many other indicators – such as life expectancy – because it can be measured with relative accuracy in developing countries (Filmer and Pritchett, 1997). Infant mortality can also be measured relatively accurately, but it fails to capture mortality from many serious health conditions which are responsive to health care, such as diarrhoea and respiratory infections.

There is much evidence that child mortality rates are responsive to appropriate interventions in the health sector, and to policies that improve access to clean water. According to the World Health Organization (WHO), seven out of ten childhood deaths in developing countries can be attributed to five causes: acute respiratory infection, diarrhoea, measles, malaria and malnutrition (WHO, 1997). The WHO also claims that many of these deaths can be prevented by better health management, using relatively low-cost interventions.[19] This statement is backed by a number of research

[19] For example, low-cost oral antibiotics can be used to effectively treat many acute respiratory infections (such as pneumonia), which are the leading cause of child mortality in developing countries.

findings that an increase in health inputs of the appropriate nature causes a reduction in child mortality or associated diseases (Deolalikar, A. and R. Laxminarayan, 2000; Frankenberg, 1993; Jamison et al., 1993; Panis and Lillard, 1994). In the case of diarrhoea, a contributing factor is often the lack of access to clean water, which is why policies in the water sector may affect child mortality.

Since child mortality is susceptible to appropriate health and water sector interventions, and since decentralization in these sectors may affect the nature of these interventions, child mortality and decentralization may be related. Since child mortality is such an important indicator of a community's health status, the extent and nature of this relationship needs to be examined.

This is done using an equation that is very similar to equation (1.5), but with additional right-hand side regressors, and with two sets of decentralization and privatization variables included – those for the water and those for the health sector:

$$M_{ij} = a_{0m} + a_{1m} y_{ij} + a_{2m} s_{ij} + a_{3m} D_{PS,ijw} + a_{4m} PP_{ijw}$$

$$+ a_{5m} D_{PS,ijh} + a_{6m} PP_{ijh} +$$

$$+ a_{7m} E_j + a_{8m} p_{ij} + a_{9m} \dot{p}_{ij} + a_{10m} t_{ij} + a_{11m} r_{ij}^{MAL} + \varepsilon_{ijm} \qquad \ldots(1.6)$$

where "i" and "j" denote the city and country, and where:

(i) M_{ij} is the mortality rate for children under 5 years of age, in each city;

(ii) $D_{PS,ijk}$ and PP_{ijk}, $\{k = w, h\}$, are – as described in the discussion of Equation (1.5) in Section 1.4-Ia – dummy variables for fully decentralized provision and

As another example, immunization can reduce rates of infection from measles and some strains of pneumonia.

partial private-sector involvement, respectively, in sector "k" (Section 1.4-III below explains in detail how these are constructed);

(iii) y_{ij}, s_{ij}, E_j, p_{ij}, $\dot{p}_{ij}$ and t_{ij} are exactly as described for equation (1.5), in Section 1.4-I;

(iv) r_{ij}^{MAL} is a dummy variable for the cities in areas with endemic malaria risk; and:

(v) ε_{ijm} is an error term.

Low child mortality has often been statistically linked with high per-capita income and low ethnolinguistic fractionalization (Filmer and Pritchett, 1997; Jamison et al., 1996; Pritchett and Summers, 1996); the latter are therefore included as regressors in equation (1.9). The sub-standard or slum housing variable, a poverty measure, is also included since child mortality is strongly associated with poverty (Filmer and Pritchett, 1997).

The dummy variable for cities in areas with endemic malaria risk is taken from Gallup, Sachs and Mellinger (1999), and is based in turn on information provided by the World Health Organization. Malaria is recognized as one of the leading causes of child mortality in poorer tropical countries (WHO, 1997).

Finally, the city population, population growth and population density variables are included in this regression for the same reasons as in regression (1.5): they may affect the provision of water and health care, and this may, in turn, affect child mortality.

One problem with estimating equation (1.6) in its present form is that there is some multicollinearity between the decentralization variable for the water sector, and that for the health sector. Cities with decentralized water provision are more likely to have decentralized health provision. Similar comments apply for the privatization variable. To ensure that the coefficient estimates for the equation are not significantly affected by multicollinearity, three versions of the equation are estimated. In the first, equation (1.6) is estimated in its present form. The equation is then re-estimated twice – first without the water decentralization and privatization variables, and then without the health decentralization and privatization variables.

1.4-II Model Treating Decentralization as Exogenous

1.4-IIa Basic Outline of Model With Local Public Good Output as the Dependent Variable

Estimating equations (1.5) and (1.6) in their present form using ordinary least squares

leads to biased estimates if the decentralization variable is in fact endogenous and correlated with the error terms – a situation which, as argued above, is very likely to be the case. The most obvious way to correct for such a bias would be to find one or two good instruments, and then to perform the estimation using two-stage least squares. However, when the endogenous variable of concern is a dummy variable, as is the case here, two-stage least squares – while generating unbiased estimates – leads to greatly increased standard error in the estimated coefficient of the variable of interest, in turn causing much reduced t-ratios (Heckman, 1979; Greene, 1997; Angrist, 2000). The preferred method in this case is to perform joint estimation of the main equation of interest, together with a probit equation where the dummy endogenous variable is the dependent variable. When doing this, it is important to find a set of one or more exogenous variables that are strongly related with the dummy endogenous variable and therefore belong in the probit equation, but not in the main equation of interest. Greene (1997) discusses these issues and presents a model along these lines, called the "treatment effects" model.

In the present context, the endogeneity of the dummy decentralization variable in equation (1.5) – where the dependent variable is the output of a local public good – can be addressed using a version of the "treatment effects" model, with the following equations jointly estimated:[20]

$$G_{ijk} = a_{0k} + a_{1k} y_{ij} + a_{2k} s_{ij} + a_{3k} D_{PS,ijk} + a_{4k} PP_{ijk}$$
$$+ a_{5k} E_j + a_{6k} p_{ij} + a_{7k} \dot{p}_{ij} + a_{8k} t_{ij} + \varepsilon_{ijk} \qquad \ldots(1.5)$$

$$D_{PS,ijk} = 1 \quad \text{if} \quad b_{0k} + b_{1k} y_{ij} + b_{2k} E_j + b_{3k} p_{ij} + \mathbf{H}_k'\mathbf{z}_{ijk} + v_{ijk} > 0$$

$$D_{PS,ijk} = 0 \quad \text{if} \quad b_{0k} + b_{1k} y_{ij} + b_{2k} E_j + b_{3k} p_{ij} + \mathbf{H}_k'\mathbf{z}_{ijk} + v_{ijk} \leq 0 \qquad \ldots(1.7)$$

where "i" and "j" denote the city and country; where "k" $\{k = w, e, h\}$ denotes the public good provided ("w" for water, "e" for education" or "h" for health); and where:

(i) G_{ijk}, y_{ij}, s_{ij}, $D_{PS,ijk}$, PP_{ijk}, E_j, p_{ij}, $\dot{p}_{ij}$ and t_{ij} in equation (1.5) are as described in Section 1.4-Ia;

[20] The dummy "partial private-sector involvement" variable may, in fact, also be endogenous; countries with strong institutions may, for example, be more willing than others to privatize key public-sector functions. This endogeneity would have to be corrected for, if this was one of the main variables of interest. Such considerations are important but are set aside in this paper, since the main aim is to study the impact of decentralization and not privatization.

(ii) $\mathbf{z}_{ijk}$ is a vector of exogenous variables that affect decentralization, but are not correlated with the error term in (1.5), the public good equation (with $\mathbf{H}_k$ representing the parameter coefficients of $\mathbf{z}_{ijk}$ in equations (1.7));

(iii) ε_{ijk} and v_{ijk} are error terms *that are correlated with each other*, with correlation coefficient ρ_k.

If indeed decentralization is endogenous, then there are factors affecting public good output that are not captured by the right-hand side variables in equation (1.5) – and which therefore appear as part of the error term ε_{ijk} – that are, in turn, determinants of decentralization. But if this is the case, then these factors will also be a part of the error term v_{ijk} in the decentralization equation (1.7). Therefore, by taking into account the possible correlation ρ_k between the two error terms when performing the joint estimation, the endogeneity of the decentralization variable is addressed and consistent coefficient estimates are obtained (Greene, 1997).

Equations (1.7) and (1.5) are estimated under the assumption that the errors ε_{ijk} and v_{ijk} follow a bivariate Normal distribution. One way to proceed is to jointly estimate the equations using Full-Information Maximum Likelihood. However, there is an alternative and computationally simpler procedure, which is based on a two-stage estimation technique first proposed by Heckman (1979) and described in Greene (1997). Equation (1.7) is first estimated individually as a probit equation, using standard maximum likelihood techniques. If the vector of resulting estimated coefficients $\{\hat{b}_{0k}, \hat{b}_{1k}, \hat{b}_{2k}, \hat{b}_{3k}, \hat{\mathbf{H}}_k\}$ is labelled $\hat{\mathbf{B}}_k$, and if $\mathbf{x}_{ijk}$ is a vector of values of *all* right-hand side variables in equation (1.7) for any particular observation, then the next step is to estimate:

$$G_{ijk} = a_{0k} + a_{1k}y_{ij} + a_{2k}s_{ij} + a_{3k}D_{PS,ijk} + a_{4k}PP_{ijk}$$

$$+ a_{5k}E_j + a_{6k}p_{ij} + a_{7k}\dot{p}_{ij} + a_{8k}t_{ij} + a_{9k}Mills_{ijk} + u_{ijk} \qquad \text{...(1.5')}$$

where $Mills_{ijk} = D_{PS,ijk}\dfrac{\phi(\hat{\mathbf{B}}_k\mathbf{x}_{ijk})}{\Phi(\hat{\mathbf{B}}_k\mathbf{x}_{ijk})} - (1 - D_{PS,ijk})\dfrac{\phi(\hat{\mathbf{B}}_k\mathbf{x}_{ijk})}{1-\Phi(\hat{\mathbf{B}}_k\mathbf{x}_{ijk})}$;

and where $\phi(.)$ and $\Phi(.)$ represent the density and cumulative density, respectively, of the standard Normal distribution.

Equation (1.5') is the second-stage equation in this two-stage estimation process. It is exactly the same as equation (1.5) given above, except that it includes an additional right-hand side variable $Mills_{ijk}$, commonly called the "Mills ratio." This variable is a function of the estimated coefficients and right-hand side variables in the first-stage equation (1.7). The decentralization variable is not correlated with the error term u_{ijk} in this equation, and therefore there is no longer an endogeneity problem. This can be proved by demonstrating that $E(u_{ijk} \mid D_{PS,ijk} = 1) = 0$ and $E(u_{ijk} \mid D_{PS,ijk} = 0) = 0$. Full details are given in Theoretical Appendix 1.2.

This appendix also shows how the correlation ρ_k between the error terms ε_{ijk} and v_{ijk} in the original system of equations can be estimated. A high estimate for ρ_k implies that the endogeneity problem with regard to the decentralization variable is a serious one; in such a case, treating decentralization as exogenous in the estimation is likely to lead to serious bias. Conversely, a low estimate for ρ_k means that ignoring the endogeneity of decentralization in the estimation may not introduce large bias in the results.

Equation (1.5') is estimated using ordinary least squares. With the endogeneity problem now removed, this gives consistent coefficient estimates (Greene, 1997). However, the standard ordinary least squares formula for the variance covariance matrix for the coefficient estimates is no longer applicable, for two reasons. First, the errors u_{ijk} are heteroscedastic, as shown in Theoretical Appendix 1.2. Second, there is additional variance introduced because the Mills ratio variable $Mills_{ijk}$ is a function of the parameter estimates $\hat{\mathbf{B}}_k$, which are not constants and have, in turn, their own distribution.

Theoretical Appendix 1.2 provides an expression for the asymptotic variance covariance matrix for the coefficient estimates in equation (1.5'). Using this expression, the standard errors and t-ratios for these coefficient estimates can be computed. These t-ratios can then be used to determine the statistical significance of individual right-hand side variables in equation (1.5'), in the usual way.

There remains the issue of finding a set of exogenous variables $\mathbf{z}_{ijk}$ that should be included as determinants of decentralization in equation (1.7), but which can justifiably be omitted from equation (1.5). This is discussed next, in Section 1.4-IIb. Section 1.4-IIc explains how the child mortality equation (1.6) is estimated, taking into account the endogeneity of the dummy decentralization variable – in the same way as described in this section. All regression results for the two-stage estimation process are discussed in detail, for all sectors, in Section 1.5-II.

1.4-IIb Exogenous Variables Affecting Decentralization But Not Public Good Provision

In performing the two-stage estimation process described above, it is especially important to find good candidates for the vector $\mathbf{z}_{ijk}$. This vector should include one or more variables that satisfy two criteria. First, they should have a strong and statistically significant impact on the decentralization variable $D_{PS,ijk}$ in equation (1.7). Second, their omission from equation (1.5) should be justifiable. In other words, they should not have a direct impact on the provision of public goods; neither should they be correlated with a variable that has a direct impact on this provision. Thus, they act very much as instruments; if estimation was done using two-stage least squares,[21] these variables could be used as instruments for the endogenous variable $D_{PS,ijk}$.

Finding suitable instruments to correct for endogeneity bias can in general be difficult; in the present context, it is triply so because there are three different sectors to take into account. Nevertheless, two variables were found that, together, satisfy the two criteria for inclusion in the vector $\mathbf{z}_{ijk}$ reasonably well.[22]

The first of these variables is the total population of the *country* where any given city is located. This variable can justifiably be omitted from (1.5), the equation explaining the provision level of the public good. At the same time, in a number of

[21] The two-stage estimation process described in the previous section is the preferred method in the current context, because the endogenous variable is a dummy variable. See the first paragraph of Section 1.4-IIa for a discussion of this.

studies, this and other measures of country size have been found to be statistically significant determinants of decentralization from the central to lower-level governments (e.g. Oates, 1972; Panizza, 1999). The rationale here is that in small countries, there are likely to be real cost savings in centralizing a substantial portion of public-sector activity. But in large countries, it is more cost-efficient and administratively easier for decentralized jurisdictions, because of their own significant size, to provide their own outputs of a wide range of public goods (Oates, 1972). Admittedly, the present paper differs from these previous studies in that it focusses solely on decentralization to local governments; arguably, country size is more likely to affect decentralization from central to *state* or regional governments. The dataset assembled for this paper show, however, that country size affects the likelihood of decentralization even at the local-government level – as seen below.

The second variable found to be a good candidate for inclusion in $\mathbf{z}_{ijk}$ is a dummy variable for countries that fought for their independence, in modern times – defined as the mid-18th century onwards. This variable takes the value 1 for countries that engaged in a full-scale war or revolution to repel colonizers or occupying powers – ignoring temporary occupation, such as during the World Wars. Countries in this category include, in particular, the ex-Spanish colonies, who gained their independence after repelling the Spanish in the early 1800s. Also included are Bangladesh and modern Greece, who gained independence after bloody battles with Pakistan (in 1971) and the Ottoman Turks (in 1830), respectively. The ex-British and

[22] The author wishes to express his thanks to Professors Roger Betancourt and Wallace Oates for guidance in the process of finding suitable variables to include in this vector.

ex-French colonies in the dataset are *not* included as countries that fought for independence; they were voluntarily granted independence by their colonizers, mostly after the Second World War. Similarly, Brazil is not included, since it gained its independence peacefully. Also excluded are the European powers such as the United Kingdom and Germany; they fought many battles against invaders earlier in the millenium when they were developing as nations, but they were not occupied in modern times.[23] Data Appendix 1 provides a complete listing of which countries are classified as having fought for independence in modern times.

The rationale for the inclusion of this variable as a determinant of decentralization is that, after a period of struggle and subsequent liberation from occupying powers, there has historically been a backlash against the system imposed by the colonizers, and against centralized rule in general (Bulliet et al., 1997; Diamond et al., 1988a). One of the best examples of this is the United States. After the American Revolution in 1776 – where the English were involuntarily repelled from one of their prize colonies – the United States established one of the most decentralized systems in the world. The US Constitution is well-known for its emphasis on checks and balances, on decentralization of authority to the states, and on deconcentration of power in general (Lipset, 1988).

But the path followed by the United States after liberation is not unique, especially not in the Americas. In the early 1800s, the Latin American countries (other

[23] As a form of sensitivity analysis, the empirical estimation – for both equations in the two-stage estimation process – was also done with European countries classified as having fought for independence. The results were qualitatively similar to those reported in this paper, where for European countries the value of the "fought for independence" dummy variable is 1. An additional reason for adopting the present approach is that, when the "fought for independence" dummy variable takes the

than Brazil) repelled the Spanish – known as tyrannical rulers – in their own wars of independence. Subsequently, the new leaders espoused Constitutionalism, as well as various forms of decentralized rule and power deconcentration, in an attempt to protect individual rights and liberties (Bulliet et al., 1997; Diamond et al., 1988a).

Many historians classify the period starting from the mid-1700s as the beginning of a new phase in nation-building in the world (Bulliet et al., 1997). Modern notions about democracy and self-governance were beginning to spread at this time. Colonies that physically ejected their occupiers during this period, and which rejected the system imposed by the latter, were especially liable to embrace some of the modern concepts regarding nation-building (Bulliet et al., 1997; Keen, 1996). By contrast, the older powers such as England and Germany sought to combine the modern notions of self-rule and decentralization with elements of the old order – centered around monarchy and tradition, and around systems where power was often concentrated in the hands of a few (Bulliet et al., 1997; Dornberg, 1996). It is for this reason that the dummy variable for countries that fought for independence only applies when the latter was won after the mid-1700s. Many of the old European powers waged battles against colonizers or invaders earlier in the millenium, but there is no evidence that this led to the enhanced adoption of modern notions about nation-building and self-rule.

Outside of the Americas, many ex-colonies – especially those formerly controlled by Britain (besides the United States) and France – were granted their independence only after the Second World War. Most chose to retain, in most part, the

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value 1 for European countries, it may be partly picking up the fact that the European countries are systems imposed by their ex-colonizers – systems that were sometimes very centralized (Diamond et al., 1988b; Diamond et al., 1998c; Mason, 1997). Even within the Americas, one of the few ex-colonies that was granted independence without a war – Canada – ended up with a Constitution that was partially written by its ex-colonial master Britain, at the time of independence in 1867. Lipset (1988) notes how the Canadian system, even after independence, retained the hierarchical distinctions and strong central government that were characteristic of Britain; unlike in the United States, the central government was able to veto or "disallow" provincial laws. All of this is in stark contrast with the path followed by most of the ex-colonies that fought full-scale wars of independence – especially those in the Americas.

The regressions results discussed below show that the "fought for independence" dummy variable performs well, statistically, as a determinant of decentralization in all three public good sectors analyzed in this paper. Furthermore, there is little reason why this variable should be correlated with the error term in (1.5), the public good output equation – hence the suitability of this variable for inclusion in the vector of instruments $\mathbf{z}_{ijk}$.

It may be the case, of course, that when this dummy variable is included in the decentralization equation (1.7), it is picking up effects other than the hypothesized relationship between fighting for independence and decentralization. Since most of the countries that fought for independence are from the Americas, there may be other factors specific to this region that account for the results in the estimation. It may be, for example, that the number of years since independence is a measure of a nation's

more likely to be decentralized simply because they are richer.

level of maturity, which may be a key determinant of decentralization. If this is so, then one would expect the countries in the Americas, most of which obtained their independence before this century, to be more decentralized than other countries, ceteris paribus.

Even if some or all of this is true, that by itself is not a serious thing. The factors that are possibly being picked up by the "fought for independence" variable, besides the fact of having fought for independence – the date of independence could be one of these – are likely to be exogenous factors that are uncorrelated with the error terms in the public good equation. Hence, the "fought for independence" variable fulfils the criteria for inclusion in the vector of instruments $\mathbf{z}_{ijk}$, even if the exact mechanism by which it affects decentralization may not be fully certain.

Notwithstanding this, two variables other than the "fought for independence" dummy variable were each tried as an instrument in the vector $\mathbf{z}_{ijk}$, in place of the "fought for independence" dummy variable. These are: (i) a dummy variable for all ex-Spanish colonies; and: (ii) a variable representing the log of the number of years since independence. The first of these performed better in the decentralization equation (1.7) than the second, but slightly less well than the "fought for independence" dummy variable. In both cases, the final results – when the full two-stage estimation process was carried out – were qualitatively similar to the results obtained when the "fought for independence" variable is used as the instrument. [24] [25]

[24] When estimating using the "years since independence" variable, there is an issue as to how to treat the European countries. Different approaches were adopted for this. First, the European countries were simply dropped from the dataset. Next, it was assumed that the maturity level of a country was related to the number of years since independence, up to an arbitrary cutoff point. Different values for the latter

1.4-IIc Child Mortality as the Dependent Variable

The preceding sections showed how equation (1.5) – where the dependent variable is the output of a local public good – was re-estimated using a two-stage procedure, taking into account the endogeneity of the dummy decentralization variable. A similar two-stage approach was followed for equation (1.6), the child mortality equation.

As noted in Section 1.4-Ib, three different versions of equation (1.6) were initially estimated with the decentralization variable treated as exogenous. First, the full equation was estimated. Then, the equation was re-estimated twice – first without the water sector decentralization and privatization variables, and then without the health sector decentralization and privatization variables. The rationale given for this was that including the decentralization and privatization variables from both sectors in the same regression introduces some multicollinearity problems.

The same rationale applies when the equation is estimated as part of a two-stage procedure. But now there is an additional consideration. Including decentralization and privatization variables from the water as well as health sectors in the estimation makes the computation cumbersome, because the equation then has two dummy endogenous variables as regressors (the decentralization variable from each sector). Handling such an estimation would not be difficult with a large enough dataset; two first-stage regressions would be needed – one for each sector – and two

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were tried out. In all cases, the statistical performance of the "years since independence" variable was not as good as that of the "fought for independence" variable.

[25] There is also the issue, when estimating using the "years since independence" variable, of the functinoal form that should be used. Functional forms other than the log were tried out for the "years

"Mills ratio" variables would have to be inserted in the second-stage equation before estimation. In the current context, however, the relatively small datasets do not allow such an estimation to be carried out with sufficient robustness. In addition, the multicollinearity problem is compounded when two "Mills ratio" variables are included in the estimation. Thus, this type of estimation is avoided; results are presented for two-stage regressions focussing first on the impact of the water sector decentralization variable, and then on the health sector decentralization variable. In each case, the first-stage equation in the two-stage estimation procedure is equation (1.7), estimated either for the health sector or the water sector.

Specifically, the following modified version of (1.6), the child mortality equation is estimated:

$$M_{ij} = a_{0m} + a_{1m} y_{ij} + a_{2m} s_{ij} + a_{3m} D_{PS,ijk} + a_{4m} PP_{ijk} + a_{5m} E_j$$

$$+ a_{6m} p_{ij} + a_{7m} \dot{p}_{ij} + a_{8m} t_{ij} + a_{9m} r_{ij}^{MAL} + a_{11m} Mills_{ijk} + u_{ijm} \qquad \text{...(1.6')}$$

with $Mills_{ijk} = D_{PS,ijk} \dfrac{\phi(\hat{\mathbf{B}}_k \mathbf{x}_{ijk})}{\Phi(\hat{\mathbf{B}}_k \mathbf{x}_{ijk})} - (1 - D_{PS,ijk}) \dfrac{\phi(\hat{\mathbf{B}}_k \mathbf{x}_{ijk})}{1 - \Phi(\hat{\mathbf{B}}_k \mathbf{x}_{ijk})}$;

where "i" and "j" denote the city and country; where "k" $\{k = w, h\}$ denotes either the water sector ("w") or the health sector ("h"); and where:

(i) M_{ij}, $D_{PS,ijk}$, PP_{ijk}, y_{ij}, s_{ij}, E_j, p_{ij}, $\dot{p}_{ij}$, t_{ij} and r_{ij}^{MAL} are exactly as described for equation (1.6) in Section 1.4-Ib; and:

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since independence" variable. In all cases, the variable did not perform as well as the "fought for independence" variable.

(ii) The "Mills ratio" variable $Mills_{ijk}$ is a function of the coefficient estimates $\hat{\mathbf{B}}_k$ and the right-hand-side variables $\mathbf{x}_{ijk}$ in the first-stage equation estimated, which is equation (1.7) estimated for sector "k".

The estimation technique here is virtually identical to that described in Section 1.4-IIa – where the dependent variable was the output of a local public good – and the comments made there on the estimation also apply here. Again, Theoretical Appendix 1.2 gives more details on the rationale behind the "Mills ratio" variable, and on the derivation of t-ratios for the coefficient estimates in equation (1.6'). All regression results for the two-stage estimation process are given in full, for all sectors, in Section 1.5-II.

1.4-III Construction of Decentralization and Privatization Variables

The decentralization variable was constructed from the United Nations Global Urban Indicators (UNGUI) city-level database (United Nations, 1999). This database includes information on the level(s) of government providing each of the three public goods in the current analysis (water supply, education and public health care). As an illustration, for the water supply sector, answers are supplied for each city – by local government officials and city experts – to the following question[26]:

"Which types of agencies deliver water supply services to the population? In each of the following five cases, indicate "Yes" if significant services (more than 20%) are provided by the indicated type of organization (otherwise indicate "No"): (i) Local

[26] Since this question is presented in isolation here, without the rest of the questionnaire, it has been paraphrased slightly to facilitate understanding.

Government (ii) National Government (iii) State or Regional Government (iv) Semi-Public Body or Parastatal (v) Private Sector."

A separate box for a "Yes"/"No" response is given for *each* of the five types of providers indicated. Note that these are not mutually exclusive choices; it is possible for more than one box to be checked "Yes", indicating more than one level of government providing water supply services, or a combination of public and private provision. Since the aim of this paper is to analyze decentralization within the public sector, however, the few cities where the private sector is cited as the sole provider of significant services were dropped from the dataset before estimation.[27]

Parastatals are listed in the question as one of the five types of providers; these are defined as publicly-owned bodies, with functions handled by a commercial or autonomous entity.[28] Although they may function like a fully private entity in many respects, key decisions are often made in practice by government officials (Shirley and Nellis, 1991). For the purposes of this paper, a parastatal is treated as a fully public organization, which is part of the national, state/regional or local government – depending on which of the latter owns it. This classification was done using information from World Bank documents and project reports, since the UNGUI database does not provide details of parastatal ownership.[29]

[27] As noted in Section 1.4-Ia, only five cities were originally cited in the data as cases where the private sector is the only provider of significant services, for water services. These were dropped from the dataset for the water regressions before estimation. For education and health, there was no city in the original dataset where all significant services are provided only by the private sector.
[28] This definition is not always applied in the strictest sense; a private body with majority government ownership can justifiably be classified as a parastatal, if the government plays a significant decision-making role.
[29] In most cases, the parastatals were owned by the national or state government. In no case was there joint ownership by more than one level of government.

The question above is also posed for the provision of education and health care, in the UNGUI database. Using the three sets of answers, the following dummy variable for decentralization – from the central or State to the local government – was constructed for *each* of the three public goods in the analysis:

- "*Full Decentralization in the Public Sector* (D_{PS}) means that significant services are *not* provided by the national or State (or regional) government. They are provided *only* by the local government, and possibly (but not necessarily) also by the private sector.[30]
- "*Full or Partial Centralization in the Public Sector* (C_{PS})" means that significant services are provided by the national or State (or regional) government, or both. At the same time, the local government may also provide significant services; but if it does, it is not the only level of government doing so. Again, the private sector may or may not provide significant services.

As noted above, the case where all significant services are provided *only* by the private sector does not apply, because the few cities where this is the case were dropped from the dataset before estimation. Thus, for all cities, it must be the case that either provision is fully decentralized to the local government (D_{PS}=1), or there is

[30] Private-sector provision could, of course, be funded from user fees collected by the provider, from government revenue, or both. In the case of the education and health sectors, private-sector provision generally indicates provision by private schools, hospitals or clinics – coexisting with public ones – and usually (but not always) funded mostly or entirely from user fees. For the water sector, private-sector provision generally means some but not all services provided by private companies; here there is no presumption that funding comes mostly from user fees. The exception is when there is fully privatized provision in the water sector, which occurs in only five cities in the original sample assembled for the water regressions. Here provision is funded mostly from user fees, which are subject to some government regulation. But as noted earlier in Section 1.4, these five cities were dropped from the sample before estimation.

partial or full involvement by a higher-level government (C_{PS}=1). In other words, the dummy variables D_{PS} and C_{PS} are mutually exclusive and mutually exhaustive.

In either case ("D_{PS}"=1 or "C_{PS}"=1), the private sector may or may not provide significant services. The following dummy variable is used to characterize private-sector involvement in either case:

- "*Partial Private-Sector Involvement (PP)*" means that the private sector provides significant services; however, it is not the *exclusive* provider of these. (This dummy variable may or may or may not take the value 1 under "D_{PS}" and "C_{PS}".)

Most of the regressions are specific to the provision of one local public good – running water, education or health care. But in the regressions reported in Section 1.6, the dependent variable is the amount of taxes or government revenue collected, per capita. For these regressions, a "*Three-Sector Decentralization Index*" was formed for each city. This is a weighted sum of 3 dummy variables: the decentralization dummy variables ("D_{PS}") for each of the three public good sectors. The weighting across sectors reflects the approximate contribution of each to the total government budget. A similar approach was used to form the "*Three-Sector Private-Sector Involvement Index*" for each city, using the partial private-sector involvement (PP) variables. Full details on these two index variables are provided in Data Appendix 1.

1.4-IV Description of Data Used and Data Sources

A dataset with one observation for each of a range of cities worldwide was constructed for the empirical analysis. The cities are listed in Table 1.2A most are from developing countries but a significant number are from developed countries. In the regression analysis, two separate sets of regressions are performed: one using all available data, and the other using just data on developing-country cities. Summary statistics for both sets of regressions are presented in Tables 1.2Band 1.2C

Table 1.2Bshows that the cities in the full dataset have per-capita products ranging from $247 (for Sana'a in Yemen) to $38,181 (for Cologne in Germany). Both small and large cities are included in the full dataset; the city populations range from about 50 thousand to about 9.9 million. The range for city populations in the dataset with only developing-country cities is similar, as shown in Table 1.2c; however, the city per-capita products now range from $247 (for San'a) to $5,850 (for Rio de Janeiro in Brazil).

The choice of which cities to include in each set of regressions was based entirely on data availability. The regressions can be classified into six different categories, with a slightly different sample of cities used for each, because different cities have different variables with missing data. The six categories of regressions using the full dataset, with the total number of cities for each included in parentheses, are those relating to: (i) the water sector (85); (ii) education quality or classroom size (83); (iii) education quantity or enrollment rates (30); (iv) the health sector, excluding child mortality (76); (v) child mortality (75); and: (vi) tax or revenue (40). The overlap among these six different samples is very large, as Table 1.2a indicates. All data are for the year 1993.

The variables used in the analysis, listed in Tables 1.2Band 1.2C are all available at the city level, with the exception of a subset of variables that reflect characteristics of the *country* where each city is located. These are: (i) the "ethnolinguistic fractionalization" of a country, or the degree of its ethnic diversity; (ii) the total population in a country; and: (iii) a dummy variable for countries that fought for independence in modern times A full description of data sources, and more details on the data and variables, are given in Data Appendix 1.

1.5 Empirical Results When Decentralization Is Treated As Exogenous, Compared to When It is Treated As Endogenous

In Section 1.2, it was noted that most studies on decentralization have treated it as exogenous – ignoring its dependence on institutional and other factors – and have thereby introduced possible bias into their results. To highlight the seriousness of the problem, this paper presents two sets of results for equations (1.5) and (1.6): one that treats decentralization as exogenous, and another that takes into account its endogeneity using the two-stage estimation procedure described in Section 1.4-II. The first set of results is discussed in Section 1.5-I, and the second in Section 1.5-II. All regressions discussed in this section are estimated using the full dataset described in Section 1.4-IV – with developed as well as developing countries included.

1.5-I Results for the Output and Impact Indicators When Decentralization Is Treated As Exogenous

When equations (1.5) and (1.6) are estimated using ordinary least-squares, decentralization is effectively being treated as exogenous. Estimated in this way, the equations are thus examining whether decentralized cities provide higher public good provision levels than other cities – and not whether decentralization *causes* higher provision levels. The results are presented as regressions (3.1) to (3.10), in Table 1.3.

Analyzing first the seven regressions with public good output measures as dependent variables – (3.1) to (3.7) – Table 1.3 shows that the decentralization variable is statistically significant in three of these, at the 5% level. In a fourth, the variable is statistically significant at the 10% level. Overall, these regressions show that decentralized cities perform better that other cities in terms of at least *some* output indicators of public good provision.

Specifically, the decentralized cities in the dataset perform better, in general, in the indicators that measure some aspect of quality, rather than quantity or coverage of the population.[31] Two of the three indicators that measure coverage – primary and secondary school enrolment rates – are not found to be higher in decentralized cities than elsewhere. The third indicator of coverage – the proportion of city resident with piped water – is statistically significant only at the 10% level. Conversely, the three regressions where the decentralization variable is statistically significant at the 5% level all have some form of quality measure as the dependent variable – the average per-person consumption of water, and the average classroom size in primary and secondary schools. Admittedly, the hospital beds per person indicator – a quality measure – is not found to be higher in decentralized cities than elsewhere. However, this is just one dimension of quality in the health sector, which – arguably – presents more measurement difficulties than the other sectors. If the data permitted an analysis of other quality indicators in the health sector, different results may well be obtained.

One caveat should, however, be noted regarding the preceding comments. As mentioned earlier in Section 1.4-Ib, the two education enrolment rate regressions were

[31] I am grateful for Professor Roger Betancourt for pointing this out.

run using a dataset of just 30 cities, because of data limitations; the results from this small dataset should therefore be interpreted with caution. If these two regressions were dropped from the dataset, the decentralization variable would be statistically significant, at the 10% level or higher, in four out of the five remaining regressions with an output indicator as a dependent variable. These four regressions would be those for the water and education sectors; the overall evidence would then suggest that decentralized cities perform better in terms of the available output indicators for these two sectors, but not for the health sector.

Turning next to the results for the child mortality regressions – given in Part II of Table 1.3 – the dummy variable for decentralization in the water sector is statistically significant at the 5% level in the two regressions in which it appears – (3.8) and (3.10). But the dummy variable for decentralization in the health sector – which appears in regressions (3.8) and (3.9) – is statistically significant only in (3.9), and only at the 10% level. The reduced significance of the latter in regression (3.8) may be due in part to multicollinearity in this regression between the water and health decentralization variables, a problem which was first brought up in Section 1.4-Ib. Nevertheless, this set of results – where the dependent variable is child mortality – mirrors those for the public good output regressions, (3.1) to (3.7), in two respects: First, in both sets of results, the health decentralization variable was either statistically insignificant, or significant only at the 10% level. Second, the opposite is true of the water decentralization variable; it is, on the whole, statistically significant in both sets of results. (The education decentralization variable does not appear in the child mortality regressions.) Thus, the two sets of results reinforce each other, which is logical given the premise that – as argued in Section 1.4-IIbiv – child mortality is affected by provision levels of local public goods.

Although the coefficients of the decentralization variables are of primary interest in these regressions, it is useful to examine the other coefficients as well. As noted above, the "partial private-sector involvement" dummy variable takes the value one when the private sector provides significant services, jointly with one or more levels of government. The coefficients of this variable appear at first to have the wrong sign in some of the regressions; the conventional wisdom is that privatization – full or partial – typically increases efficiency in provision (World Bank, 1997). Yet in practice, partial privatization may cause customers with ability to pay to switch from public to private provision, draining resources from the public sector and disproportionately reducing provision levels to the poorer residents. Also, the coefficient on the partial privatization variable may be biased downwards because of a reverse causality problem: in cities with poor provision by the public sector, the private sector is likely to flourish, especially for health and education.

The results for the coefficients of the income-related variables are mostly as expected. Per-capita income has a strong positive relationship with all the dependent variables. Similarly, the variable for the proportion of sub-standard housing, a poverty measure for each city, has a coefficient that is statistically significant at the 10% level or higher – with the expected sign – in the water connections and the child mortality regressions. The same is true for the enrollment rate regression for secondary schools, but not for primary schools; this may be due to the small sample for these regressions, a point that was also brought up above.

The city population growth rate has a negative and significant effect on some of these dependent variables, a result that is again largely expected. The city population variable is also statistically significant, with a positive sign, in some regressions – notably in the water sector, suggesting there may be economies of scale in the provision of water at the city level. The coefficient of the population density variable in the water regressions is not, however, statistically significant. This may be due to the measurement problems mentioned in Section 1.4-I for this variable.

The results show that a larger "ethnolinguistic fractionalization" means less people with water connections, and lower total water consumption. This is logical, since it is the poor rather than the rich who suffer from a lack of connections, and whose demand for water thus exceeds the supply. Finally, the coefficient of the malaria dummy for the child mortality regressions is positive and statistically significant, as expected.

Overall, these regressions show that, after controlling for per-capita income, cities with decentralized water sectors – and to some extent, those with decentralized education sectors – have higher measured levels of output indicators in these sectors than other cities. Child mortality is also shown to be lower in cities with decentralized water sectors than in other cities. There is evidence, furthermore, that decentralized cities perform better in public good provision than other cities, overall, when performance is measured using quality indicators – although less so when it is measured using indicators of access or coverage. Following the analysis in the theoretical section (Section 1.3), higher provision levels – when they exist – probably imply one or more of the following: lower-cost provision, a more efficient public sector, less underprovision of the good, or a greater emphasis on redistribution – all generally positive developments.

1.5-II Results for the Output and Impact Indicators, With Decentralization Treated As Endogenous

The results of the previous section suggest that the level of public good provision is, on the whole, larger in decentralized cities than elsewhere. However, it is not clear to what extent this is attributable to decentralization, and to what extent it is the result of institutional and other factors that are, themselves, causes of decentralization. In other words, the endogeneity of decentralization is ignored in the estimation. Unless appropriate corrections are made, institutional and other determinants of decentralization are likely to be subsumed in the error terms in equations (1.5), and could be correlated with the decentralization variable – resulting in endogeneity bias in the coefficient of the latter when the equations are estimated. Similar comments apply to equation (1.6), the child mortality equation.

Section 1.4-II describes in full the two-stage estimation procedure used to address this problem. It explains how equation (1.7) – a probit equation with decentralization as the dependent variable – is estimated as the first-stage equation. Next, it describes how, as the second stage in the estimation process, a "Mills ratio" variable – derived from the first-stage regression – is added in equation (1.5) or (1.6) to corrects for the endogeneity of the decentralization variable. The corrected versions of the two equations are labelled (1.5') and (1.6').

The results from estimating the first-stage equation, (1.7), are presented in Table 1.4A, while those for the second-stage equation, (1.5') or (1.6'), are given in Table

1.4B. The second-stage regressions here are estimated using the same public good output and impact indicators for dependent variables as in Section 1.5-I – where decentralization was treated as exogenous – with two exceptions. Those exceptions are the primary and secondary school enrollment rates. In regressions with these as dependent variables, the variation in the additional regressors included in the first-stage equation – the dummy variable for the countries that fought for independence and the total country population variable – would be too small for meaningful results to be obtained. This is because these additional regressors vary across countries and not cities, and there are only 16 countries in the enrollment rate regression sample. In any case, the results of Section 1.5-I suggest that enrollment rates are no higher in decentralized cities than in other cities; thus, there is little reason to believe that decentralization causes higher enrollment rates.

Analyzing first the first-stage results in Table 1.4A, the city per-capita product variable is statistically significant – at the 10% level or better – in the water and education sectors, but not in the health sector. Many have observed and found evidence to support the proposition that richer countries and cities are on the whole more decentralized than poorer ones (e.g. Oates, 1972). However, this need not be the case for the provision of certain types of public goods; many rich countries, especially in Western Europe, take the view that the central government should play a large role in the education and especially the health sectors (McLean and King, 1999; Riita-Liisa, 1999). There are many reasons for this; one is a notion that – rightly or wrongly – centralization helps ensure adherence to the principles, cherished in many European countries and elsewhere. of universal education and health care. Thus, the lack of an observed relationship between per-capita income and decentralization in the health sector, and a weak relationship between these two variables in the education sector, are not particularly surprising.

The one variable that emerges as a strong determinant of decentralization in all three sectors is the dummy variable for the countries that fought for independence.[32] The variable representing the total country population is statistically significant - at the 5% level – in the water and health sectors, but not in the education sector. Together, these variables perform well as determinants of decentralization. This is important, since they both play the role, effectively, of instruments that appear in the first-stage regressions but not the second-stage ones – as explained in detail in Section 1.4-II.

Turning next to the second-stage regressions, in Table 1.4B, the first thing to determine in each case is whether the "Mills ratio" variable is statistically significant. If it is, then this suggests that its inclusion in the regression makes a significant difference and is warranted. In turn, this means that estimating the equation without correcting for the endogeneity of the decentralization variable may introduce substantial inaccuracy in the estimation.

Another important step in evaluating the results is to examine the estimate obtained for ρ_k, the correlation between: (i) the error term v_{ijk} in the first-stage probit equation (1.7); and: (ii) the error term ε_{ijk} in equation (1.5) or ε_{ijm} in equation (1.6). An estimate $\hat{\rho}_k$ for this correlation is obtained from the results of the first-stage and

[32] As mentioned earlier in See Section 1.4-IIb, alternative specifications were tried, with the "fought for independence" dummy variable dropped, and with other related variables used in its place. As noted there, the overall results were similar qualitatively, although the alternatives did not perform as well as the "fought for independence" dummy as determinants of decentralization.

second-stage regressions. The procedure used for this is given in Theoretical Appendix 1.2, and the estimate $\hat{\rho}_k$ for each set of regressions is given in Table 1.4B. This estimate is important for two reasons. First, it is an indicator of the accuracy of the estimation process and the robustness of the results; if its value is well outside the range of -1 to 1 – the range within which any correlation coefficient must lie – the overall results of the estimation may be suspect. Second, as explained in Section 1.4-IIa, the correlation estimate $\hat{\rho}_k$, or more precisely the parameter ρ_k being estimated, is an indicator of the extent and nature of the endogeneity of the decentralization variable. If there is a serious endogeneity problem with regard to the decentralization variable, then the true value of ρ_k will be large in magnitude. If the factors that make decentralization more likely also enhance provision levels of the local public good in question – and this paper claims that this may often be the case – then the true value of ρ_k will be positive for the relevant public good output equation.

In fact, as shown in Table 1.4B, the "Mills ratio" variable is statistically significant in all the second-stage regressions, except the health sector regression (4B-7). The estimate of the correlation $\hat{\rho}_k$ is well within the expected bounds. Furthermore, it is positive in the public good output regressions (4B-1) to (4B-7) – except for the health sector – but negative in the child mortality regressions. In general, the estimate $\hat{\rho}_k$ is reasonably large in magnitude, except for the health sector regression.

All of this suggests that, in all sectors except the health sector, the decentralization variable in equations (1.5) and (1.6) is indeed strongly endogenous, and possibly highly correlated with the error terms in those equations without the "Mills ratio" correction. It is thus not surprising that the estimated coefficient of the decentralization variable itself in each of the Table 1.4B regressions is, in general, considerably smaller than the corresponding coefficient estimate in Table 1.3 – where no correction was made for the endogeneity of the decentralization variable.

But a stronger statement can be made about the decentralization variables in the Table 1.4B regressions: *none of the coefficients of the decentralization variables is significantly different from zero in any of the regressions*. This finding differs markedly from the results reported in Table 1.3, where the decentralization variable was treated as exogenous in the regressions. Clearly, the bias introduced when the endogeneity of decentralization is ignored is substantial, at least for the water and education sectors. When this bias is corrected for, there is no evidence that decentralization itself has any impact on the chosen output and impact indicators of public good provision.

1.5-III Conclusions

The regression results reported in Section 1.5 illustrate clearly that, when examining the impact of decentralization on public good provision, it is important to take into account the endogeneity of decentralization. The results from the Section 1.5-I regressions indicate that the levels of some public good output and impact indicators are higher in decentralized cities than in other cities, particularly when the decentralization has occurred in the water or education sector. Yet these results do not imply that these higher indicator levels in decentralized cities are *caused* by decentralization itself. By using a two-stage procedure to correct for the endogeneity of decentralization, it was shown in Section 1.5-II that the apparent impact of decentralization on public good provision can in fact be attributed to factors other than decentralization itself. The correlation of these factors with the decentralization variable is not taken into account in the Section 1.5-I regressions, which accounts for the statistical significance of this variable in many of these regressions.

1.6 The Impact of Decentralization on Revenues and Expenditure

In order to determine the impact of decentralization on the efficiency with which a local public good is provided, it would be desirable to control for revenues collected by the government to fund the good. For equation (1.5) or (1.5'), this means including an additional variable on the right-hand side: some measure of the per-capita public funds – raised through user fees or other sources of public revenue – that are allocated to water supply, education or health.

Unfortunately, data on measures of this type are not available. The only user fee measure available is the median price of water; but this is very different from the average price, and cannot be used to compute the total amount of user fees. Furthermore, user fees show only part of the picture; most governments fund public water supply services through user fees as well as taxes or other sources of public revenue.[33]

There are data on total taxes and total government expenditure or revenue, including user fees as well as grants and borrowing from all sources,[34] but these are

[33] An additional problem with the available data on the median water price is that the data applies to water consumed from all sources, piped and non-piped.
[34] Defined in this way, total revenue is equivalent to total government expenditure.

limited in two important ways. First, these data do not provide a detailed enough breakdown of how the funds are allocated across different public good sectors and different types of expenditure. Second, data on revenue accruing to all three levels of government – central, State or regional and local – are scarce; among the cities in the dataset used for this paper, only 40 have information of this kind available, and these are disproportionately from developed countries.

Given the nature of the available data, it is not possible to directly address the question of whether decentralization has an impact on the efficiency with which public goods are provided. But some indirect evidence on this issue can be obtained by estimating the impact of decentralization on total taxes or total public revenue – even though this can be done only using a limited sample of 40 cities. According to the results of Section 1.5-I, several public good output and impact indicators are higher in decentralized cities than in other cities. If, at the same time, the level of taxes or public revenue is the same or lower in decentralized cities than elsewhere, then this indicates one of two possibilities. First, decentralized cities allocate larger proportions of their government budgets to the public goods in question than to other uses. Or second, decentralized cities provide the public goods more efficiently, or at lower cost, than other cities.

This line of reasoning would not be particularly appealing if the public goods in question accounted for only a small part of the total public budget. In most countries, however, public spending on education and health – two of the three sectors in the current analysis – take up a very significant portion of the public budget. An analysis of aggregate central government data available from World Bank (2000) shows that, on average, about a third of the total central government budget in developing countries goes towards spending on these two sectors. The figure for developed countries is similar. Although a breakdown along these lines is not available for the local government, and only to a limited degree for state governments, the corresponding figures for these lower-level governments is likely to be of a similar magnitude.

To empirically examine the link between decentralization and the level of total taxes or public revenue, an equation similar to (1.5) is estimated, but with a per-capita measure of taxes or government revenue as the dependent variable. Because the available tax and revenue data are not sector-specific, the decentralization and privatization variables in the equation cannot be sector-specific either. Composite measures of the overall extent of decentralization and privatization are needed.

Such a modified form of equation (1.5) is presented below:

$$R_{ij} = b_0 + b_1 y_{ij} + b_2 DecIndex_{PS,ij} + b_3 PvIndex_{ij}$$

$$+ b_4 E_j + b_5 p_{ij} + b_6 \dot{p}_{ij} + b_7 t_{ij} + \eta_{ij} \qquad \ldots(1.8)$$

where "i" and "j" denote the city and country; and where:

R_{ij} is the log of the total tax or total government revenue – with grants and borrowing included in the latter – collected by all levels of government in the city, added together and then divided by the city population;

$DecIndex_{PS,ij}$ is the "Three-Sector Decentralization Index," a weighted sum of the decentralization variables (D_{PS}) for the three sectors(see Section 1.4-III and the Data Appendix 1 for details);

$PvIndex_{PS,ij}$ is the "Three-Sector Private-Sector Involvement Index," formed using mainly the three partial private-sector involvement (PP) variables[35] for the three sectors (see Section 1.4-III and Data Appendix 1 for details);

η_{ij} is an error term;

and where the notation for the other right-hand side variables is described above (in Section 1.4-I.

Some insights may also be provided by estimating the following equation:

$$WPR_{ij} = c_0 + c_1 y_{ij} + c_2 D_{PS,ij} + c_3 PP_{ij}$$
$$+ c_4 E_j + c_5 p_{ij} + c_6 \dot{p}_{ij} + c_7 t_{ij} + \omega_{ij} \qquad \ldots(1.9)$$

where WPR_{ij} is the log of the median price or user fee for water, and ω_{ij} is an error term; and where the notation for the other variables is given above (Section 1.4-I).

As in the case of equations (1.5) and (1.6), equations (1.8) and (1.9) are each estimated using two different approaches. Estimation is first carried out with the decentralization variable treated as exogenous, with the results reported in Section 1.6.1. Next, the equations are re-estimated, with the decentralization variable treated this time as endogenous. The re-estimation for equation (1.9) is done using exactly the same two-stage procedure as described above, for equations (1.5) and (1.6). The coefficient estimates for (1.7) – the first-stage equation, estimated for the water sector – are used to form a "Mills ratio" variable, which is then inserted in the second-stage estimation of equation (1.9).

The re-estimation of equation (1.8) to take into account the endogeneity of decentralization is somewhat more straightforward; the decentralization variable is now no longer a discrete binary variable which can take one of two values. As explained in Section 1.4-III, it is a weighted average of three dummy variables, and can thus take one of several (to be exact, 8) values. For estimation purposes, it is closer in nature to a continuous variable than a binary one. Therefore, the two-stage procedure described above – recommended over Two-Stage Least Squares for dummy endogenous variables (see Section 1.4-IIa), is not appropriate here. Here, Two-Stage Least Squares is used to perform the estimation. The instruments used are the two components of the vector $\mathbf{z}_{ijk}$, which were also used effectively as instruments in the two-stage estimation procedure with the dummy endogenous variable: the log of the total country population and a dummy variable for countries that fought for independence in modern times. All regressions in this section, as in the case of Section 1.5, are estimated using the full dataset described in Section 1.4-IV – with developed as well as developing countries included.

1.6-I The Impact of Decentralization on Prices, Taxes and Expenditures, Treating Decentralization As Exogenous

Equations (1.8) and (1.9) are first estimated in their present form using ordinary least-squares, with the decentralization variable effectively treated as exogenous. The results are presented as regressions (5.1) to (5.3), in Table 1.5. They indicate that total revenue and total taxes accruing to all levels of government are no higher in

[35] The Full Privatization (FP) dummy variable is not used to form this index because the regressions where the index is used can only be run using a sample of 40 cities, because of data limitations. None of these has FP in any of the three sectors.

decentralized cities than in other cities – even though the results of Section 1.5-I showed that residents in the former enjoy higher levels of at least some indicators of public good output and impact. The sample used for the tax and revenue regressions is small, and the results should ideally be confirmed with larger samples. Nevertheless, following the logic outlined earlier in Section 1.6, there is evidence that public goods are provided more efficiently or at lower cost in decentralized cities than elsewhere, provided one assumption is made: that there are no significant differences between decentralized and other cities in patterns of public budget allocation across different uses.

Although the main focus is not on the "3-Sector Private-Sector Involvement Index" variable, the fact that its coefficient in regressions (5.1) and (5.2) is not statistically significant merits some discussion: One might expect that higher private-sector involvement would mean a reduced role for the public sector and hence reduced taxes. But on further reflection, this result is not so surprising. If more private schools or clinics are built, this does not mean that some public facilities must be shut down, or that funding to the latter would necessarily be reduced.[36] Furthermore, the private sector may play a large role even when government revenues or taxes are high, if the latter are used inefficiently to provide public services.

[36] This argument is applicable to schools and clinics, but not to public goods like running water or electricity; in general, the private sector can only play a role in these sectors if the government sells them the relevant assets, or the rights to provide services. Thus a greater role for the private sector usually means a lesser one for the government, in these particular sectors. This intuition is borne out by the data; if equation (1.6) is re-estimated, with the 3-Sector Decentralization Index variable omitted from the regression, and with the full and partial decentralization variables for the water sector only included on the right hand side, the coefficients on the latter are negative and highly significant.

The results from the water price regression show that median water prices faced by residents in decentralized cities are not significantly different from those in other cities. This is consistent with the results from the tax and revenue regressions.

1.6-II The Impact of Decentralization on Prices, Taxes and Expenditures, With Decentralization Treated as Endogenous

Table 1.6 presents the results from estimating equations (1.8) and (1.9), with the decentralization variable treated as endogenous rather than exogenous. The procedures used to correct for this endogeneity are described at the beginning of Section 1.6. The results are, qualitatively, very similar to those in Table 1.5, where the decentralization variable is treated as exogenous.

1.6-III Conclusions

The regression results reported in Section 1.6 complement the results in Section 1.5. The Section 1.5-I regressions showed that a number of public good output and impact indicators are higher in decentralized cities than elsewhere. According to the results in Section 1.6, the higher levels of these indicators are not accompanied by higher taxes or government revenue. If, compared to other cities, decentralized cities allocate similar proportions of their total public budget to the provision of the goods in question, then the following can be inferred: that local public goods are provided more efficiently, or at lower cost, in decentralized cities than elsewhere.

Even if this inference can be made, however, the results do not imply that the greater efficiency of provision in decentralized cities is *caused* by decentralization itself.

By using a two-stage procedure to correct for the endogeneity of decentralization in the regressions in Sections 1.5-II and 1.6-II, it was shown that decentralization has no impact either on the different public good output and impact indicators examined, or on the levels of taxes and public revenue.[37] In sum, when the endogeneity of the decentralization variable is corrected for, there is no evidence that it changes the efficiency or cost of local public good provision.

1.7 Empirical Analysis With Just Developing Countries in the Dataset

The results reported in Sections 1.5 and 1.6 were obtained using a dataset with developed as well as developing countries included. This dataset is described in Section 1.4-IV; it is in fact, dominated by developing countries. It is, nevertheless, useful to re-estimate all public good output and impact equations with the developed countries dropped from the dataset. This section presents the results from conducting re-estimation along these lines. The samples of cities used for the re-estimation are listed in Table 1.2a, with summary statistics provided in Table 1.2c.

The results from re-estimating equations (1.5) and (1.6) using the developing-country dataset, with the decentralization variable treated as exogenous, are given in Table 1.7. These results mirror those in Table 1.3, although there is no attempt now to estimate the education enrolment rate regressions, due to the small size of the sample that would have to be used. In fact, the two sets of results – those using the full dataset (in Table 1.3), and those using the developing-country dataset (in Table 1.7) – are very

[37] In the case of the latter, of course, the introduction of the institutional variables makes no difference to the result: the decentralization variable is not statistically significant in any of the tax or revenue regressions, with or without the institutional measures.

similar. In both sets of regressions, the water and education decentralization variables are statistically significant at the 10% level or better in all cases, except (for the Table 1.3 results) where the dependent variable is the primary or secondary school enrolment rate. And as noted earlier in Section 1.5-I, results using the latter should be interpreted with caution due to the small sample size.

The results from performing the two-stage estimation procedure described in Section 1.4-II, using the developing-country dataset, are given in Tables 1.8A and 1.8B. The regressions in these two tables mirror those in Tables 1.4A and 1.4B, where the full dataset is used for the estimation. Again, the two sets of results are very similar. In particular, in both sets of regressions, the decentralization variables are statistically insignificant.

Finally, the developing-country results from estimating equations (1.8) and (1.9), first treating decentralization as exogenous, then treating it as endogenous, are given in Tables 1.9 and 1.10 respectively. These mirror the results in Tables 1.5 and 1.6, which are derived using the full dataset. Again, the results for the two sets of regressions are similar. In all cases, the decentralization variable is not statistically significant in any of the regressions.

In summary, the general conclusions drawn from the regression results using the developing-country dataset also apply for the results using the developing-country dataset. In developing countries, there is evidence that the levels of some public good output and impact indicators are higher in decentralized cities than in other cities, particularly when the decentralization has occurred in the water or education sector. Furthermore, there is no evidence that these higher levels are accompanied by higher taxes or government revenue, suggesting that decentralized cities may provide some types of public goods more efficiently than other cities. However, these higher levels in decentralized cities are not *caused* by decentralization itself, but rather by the determinants of decentralization, or by other factors that are associated with but not caused by decentralization.

1.8 Concluding Comments

The main message of this paper is that, when evaluating the impact of decentralization, it is vital to take into account the endogeneity of decentralization. The extent and nature of decentralization are not randomly determined; they are affected by institutional and other factors. If the latter are ignored, then improvements in public good provision may in some circumstances be mistakenly attributed to decentralization, when they are in fact caused by other factors that are associated with but not caused by decentralization.

The empirical analysis in this paper has several shortcomings, due largely to data constraints; a few of these are mentioned here. First, the sample sizes for the school enrollment rate regressions, as well as those with tax or revenue variables on the left-hand side, should ideally be larger. Furthermore, there are no data on public funds allocated to, or user fees collected from, specific public good sectors; the available tax and revenue data are not disaggregated in this way. If data on public expenditure within individual sectors were available, these – together with the available output measures – would enable per-unit cost indicators to be computed for each sector. The relationship between these and the decentralization variables could then be examined.

Second, it would be ideal if better decentralization measures were available. The ones in this paper do not sufficiently distinguish between different types of local government control. In practice, even if the local government is nominally in charge of a service, there are variations in the extent to which it is allowed to make key decisions (Dillinger, 1994). There are also variations in the financing instruments it has at its disposal: different local governments face different constraints on the tax rates and user fees they can impose, and on their ability to borrow (Ter-Minassian, 1997).

In addition, the decentralization measures in this paper focus only on the economic functions of governments. Yet the full benefits of economic decentralization – if any – may be felt only in a politically decentralized country. The latter implies a strong participatory role for local residents in the local government's decisionmaking process, through free and fair local elections or through other means (Seddon, 1999). The extent to which this occurs should ideally be incorporated in the decentralization measures.

Finally, the empirical analysis could also be improved if the data permitted the inclusion of other determinants of decentralization, besides those considered in this study. A more thorough evaluation could then be conducted of the factors that influence both decentralization and public good provision, and which therefore could account for some of the endogeneity bias in the estimation of the impact of decentralization. These factors could include institutional measures of governance or corruption – although it should be noted that these can be difficult to measure accurately, and there could be reverse causality between them and the decentralization variable.

Table 1.2A. Cities Included in Regression Samples[1,2]

*(Developing Countries marked with an asterisk *)[3]*

		Sector Regressions					Tax and Revenue Regressions
		Water Sector	*Education Sector (excluding enrolment rate regressions)*	*Education Sector (enrolment rate regressions only)*	*Health Sector*	*Child Mortality*	*Tax and Revenue*
Regression numbers:		*3.1, 3.2, 4A-1, 4B-1, 4B-2, 5.3, 6.3*	*3.3, 3.4, 4A-2, 4B-3, 4B-4*	*3.5, 3.6*	*3.7, 4A-3, 4B-7*	*3.8, 3.9, 3.10, 4A-1, 4A-3, 4B-9, 4B-10*	*5.1, 5.2, 6.1, 6.2*
Country	*City*						
Bangladesh*	**Chittagong**	X	X	X	X	X	
	Tangail	X	X		X	X	
Bolivia*	**Cochabamba**	X	X	X		X	X
	El Alto	X	X			X	X
	La Paz	X	X	X	X	X	X
	Santa Cruz	X	X			X	X
Botswana*	**Gaborone**	X	X		X	X	X
Brazil*	**Brasilia**	X		X			
	Curitiba	X	X	X	X	X	X
	Recife	X		X			
	Rio de Janeiro	X	X	X	X	X	X

Burkina Faso	Bobo-Dioulassou	X	X		X	X	
	Koudougou	X	X		X	X	
	Ouagadougou	X	X		X	X	
Cameroon*	Douala	X	X		X	X	
	Yaounde	X	X			X	
Canada	Toronto	X	X	X	X	X	X
Chile*	Santiago	X	X	X	X	X	X
Colombia*	Bogota	X		X	X	X	X
Congo*	Brazzaville	X			X	X	
Cote d'Ivoire*	Abidjan	X	X	X	X	X	
	Bouake		X		X		
Denmark	Copenhagen	X	X	X	X	X	X
Ecuador*	Guayaquil	X	X	X	X	X	
Egypt*	Assiout	X	X		X	X	
	Cairo	X	X	X	X	X	
	Gharbeya	X	X		X	X	
	Tenth of Ramadan	X					
El Salvador*	San Miguel	X	X		X	X	
	San Salvador	X	X	X	X	X	
	Santa Ana	X	X		X	X	
Gambia*	Banjul	X	X		X	X	

Germany	Duisburg	X	X	X	X	X	X
	Erfurt	X	X	X		X	X
	Koeln		X	X	X		X
Ghana*	Kumasi	X	X		X		
	Tamale	X	X		X		
Greece*	Athens	X	X	X	X	X	
Guatemala*	Guatemala City	X	X				
Guinea*	Conakry	X	X		X	X	
India*	Bangalore	X	X	X	X	X	X
	Bhiwandi	X	X	X	X	X	X
	Chennai	X	X	X	X	X	X
	Delhi	X	X	X	X	X	X
	Gulbarga	X	X		X	X	X
	Hubli-Dharbad	X	X		X	X	X
	Lucknow	X	X		X	X	X
	Mumbai	X	X	X	X	X	X
	Mysore	X	X		X	X	X
	Tumkur	X	X		X	X	X
	Varanasi	X	X		X	X	X
Indonesia*	Bandung	X	X	X	X	X	X
	Banjarmasi	X	X		X	X	X
	Jakarta	X		X	X	X	X
	Medan	X	X	X	X	X	X
	Semarang	X	X	X	X	X	X
	Surabaya	X	X	X	X	X	X

Jordan*	**Amman**	**X**	**X**		**X**	**X**	
Kenya*	**Mombasa**	**X**	**X**		**X**	**X**	
	Nairobi	**X**	**X**	**X**			
	Nakuru	**X**	**X**		**X**	**X**	
Madagascar*	**Antanarararivo**	**X**	**X**		**X**	**X**	
Morocco*	**Rabat**	**X**	**X**		**X**	**X**	
Namibia*	**Windhoek**	**X**	**X**		**X**	**X**	
Netherlands	**Amsterdam**	**X**	**X**	**X**	**X**	**X**	**X**
	Tilburg	**X**	**X**	**X**	**X**		**X**
Niger*	**Niamey**	**X**	**X**		**X**	**X**	
Nigeria*	**Ibadan**	**X**	**X**			**X**	
	Kano	**X**	**X**				
	Lagos	**X**	**X**				
	Onitsha	**X**	**X**			**X**	
Paraguay*	**Asuncion**	**X**	**X**	**X**	**X**		**X**
Peru*	**Cajamarca**	**X**	**X**		**X**	**X**	**X**
	Lima	**X**	**X**	**X**	**X**	**X**	**X**
	Trujillo	**X**		**X**	**X**	**X**	**X**
Senegal*	**Dakar**	**X**	**X**	**X**	**X**	**X**	
Sierra Leone*	**Freetown**	**X**	**X**		**X**	**X**	
Sri Lanka*	**Colombo**	**X**	**X**		**X**	**X**	
Sudan*	**Khartoum**	**X**	**X**		**X**	**X**	
Sweden	**Stockholm**	**X**	**X**	**X**	**X**	**X**	**X**

Tanzania*	Arusha	X	X		X	X	
	Dar Es Salaam	X	X		X	X	
	Mwanza	X	X		X	X	
Tunisia*	Tunis	X	X		X	X	
Uganda*	Mbale		X		X	X	
United Kingdom	Bedfordshire		X		X		
	Cardiff		X		X		
	Hertfordshire		X				
Yemen*	Sana'a	X	X		X	X	
Zimbabwe*	Bulawayo	X	X		X	X	X
	Harare	X			X	X	X
Total number of cities		85	83	30	76	75	40
Total number of countries		42	42	16	42	41	13

Notes. 1. All "transition economies" (i.e. the Eastern European and former Soviet Union countries), as well as countries with a Socialist background, including China and Cuba, were dropped from the samples, because these were not considered comparable with the other countries.
2. A cross is used to indicate each city included in the sample for the relevant regression. The choice of which cities to include in each set of regressions was based entirely on data availability. The sample differs for the six different sets of regressions (i.e. for the water, education and health sectors, as well as those explaining child mortality and tax or revenue), because different cities have different variables with missing data. The overlap among these six different samples, however, is very large, as the table indicates.
3. All countries classified by the World Bank as "High Income" in 1993 were considered developed countries. The rest were considered developing countries, and are marked with an asterisk in the table.

Table 1.2B. Summary Statistics for Regression Samples[1,2,4]
(with all countries – developed and developing – included)

		Sector Regressions					Tax and Revenue Regressions
		Water Sector	*Education Sector (excluding enrolment rate regressions)*	*Education Sector (enrolment rate regressions only)*	*Health Sector*	*Child Mortality*	*Tax and Revenue*
Regression numbers:		*3.1, 3.2, 4A-1, 4B-1, 4B-2, 5.3, 6.3*	*3.3, 3.4, 4A-2, 4B-3, 4B-4*	*3.5, 3.6*	*3.7, 4A-3, 4B-7*	*3.8, 3.9, 3.10, 4A-1, 4A-3, 4B-9, 4B-10*	*5.1, 5.2, 6.1, 6.2*
Variable							
City population	***Mean***	**1,926**	**1,769**	**3,441**	**2,067**	**2,085**	**2,691**
(thousands)	***Std. Dev.***	**2,967**	**2,712**	**3,999**	**3,182**	**3,164**	**3,474**
	Maximum	**9,926** ***(Mumbai, India)***	**9,926** ***(Mumbai, India)***	**9,926** ***(Mumbai, India)***	**9,926** ***(Mumbai, India)***	**9,926** ***(Mumbai, India)***	**9,926** ***(Mumbai, India)***
	Minimum	**50** ***(Tenth of Ramadan, Egypt)***	**54** ***(Mbale, Uganda)***	**213** ***(Erfurt, Germany)***	**54** ***(Mbale, Uganda)***	**59** ***(Cajamarca, Peru)***	**59** ***(Cajamarca, Peru)***

City per-capita product ($/year)	*Mean*	3,854	4,048	7,218	4,017	4.091	6,218
	Std. Dev.	7,875	8,217	11,041	8,366	8,217	10,599
	Maximum	38,181 *(Cologne, Germany)*	38,181 *(Cologne, Germany)*	38,181 *(Cologne, Germany)*	38,181 *(Cologne, Germany)*	38,181 *(Cologne, Germany)*	38,181 *(Cologne, Germany)*
	Minimum	247 *(Sana'a, Yemen)*	247 *(Sana'a, Yemen)*	261 *(Chittagong, Bangladesh)*	247 *(Sana'a, Yemen)*	247 *(Sana'a, Yemen)*	287 *(Lucknow, India)*
City population growth rate (%)	*Mean*	3.7	3.5	2.7	3.7	3.7	3.2
	Std. Dev.	3.2	3.3	3.9	3.3	3.3	3.9
City population density (persons per hectare)	*Mean*	195				205	200
	Std. Dev.	176				181	178
Proportion of sub-standard housing in city	*Mean*	0.39		0.36		0.37	0.32
	Std. Dev.	0.29		0.30		0.29	0.28
Proportion in city with piped water connections	*Mean*	0.61					
	Std. Dev.	0.29					
Average per-person residential water use (litres/person/day)	*Mean*	124					
	Std. Dev.	89					
Average number of primary-school children per classroom	*Mean*		42				
	Std. Dev.		16				
Average number of secondary-school children per classroom	*Mean*		42				
	Std. Dev.		15				
Proportion of eligible children enrolled in primary school	*Mean*			90			
	Std. Dev.			15			
Proportion of eligible children enrolled in secondary school	*Mean*			67			
	Std. Dev.			30			
Average number of hospital beds per city resident	*Mean*				0.004		
	Std. Dev.				0.003		

Child mortality rate (proportion of children dying before age 5)		*Mean*					0.06	
		Std. Dev.					0.05	
Total taxes per city resident ($)		*Mean*						1,725
		Std. Dev.						3,175
Total public expenditure per city resident ($)		*Mean*						2,128
		Std. Dev.						3,874
Median price of water ($/m³)		*Mean*	1.12					
		Std. Dev.	2.39					
Water Sector	Decentralization in public sector[2] ($D_{PS,w}$)	*Mean*	0.24				0.28	
	Partial private-sector involvement[2] (PP_w)	*Mean*	0.11				0.09	
Education Sector	Decentralization in public sector[2] ($D_{PS,e}$)	*Mean*		0.14	0.14			
	Partial private-sector involvement[2] (PP_e)	*Mean*		0.75	0.63			
Health Sector	Decentralization in public sector[2] ($D_{PS,h}$)	*Mean*				0.12	0.12	
	Partial private-sector involvement[2] (PP_h)	*Mean*				0.71	0.74	
3-Sector Decentralization Index[3]		*Mean*						0.15
3-Sector Privatization Index[3]		*Mean*						0.69
Dummy for malaria[2]		*Mean*					0.59	
Dummy for "countries that fought for independence"		*Mean*	0.20	0.18		0.20		

Total country population (millions)	*Mean* *Std. Dev.*	149 (282)	156 (293)		162 (298)		
	Total number of cities	85	83	30	76	75	40
	Total number of countries	42	42	16	42	41	13

Notes. 1. See Table 2a.
2. The "Decentralization in Public Sector", "Partial Private-Sector Involvement", "countries that fought for independence" and malaria variables are all dummy variables that take the value 0 or 1. For each of these dummies, the mean indicates the proportion of cities for which it takes the value 1.
3. The 3-Sector Decentralization Index and the 3-Sector Privatization Index variables are each a weighted sum of 3 dummy variables: the decentralization or private-sector involvement variables for each of the three sectors analyzed. The main text (Section 4) and the Data Appendix explain how these indices are constructed. Each takes a value between zero and one (inclusive).
4. All data are for the year 1993.

Table 1.2C. Summary Statistics for Regression Samples[1,2,4] (with only developing[5] countries included)

		Sector Regressions				Tax and Revenue Regressions
		Water Sector	*Education Sector (excluding enrolment rate regressions)*	*Health Sector*	*Child Mortality*	*Tax and Revenue*
Regression numbers:		*7.1, 7.2, 8A-1, 8B-1, 8B-2, 9.3, 10.3*	*7.3, 7.4, 8A-2, 8B-3, 8B-4*	*7.7, 8A-3, 8B-7*	*7.8, 7.9, 7.10, 8A-1, 8A-3, 8B-9, 8B-10*	*9.1, 9.2, 10.1, 10.2*
Variable						
City population (thousands)	*Mean*	2,058	1,889	2,196	2,236	3,035
	Std. Dev.	3,113	2,854	3,330	3,315	3,704
	Maximum	9,926	9,926	9,926	9,926	9,926
		(Mumbai, India)	*(Mumbai, India)*	*(Mumbai, India)*	*(Mumbai, India)*	*(Mumbai, India)*
	Minimum	50	54	54	59	59
		(Tenth of Ramadan, Egypt)	*(Mbale, Uganda)*	*(Mbale, Uganda)*	*(Cajamarca, Peru)*	*(Cajamarca, Peru)*
City per-capita product ($/year)	*Mean*	1,166	1,091	1,143	1,202	1,282
	Std. Dev.	1,457	1,474	1,462	1,505	1,466
	Maximum	5,850	5,850	5,850	5,850	5,850
		(Rio de Janeiro, Brazil)	*(Rio de Janeiro, Brazil)*	*(Rio de Janeiro, Brazil)*	*(Rio de Janeiro, Brazil)*	*(Rio de Janeiro, Brazil)*
	Minimum	247	247	247	247	287
		(Sana'a, Yemen)	*(Sana'a, Yemen)*	*(Sana'a, Yemen)*	*(Sana'a, Yemen)*	*(Lucknow, India)*
City population growth rate (%)	*Mean*	4.2	4.3	4.1	4.2	3.9
	Std. Dev.	3.1	2.7	3.3	3.3	4.0

City population density (persons per hectare)	*Mean* *Std. Dev.*	226 191			228 192	230 193
Proportion of sub-standard housing in city	*Mean* *Std. Dev.*	0.44 0.28			0.42 0.27	0.39 0.27
Proportion in city with piped water connections	*Mean* *Std. Dev.*	0.55 0.26				
Average per-person residential water use (litres/person/day)	*Mean* *Std. Dev.*	110 74				
Average number of primary-school children per classroom	*Mean* *Std. Dev.*		45 16			
Average number of secondary-school children per classroom	*Mean* *Std. Dev.*		45 14			
Average number of hospital beds per city resident	*Mean* *Std. Dev.*			0.003 0.002		
Child mortality rate (proportion of children dying before age 5)	*Mean* *Std. Dev.*				0.07 0.05	
Total taxes per city resident ($)	*Mean* *Std. Dev.*					166 185
Total public expenditure per city resident ($)	*Mean* *Std. Dev.*					220 338
Median price of water ($/m³)	*Mean* *Std. Dev.*	1.06 2.55				
Water Sector: Decentralization in public sector[2] ($D_{PS,w}$)	*Mean*	0.23			0.26	
Water Sector: Partial private-sector involvement[2] (PP_w)	*Mean*	0.11			0.11	

Education Sector	Decentralization in public sector[2] ($D_{PS,e}$)	*Mean*		0.12			
	Partial private-sector involvement[2] (PP_e)	*Mean*		0.82			
Health Sector	Decentralization in public sector[2] ($D_{PS,h}$)	*Mean*			0.10	0.10	
	Partial private-sector involvement[2] (PP_h)	*Mean*			0.78	0.81	
3-Sector Decentralization Index[3]		*Mean*					0.14
3-Sector Privatization Index[3]		*Mean*					0.83
Dummy for malaria[2]		*Mean*				0.76	
Dummy for "countries that fought for independence"		*Mean*	0.23	0.21	0.20	0.23	
Total country population (millions)		*Mean*	164	174	170	179	
		Std. Dev.	(298)	(312)	(306)	(315)	
		Total number of cities	78	72	67	69	32
		Total number of countries	37	36	36	36	8

Notes. 1. To 4. See Table 2b.
5. See note 3 for Table 2a.

Table 1.3 Part I. Are Decentralized Cities Better In Providing Local Public Goods? (Regression Analysis of Public Good Output and Impact Indicators, with Decentralization Treated As Exogenous)							
Sector	*Water*		*Education*				*Health*
Regression number	*(3.1)*	*(3.2)*	*(3.3)*	*(3.4)*	*(3.5)*	*(3.6)*	*(3.7)*
Dependent variable[2,4]	*Proportion of residents with piped water*[1]	*Log of average per-person residential water use*[3,6]	*-[Log of average primary -school class size]*[3,7]	*-[Log of average secondary -school class size]*[3,7]	*Proportion of eligible children enrolled in primary-school*[1]	*Proportion of eligible children enrolled in secondary-school*	*Log of average number of hospital beds per person*[3]
Constant	0.39 (1.59)	4.05** (8.92)	-3.84* (-17.08)	-4.23** (-17.17)	0.69** (3.26)	0.21 (0.78)	-6.91** (-8.92)
Log of per-capita city product[1,3]	0.05** (1.97)	0.13** (2.65)	0.06** (2.72)	0.09** (3.62)	0.05** (3.31)	0.08** (2.72)	0.21** (2.57)
Proportion of sub-standard housing in city[6]	-0.25** (-2.22)	-0.08 (-0.25)			-0.02 (-0.17)	-0.20* (-1.75)	
Decentralization in public sector[5] (D_{PS})	0.11* (1.91)	0.31** (2.10)	0.09** (1.98)	0.11** (2.11)	-0.06 (-0.76)	0.16 (1.23)	-0.36 (-0.83)
Partial private-sector involvement[5] (PP)	0.04 (0.43)	0.23* (1.78)	-0.07 (-1.33)	-0.06 (-0.91)	0.06 (0.09)	0.004 (0.04)	-0.43** (-2.27)
Ethnolinguistic fractionalization	-0.47** (-3.99)	-0.49* (-1.86)	-0.09 (-0.90)	-0.01 (-0.08)	0.04 (0.24)	-0.17 (-1.16)	0.20 (0.54)
City population growth rate	-0.66 (-0.58)	-1.39 (-0.60)	-4.32** (-2.65)	-0.70 (-0.47)	-0.91 (-0.62)	-1.38 (-0.80)	-3.98* (-1.89)
Log of city population[3]	0.05** (2.16)	0.20** (3.31)	0.01 (0.05)	-0.02 (-0.58)	0.05** (2.56)	-0.007 (-0.32)	0.04 (0.31)
Log of city population density[3]	-0.007 (-0.20)	0.12 (1.07)					
Observations	85	85	83	83	30	30	76
R^2	0.60	0.39	0.47	0.33	0.42	0.55	0.34

Notes: 1. The per-capita city product is the total city output, divided by the city population.

2. T-statistics are given in parentheses. The "*" and "**" symbols denote variables that are significant at the 10% and 5% levels, respectively.

3. All variables with a skewed univariate distribution were converted to logs before estimation.

4. Ordinary least-squares estimation was used for all regressions. In all cases, the Huber/White method was used to obtain robust variance estimators (Huber, 1967; White, 1980).

5. The decentralization and privatization variables are dummy variables; they are fully defined in the main text (Section 4). For each public good sector, provision can be characterized by one of the following: (i) decentralization in the public sector ($D_{PS}=1$, $C_{PS}=0$), either with or without partial private-sector involvement (i.e. with $PP=1$ or $PP=0$); or (ii) full or partial centralization in the public sector ($C_{PS}=1$, $D_{PS}=0$), with either $PP=1$ or $PP=0$.

(continued on next page, under Table 1.3 Part II)

Table 1.3 Part II. Are Decentralized Cities Better in Providing Local Public Goods? (Regression Analysis of Public Good Output and Impact Indicators, with Decentralization Treated As Exogenous)

Regression number	*(3.8)*	*(3.9)*	*(3.10)*
Dependent variable[2,4]	*Child mortality*[8]	*Child mortality*[8]	*Child mortality*[8]
Constant	0.08** (2.22)	0.07* (1.86)	0.08* (2.81)
Log of per-capita city product[1,3]	-0.006* (-1.88)	-0.006** (-1.98)	-0.006** (-2.00)
Proportion of sub-standard housing in city[6]	0.04* (1.79)	0.05** (2.10)	0.04* (1.86)
Decentralization in public Sector[5], for water provision ($FD_{PS,w}$)	-0.03** (-2.13)		-0.02** (-2.14)
Partial private-sector involvement[5], for water provision (PP_w)	-0.02 (-1.36)		-0.02 (-1.52)
Decentralization in public sector[5], for health care provision ($FD_{PS,h}$)	-0.03 (-1.36)	-0.03* (-1.71)	
Partial private-sector involvement[5], for health care provision (PP_h)	-0.002 (-0.18)	0.005 (0.50)	
Ethnolinguistic fractionalization	0.004 (0.20)	-0.004 (-0.25)	0.002 (0.12)
City population growth rate	0.26 (0.93)	0.32 (1.18)	0.27 (1.00)
Log of city population[3]	-0.02* (-1.89)	-0.01* (-1.82)	-0.01 (-1.59)
Log of city population density[3]	-0.02** (-2.10)	-0.02** (-2.14)	-0.02* (-1.95)
Dummy for malaria[9]	0.03** (2.71)	0.04** (3.36)	0.03** (2.99)
No. of observations	75	75	75
R^2	0.40	0.36	0.39

Notes: (continuation from previous page, under Table 3 Part I)

6. In regression (3.2), the dependent variable includes consumption of piped water as well as water from other sources, e.g. buckets bought from private vendors, and water collected from streams.
7. Class size (in regressions 3.3 and 3.4) is the number of students per classroom.
8. Child mortality (regressions 3.8 to 3.10) is the proportion of all children who die before the age of 5.
9. The dummy for cities in malaria-endemic areas captures the increased endemic risk in these areas of contracting malaria. Data for this dummy variable is from Gallup, Sachs and Mellinger (1999), and is based on information from the World Health Organization.

Table 1.4A. Decentralization As a Dependent Variable: A Probit Analysis (First Stage Equations in Two-Step Estimation Procedure)			
	Water Sector	*Education Sector*	*Health Sector*
Regression number	*(4A-I)*	*(4A-II)*	*(4A-II)*
Dependent variable[2,5,6]	*Decentralization*[4]	*Decentralization*[4]	*Decentralization*[4]
Constant	-8.86** (-4.63)	-4.06** (-2.40)	-9.61** (-2.66)
Log of per-capita city product[1,3]	0.34** (2.84)	0.26* (1.90)	0.37 (1.60)
Ethnolinguistic fractionalization	0.72 (1.25)	0.23 (0.33)	1.14 (1.04)
Log of city population[3]	-0.04 (-0.31)	-0.19 (-1.09)	-0.31 (-1.37)
Dummy for "countries that fought for independence"[7]	0.93** (2.60)	1.08** (2.70)	2.07** (3.83)
Log of total country population	0.30** (3.44)	0.04 (0.48)	0.25** (2.17)
No. of observations	85	83	76
Pseudo R^2	0.14	0.16	0.27

Notes: 1 to 3. See notes for Table 1.3 Part I.

4. For each sector, the dependent variable in each regression – decentralization – takes the value one if there is "decentralization in the public sector" ($C_{PS}=0$, $D_{PS}=1$). Otherwise, it takes the value zero. All regressions were done
using the probit procedure (Greene, 1997).

5. A dummy for capital cities – which are more likely to have self-rule – is another variable which should in principle be inserted on the right hand side. But it was omitted because, in practice, it is highly correlated with the "log of city population" variable, and because its introduction makes little difference anyway to the coefficients and t-statistics for the other variables (besides the city population variable). Also, its introduction makes little difference to the main results of interest in the second-stage regressions of the two-stage procedure (in Table 1.4B).

6. The "partial private-sector involvement" variable (PP) may in principle affect the relative probabilities of occurrence of full decentralization, partial decentralization and full centralization in the public sector. When introduced into the regression, however, its coefficient is insignificant (and very small), and it makes very little difference to the results.

7. The dummy variable for "countries that fought for independence" takes the value 1 for countries that were colonized or occupied in modern times (from 1750 onwards) – not counting temporary occupations such as during the World Wars – and which engaged in war to repel their colonizers. See the main text for more details.

Table 1.4B. Does Decentralization Improve the Provision of Local Public Goods? (Regression Analysis of Public Good Output and Impact Indicators: Second Stage Equations in Two-Step Estimation Procedure, With Decentralization Treated As Endogenous)[10]

	Water Sector		*Education Sector*		*Health Sector*	*Child Mortality Equations[11]*	
Regression number	*(4B-1)*	*(4B-2)*	*(4B-3)*	*(4B-4)*	*(4B-7)*	*(4B-9)*	*(4B-10)*
Dependent variable[2,3]	*Proportion of city population with piped water[1]*	*Log of average per-person residential water use[3,6]*	*-[Log of average primary-school classroom size][3,7]*	*-[Log of average secondary-school classroom size][3,7]*	*Log of average number of hospital beds per person[3]*	*Child mortality[11]*	*Child mortality[11]*
Constant	0.32 (1.11)	4.10** (5.23)	-3.85** (-13.20)	-4.46** (-13.92)	-7.71** (-7.21)	0.08* (1.71)	0.05 (0.94)
Log of per-capita city product[1,3]	0.06** (2.01)	0.12** (2.13)	0.05* (1.67)	0.09** (3.23)	0.26** (3.21)	-0.005* (-1.85)	-0.006** (-1.99)
Proportion of sub-standard housing in city[6]	-0.25** (-1.99)	0.04 (0.13)				0.09** (3.67)	0.07** (3.18)
Decentralization in public sector[5] (D_{PS})	0.04 (0.41)	0.16 (0.95)	0.07 (1.49)	0.06 (0.96)	-0.29 (-0.62)	*Health Sector:* -0.02 (-1.21)	*Water Sector:* -0.01 (-0.91)
Partial private-sector involvement[5] (PP)	0.02 (0.27)	0.17 (1.28)	-0.07 (-1.14)	-0.05 (-0.68)	-0.50** (-2.17)	*Health Sector:* 0.004 (0.48)	*Water Sector:* 0.001 (0.06)
Ethnolinguistic fractionalization	-0.44* (-3.23)	-0.32 (-1.05)	-0.03 (-0.23)	0.16 (0.97)	0.65 (1.36)	-0.01 (-0.47)	-0.02 (-1.02)
City population growth rate	-0.24 (-0.21)	-5.16 (-1.42)	-4.28** (-2.12)	-0.96 (-0.45)	-5.74** (-2.34)	0.28 (0.98)	0.30 (0.95)
Log of city population[3]	0.04** (2.09)	0.18** (2.75)	0.04 (1.26)	-0.004 (-0.11)	-0.002 (-0.02)	-0.008 (-1.48)	-0.009* (-1.70)
Log of city population density[3]	-0.0008 (-0.05)	0.10 (0.99)				-0.02* (-1.88)	-0.02* (-1.81)

Dummy for malaria[9]						0.03** (2.45)	0.03** (2.60)
Mills ratio variable[4]	0.09* (1.74)	0.22** (2.23)	0.37** (2.46)	0.30** (1.98)	-0.20 (-0.28)	-0.07** (-2.10)	-0.07** (-2.41)
No. of observations	85	85	83	83	76	75	75
R^2	0.62	0.45	0.53	0.37	0.35	0.41	0.43
Estimated $\hat{\rho}_k$ [10]	0.51	0.71	0.65	0.61	-0.12	-0.49	0.53

Notes: 1. to 3. and 6. to 9. See notes for Table 1.3.

4. The estimated equations in this table are second-stage equations in a two-stage estimation procedure. The procedure, based on the "treatment effects" model (Greene, 1997) and is fully explained in the text. The first-stage equations are given in Table 1.5A. For each second-stage sector regression (4B-1 to 4B-7), the results from estimating the first-stage equation *for that sector* (reported in Table 1.4A) are used to form a "Mills ratio" value for each observation. The "Mills ratio" is essentially a function of the estimated coefficients as well as the right-hand side variables in the relevant first-stage equation. Full details are given in the main text. For the first child mortality equation (regression 4B-9), the relevant first-stage equation is the health sector equation in Table 1.4A, but estimated using the child mortality sample (see Table 1.2a). The Results of this first-stage equation are not reported, but they are very similar to the health sector results in Table 4A. For the second child mortality equation (regression 4B-10), the relevant first-stage equation is the *water* sector equation in Table 1.4A, estimated using the child mortality sample (see Table 1.2a). Here too, these first-stage results are similar to the water sector results in Table 4A.

10. The parameter ρ_k is the correlation between the error terms in: (i) equation (1.7), the relevant first-stage equation; and in: (ii) equation (1.5) or (1.6), the second-stage equation without the "Mills ratio" variable. See main text for further details.

11. In the first child mortality regression (4B-9), the variables "decentralization in the public sector" and "partial private-sector involvement" pertain to the health sector only. In the second child mortality regression (4B-10), these two variables pertain to the water sector only.

Table 1.5. Are Decentralized Cities Better in Providing Public Goods? (Regression Analysis of Price, Taxes and Public Revenue, Treating Decentralization As Exogenous)			
	All Sectors		*Water Sector*
Regression number	*(5.1)*	*(5.2)*	*(5.3)*
Dependent variable[2,4]	*Log of total taxes (collected by all levels of government) per resident*[3,6]	*Log of total public revenue including borrowing (going to all levels of government), per resident*[3,6]	*Log of median price of water*[3,7]
Constant	-9.93** (-8.16)	-10.47** (-6.15)	-5.55** (-4.90)
Log of per-capita city product[1,3]	0.71** (4.69)	0.86** (5.62)	0.53** (4.11)
Proportion of sub-standard housing in city[6]	-0.07 (-0.16)	0.42 (0.71)	-0.45 (-0.47)
Decentralization in public sector[5], for water provision ($D_{PS,w}$)			-0.24 (-0.55)
Partial private-sector involvement[5], for water provision (PP_w)			1.11* (1.73)
Three-Sector Decentralization Index[8]	-0.02 (-1.10)	0.01 (1.01)	
Three-Sector Private-Sector Involvement Index[8]	-0.001 (-0.06)	0.02 (0.82)	
Ethnolinguistic fractionalization	0.22 (0.62)	0.06 (0.11)	2.06** (2.81)
City population growth rate	0.99 (0.76)	0.17 (0.10)	-3.93 (-0.53)
Log of city population[3]	0.07 (1.45)	0.10 (1.25)	-0.38 (-0.46)
Log of city population density[3]	-0.18 (-1.05)	-0.08 (-0.82)	-0.64* (-1.72)
No. of observations	40	40	85
R^2	0.98	0.97	0.27

Notes: 1 to 5. See notes for Table 1.3 Part I.

6. To obtain the dependent variable in regression equation (5.1), total taxes collected in each city by all levels of government – including the local government – were divided by the city population. For the dependent variable in equation (5.2), the total expenditure (or total revenue plus grants and borrowing) by all levels of government in the city, including the local government (and excluding intergovernmental transfers), was divided by the city population.

7. In regression equation (5.3), the left-hand side variable is the median of prices faced by all household users for purchased water. This includes piped water as well as water sold (in bulk, non-piped form) by private vendors. For households without piped water that choose to fetch water themselves, the price faced is the pricepaid (or an estimate thereof) *if* they were to buy from a private vendor.

8. The 3-Sector Decentralization Index variable is a weighted sum of 3 dummy variables: the full decentralization variables for each of the three sectors analyzed. The weighting across sectors reflects the approximate contribution of each sector to the total government budget. The 3-Sector Privatization Index is similarly defined, using mainly the three partial private-sector involvement variables. Full details of both are given in the main text (section 1.4) and the Data Appendix.

Table 1.6. Are Decentralized Cities Better in Providing Public Goods? (Regression Analysis of Price, Taxes and Public Revenue, Treating Decentralization As Endogenous)			
	All Sectors		*Water Sector*[10]
Regression number	*(6.1)*	*(6.2)*	*(6.3)*
Dependent variable[2,3]	*Log of total taxes (collected by all levels of government) per resident*[3,6]	*Log of total public revenue including borrowing (going to all levels of government), per resident*[3,6]	*Log of median price of water*[3,7]
Constant	-9.78** (-9.05)	-10.46** (-6.32)	-5.96** (-4.24)
Log of per-capita city product[1,3]	0.71** (4.66)	0.90** (5.43)	0.54** (3.75)
Proportion of sub-standard housing in city[6]	0.50 (0.46)	0.40 (0.48)	-0.14 (-0.16)
Decentralization in public sector[5], for water provision ($D_{PS,w}$)			0.61 (0.50)
Partial private-sector involvement[5], for water provision (PP_w)			1.22* (1.70)
Three-Sector Decentralization Index[8] (Instrumented)[4]	0.05 (0.26)	0.03 (0.23)	
Three-Sector Private-Sector Involvement Index[8]	0.02 (0.31)	0.02 (0.57)	
Ethnolinguistic fractionalization	0.07 (0.13)	0.04 (0.06)	1.85** (2.09)
City population growth rate	0.79 (0.48)	0.21 (0.12)	-4.10 (-0.54)
Log of city population[3]	0.17 (0.52)	0.16 (0.57)	-0.17 (-0.97)
Log of city population density[3]	-0.20 (-1.11)	-0.09 (-0.89)	-0.40 (-1.32)
Mills ratio variable[4]			-0.51 (-0.70)
No. of observations	40	40	85
R^2	0.97	0.97	0.28
Estimated $\hat{\rho}_k$ [10]			-0.16

Notes: 1 to 3. See notes for Table 1.3 Part I.

4. Regressions (6.1) and (6.2) were estimated via Two-Stage Least Squares, with the following two instruments used for the endogenous Three-Sector Decentralization Index variable: (i) a dummy variable for countries that fought for independence, and: (ii) the log of the total country population. These also appeared in the regressions of Tables 1.4A and 1.5A; see also note 7 of Table 1.4A and the main text. The water sector regression (6.3) was estimated as a second-stage equation, with the first-stage regression being regression (4A-I) in Table 1.4A. The Mills ratio variable in regression (7.3) is a function of the estimated coefficients as well as the right-hand side variables in the first-stage equation. See note 4 of Table 4B and the main text (Section 1.4-II).

5. See notes for Table 1.3 Part I.

6. to 8. See notes for Table 1.5.

10. See note for Table 1.4B.

Table 1.7 Part I. Are Decentralized Cities Better in Providing Local Public Goods? (Regression Analysis of Public Good Output and Impact Indicators, with Decentralization Treated As Exogenous, and Including Only Developing Countries)

	Water Sector		*Education Sector*		*Health Sector*
Regression number	*(7.1)*	*(7.2)*	*(7.3)*	*(7.4)*	*(7.7)*
Dependent variable[2,4]	*Proportion of city population with piped water*[1]	*Log of average per-person residential water use*[3,6]	*-[Log of average primary-school classroom size]*[3,7]	*-[Log of average secondary-school classroom size]*[3,7]	*Log of average number of hospital beds per person*[3]
Constant	0.48** (2.09)	2.99** (4.56)	-3.72** (-15.53)	-3.67** (-10.77)	-6.70** (-7.48)
Log of per-capita city product[1,3]	0.04** (1.99)	0.11** (1.96)	0.09** (2.23)	0.08** (2.43)	0.20* (1.96)
Proportion of sub-standard housing in city[6]	-0.16** (-2.01)	-0.08 (-0.20)			
Decentralization in public sector[5,10] (D_{PS})	0.13** (1.99)	0.41** (2.20)	0.10* (1.83)	0.11** (2.05)	-0.46 (-0.71)
Partial private-sector involvement[5] (PP)	0.01 (0.16)	-0.22 (-1.27)	-0.06 (-0.93)	-0.01 (-0.18)	-0.46** (-2.13)
Ethnolinguistic fractionalization	-0.42** (-3.78)	-0.87** (-2.81)	-0.07 (-0.76)	-0.05 (-0.36)	0.26 (0.69)
City population growth rate	0.01 (0.02)	-2.37 (-0.83)	-4.05** (-2.62)	-0.10 (-0.08)	-3.92* (-1.82)
Log of city population[3]	0.04* (1.80)	0.19** (2.76)	0.02 (0.75)	0.02 (0.75)	-0.02 (-0.25)
Log of city population density[3]	-0.01 (-0.27)	0.15 (1.19)			
No. of observations	78	78	72	72	67
R^2	0.64	0.40	0.36	0.25	0.21

Notes:
1. to 9. See notes for Table 1.3.

Table 1.7 Part II. Are Decentralized Cities Better in Providing Local Public Goods? (Regression Analysis of Public Good Output and Impact Indicators, with Decentralization Treated As Exogenous, and Including Only Developing Countries)

Regression number	*(7.8)*	*(7.9)*	*(7.10)*
Dependent variable[2,4]	*Child mortality*[8]	*Child mortality*[8]	*Child mortality*[8]
Constant	0.08**	0.06	0.08**
	(2.04)	(1.48)	(2.58)
Log of per-capita city product[1,3]	-0.007*	-0.006*	-0.007**
	(-1.74)	(-1.86)	(-2.16)
Proportion of sub-standard housing in city[6]	0.05*	0.05**	0.05*
	(1.86)	(2.05)	(1.90)
Decentralization in public sector[5], for water provision ($FD_{PS,w}$)	-0.03**		-0.03**
	(-2.14)		(-2.16)
Partial private-sector involvement[5], for water provision (PP_w)	-0.02		-0.02
	(-1.38)		(-1.56)
Decentralization in public sector[5], for health care provision ($FD_{PS,h}$)	-0.02	-0.02	
	(-1.51)	(-1.59)	
Partial private-sector involvement[5], for health care provision (PP_h)	-0.001	0.006	
	(-0.12)	(0.60)	
Ethnolinguistic fractionalization	0.004	-0.004	0.003
	(0.21)	(-0.23)	(0.14)
City population growth rate	0.26	0.32	0.26
	(0.90)	(1.15)	(0.93)
Log of city population[3]	-0.01**	-0.01**	-0.01*
	(-2.00)	(-2.23)	(-1.94)
Log of city population density[3]	-0.02*	-0.02**	-0.02*
	(-1.90)	(-2.21)	(-1.72)
Dummy for malaria[9]	0.03*	0.04**	0.03**
	(2.64)	(3.26)	(3.02)
No. of observations	69	69	69
R^2	0.39	0.34	0.37

Notes:
1. to 9. See notes for Table 1.3.

Table 1.8A. Decentralization As a Dependent Variable: A Probit Analysis (Including Only Developing Countries)			
	Water Sector	*Education Sector*	*Health Sector*
Regression number	*(8A-I)*	*(8A-II)*	*(8A-II)*
Dependent variable[2,5,6]	*Decentralization*[4]	*Decentralization*[4]	*Decentralization*[4]
Constant	-8.81** (-4.30)	-2.04 (-0.84)	-4.38** (-2.08)
Log of per-capita city product[1,3]	0.25** (2.15)	0.28* (1.70)	0.21 (1.03)
Ethnolinguistic fractionalization	0.88 (1.51)	1.81 (1.53)	2.52* (1.96)
Log of city population[3]	-0.11 (-0.70)	-0.19 (-0.11)	-0.41 (-1.47
Dummy for "countries that fought for independence"[7]	1.18** (2.83)	2.35** (3.28)	3.27** (3.32)
Log of total country population	0.33** (3.40)	0.002 (0.02)	0.09 (1.32)
No. of observations	78	72	67
Pseudo R^2	0.17	0.29	0.43

Notes:
1 to 7. See notes for Table 1.4A.

Table 1.8B. Are Decentralized Cities Better In Providing Local Public Goods? (Regression Analysis of Public Good Output and Impact Indicators: Second Stage Equations in Two-Step Estimation Procedure, Including Only Developing Countries)[10]

	Water Sector		*Education Sector*		*Health Sector*	*Child Mortality Equations*[11]	
Regression number	*(8B-1)*	*(8B-2)*	*(8B-3)*	*(8B-4)*	*(8B-7)*	*(8B-9)*	*(8B-10)*
Dependent variable[2,4]	*Proportion of city population with piped water*[1]	*Log of average per-person residential water use*[3,6]	*-[Log of average primary-school classroom size]*[3,7]	*-[Log of average secondary-school classroom size]*[3,7]	*Log of average number of hospital beds per person*[3]	*Child mortality*[11]	*Child mortality*[11]
Constant	0.29 (1.05)	4.09** (5.48)	-3.72** (-11.22)	-4.26** (-12.32)	-7.69** (-6.07)	-0.08 (-1.10)	0.07 (1.64)
Log of per-capita city product[1,3]	0.06** (2.17)	0.15** (2.76)	0.08* (1.95)	0.06* (2.04)	0.25** (2.27)	-0.006* (-1.71)	-0.007** (-2.00)
Proportion of sub-standard housing in city[6]	-0.21** (-2.33)	-0.11 (-0.34)				0.11** (3.49)	0.08** (2.83)
Decentralization in public sector[5] (D_{PS})	0.08 (1.17)	0.22 (1.12)	0.04 (0.89)	0.07 (1.21)	-0.29 (-0.36)	*Health Sector:* -0.02 (-1.42)	*Water Sector:* -0.02 (-1.10)
Partial private-sector involvement[5] (PP)	0.02 (0.21)	0.08 (0.53)	-0.05 (-0.85)	-0.002 (-0.04)	-0.53** (-2.08)	*Health Sector:* 0.006 (0.56)	*Water Sector:* 0.004 (0.30)
Ethnolinguistic fractionalization	-0.33** (-2.28)	-0.69* (-1.79)	-0.01 (-0.12)	0.18 (1.05)	0.71 (1.47)	-0.01 (-0.37)	-0.04 (-1.51)
City population growth rate	-0.54 (-0.55)	-4.57 (-1.50)	-3.88** (-2.15)	-0.24 (-0.18)	-5.77** (-2.87)	0.26 (0.90)	0.28 (0.87)
Log of city population[3]	0.04* (1.75)	0.20** (2.95)	0.04 (1.13)	-0.003 (-0.08)	-0.01 (-0.13)	-0.01** (-2.14)	-0.01** (-2.19)
Log of city population density[3]	0.004 (0.03)	0.09 (0.99)				-0.02** (-2.31)	-0.01* (-1.98)

Dummy for malaria[9]						0.03** (2.54)	0.03** (2.79)
Mills ratio variable[4]	0.13** (2.11)	0.57** (2.54)	0.19* (1.88)	0.26** (2.30)	-0.17 (-0.21)	-0.05* (-1.83)	-0.07* (-1.94)
No. of observations	78	78	72	72	67	69	69
R^2	0.69	0.46	0.40	0.31	0.22	0.38	0.41
Estimated $\hat{\rho}_k$ [10]	0.89	0.82	0.46	0.62	-0.25	-0.37	-0.46

Notes:
1. to 11. See notes for Table 1.4B.

Table 1.9. Are Decentralized Cities Better in Providing Public Goods? (Regression Analysis of Price, Taxes and Public Revenue, Including Only Developing Countries, and Treating Decentralization As Exogenous)

	All Sectors		Water Sector
Regression number	*(9.1)*	*(9.2)*	*(9.3)*
Dependent variable[2,4]	*Log of total taxes (collected by all levels of government) per resident*[3,6]	*Log of total public revenue including borrowing (going to all levels of government), per resident*[3,6]	*Log of median price of water*[3,7]
Constant	-5.21* (-1.91)	-9.37** (-2.26)	-4.84** (-3.89)
Log of per-capita city product[1,3]	0.38** (2.13)	0.63** (2.82)	0.39** (2.42)
Proportion of sub-standard housing in city[6]	0.76 (1.64)	1.02 (1.49)	-0.23 (-0.27)
Decentralization in public sector[5], for water provision ($D_{PS,w}$)			-0.27 (-0.54)
Partial private-sector involvement[5], for water provision (PP_w)			1.12* (1.77)
Three-Sector Decentralization Index[8]	-1.62 (-0.12)	0.02 (0.72)	
Three-Sector Private-Sector Involvement Index[8]	0.01 (0.80)	0.03 (1.14)	
Ethnolinguistic fractionalization	-0.36 (-0.49)	0.36 (0.34)	2.17** (2.92)
City population growth rate	0.50 (0.63)	0.09 (0.06)	-2.15 (-0.25)
Log of city population[3]	0.11** (1.99)	0.17* (1.73)	-0.14 (-0.76)
Log of city population density[3]	-0.20 (-1.12)	-0.12 (-0.98)	-0.60* (-1.67)
No. of observations	32	32	78
R^2	0.83	0.80	0.21

Notes:

1. to 8. See notes for Table 1.5.

Table 1.10. Are Decentralized Cities Better in Providing Public Goods? (Regression Analysis of Price, Taxes and Public Revenue, And Including Only Developing Countries, And Treating Decentralization As Endogenous)			
	All Sectors		*Water Sector*[10]
Regression number	*(10.1)*	*(10.2)*	*(10.3)*
Dependent variable[2,3]	*Log of total taxes (collected by all levels of government) per resident*[3,6]	*Log of total public revenue including borrowing (going to all levels of government), per resident*[3,6]	*Log of median price of water*[3,7]
Constant	3.23** (2.08)	0.90 (0.43)	-4.90** (-3.80)
Log of per-capita city product[1,3]	0.40** (2.25)	0.72** (2.87)	0.38** (2.08)
Proportion of sub-standard housing in city[6]	2.11* (1.79)	-0.41 (-0.73)	0.17 (0.17)
Decentralization in public sector[5], for water provision ($D_{PS,w}$)			-0.06 (-0.05)
Partial private-sector involvement[5], for water provision (PP_w)			1.14 (1.62)
Three-Sector Decentralization Index[8] (Instrumented)[4]	-0.06 (-1.62)	-0.08 (-0.94)	
Three-Sector Private-Sector Involvement Index[8]	-0.01 (-0.60)	-0.03 (-0.78)	
Ethnolinguistic fractionalization	-1.66* (-1.86)	-0.83 (-0.65)	2.08** (1.98)
City population growth rate	0.82 (0.53)	0.26 (0.17)	-2.31 (-0.26)
Log of city population[3]	0.28 (1.43)	0.44 (1.43)	-0.11 (-0.58)
Log of city population density[3]	-0.25 (-1.15)	-0.11 (-0.95)	-0.50 (-1.51)
Mills ratio variable[4]			-0.13 (-0.16)
No. of observations	32	32	78
R^2	0.82	0.78	0.22
Estimated $\hat{\rho}_k$ [10]			-0.10

Notes:
1. to 10. See notes for Table 1.6.

Theoretical Appendix 1.1

Part 1

Here the full solution to the government's optimization problem in Section 1.3 of the main text is described – for the case where all individuals are identical and where the government maximizes utility. First, from the production function (1.3), note that profit maximization in the private sector means the following must hold in equilibrium:

$$F_L = w \qquad \text{...(A1.1-1)}$$

$$F_L / F_K = w / r \qquad \text{...(A1.1-2)}$$

Since L and K are fixed in quantity (in equilibrium), the derivatives F_L and F_K – and hence the returns w and r to labor and capital – are also fixed.

The government maximizes utility given by equation (1.1) in the main text, subject to the production constraint (1.3). This technique for solving optimal tax problems – maximizing the utility or indirect utility function subject to the production function, while setting aside other constraints – is a common one. (See for example Auerbach, 1985). The other constraints in this problem – equations (1.2), (A1.1-1) and (A1.1-2) – still apply, but they are not binding as far as the maximization problem is concerned, because they are a set of three constraints with three variables (T, w and r) that do not appear in the rest of the maximization problem.

Substituting for C in the utility function using the production constraint (1.3), and then maximizing with respect to G, the first-order condition (1.4) in the main text is obtained. Using the optimal value for G derived from equation (1.4), equation (1.3) can be used to derive the optimal value of C. The rates of returns to labor and capital in equilibrium, w and r, are obtained from equations (A1.1-1) and (A1.1-2); using these, as well as the optimal value of C, the individual budget constraint (1.2) can be used to compute the optimal income tax T.

To analyze the effects of changing the parameters *b* and *s*, first note that totally differentiating the budget constraint (1.2) gives:

$$dC = -dT \qquad \text{...(A1.1-3)}$$

Next, equations (1.3) and (1.4) are totally differentiated:

$$Gdb + bdG + dC + dS = 0 \qquad \text{...(A1.1-4)}$$

$$\frac{h}{U_C}U_{GG}dG - \frac{hU_G}{(U_C)^2}U_{CC}dC + \frac{U_G}{U_C}dh = db \qquad \text{...(A1.1-5)}$$

To analyze a change in the parameter *b*, *ds* is set to zero. Manipulating equations (A3) to (A5) – and noting that U_{CG}=0 by definition (see main text) – then gives:

$$dG = -[1-(GU_GU_{CC})/(U_C)^2]\phi db \qquad \text{...(A1.1-6)}$$

and $$dT = -[b+(GU_{GG})/(U_C)]\phi db \qquad \text{...(A1.1-7)}$$

where $$\phi = -\frac{1}{[(U_{GG}/U_C)]+[(bU_GU_{CC})/(U_C)^2]} \qquad \text{...(A1.1-8)}$$

Noting that U_{CC} and U_{GG} are both negative, these results show that a rise in *b* unambiguously causes *G* to fall (and vice versa); the effect on *T* is, however, uncertain. Since *MWTP=b* in equilibrium (see equation 1.4), *MWTP* and *b* move in the same direction.

It is easy to show that a rise in *b* causes utility to decrease, and vice versa. This can be seen by using the envelope theorem:

$$dU = -U_GGdb \qquad \text{...(A1-9)}$$

Next, the effects of changing s are analyzed. Setting db zero and manipulating equations (A3) to (A5) now gives:

$$dG = [(GU_G U_{CC})/(U_C)^2]\phi dS \qquad \text{...(A1-10)}$$

and $$dT = -(U_{GG}/U_C)\phi dS \qquad \text{...(A1-11)}$$

which show unambiguously that a rise in s causes G to fall and T to rise; the opposite is true when s falls. The *MWTP* stays the same since it must be equal to b (see equation 4), which remains unchanged.

Using the envelope theorem, it is easy to show that utility falls when s rises, and vice versa:

$$dU = -U_G dS \qquad \text{...(A1-12)}$$

Part 2

In Section 3 of the main text it was pointed out that, for many public goods, the government selects not the quantity but the price or user fee; consumers decide what quantity they wish to consume, given the user fee faced. I now model the user-fee case, showing that its outcome is equivalent to that in the model above, where the public good was funded from taxes rather than user fees.

Let the per-unit user fee for the public good be p_G. Then the budget constraint is:

$$wL + rK = p_G G + T + C \qquad \text{...(A1-13)}$$

where taxes T are now used solely to fund the fixed administrative budget s, and are thus constant.

The demand G for the public good is now a function of after-tax income and the per-unit user fee p_G:

$$G = G(wL + rK - T, p_G) \qquad \text{...(A1-14)}$$

where the after-tax income $wL + rK - T$ is constant, since the quantities supplied L and K of labor and capital – as well as the wage w and capital price r – are fixed (see Part 1 of the Appendix).

Utility is then given by:

$$U = U(C,G) = U[C, G(wL + rK - T, p_G)] \qquad \text{...(A1-15)}$$

The government maximizes this function, subject to the production constraint (3) in the main text. Substituting for C using equation (1.3), maximizing with respect to the per-unit user fee p_G, and then manipulating, the following is obtained:

$$\frac{U_G}{U_C} = b \qquad \text{...(A1-16)}$$

which is exactly the same as equation (1.4) in the main text. Equations (A1.1-16) and (A1.1-13) – which were derived in this user-fee case – are equivalent to equations (1.4) and (1.2) of the main text, except that public good production is now funded from user fees $p_G G$ rather than taxes. The production function (1.3) is the same for both cases. Hence the outcomes in both cases are exactly equivalent.

Part 3

This part of the Appendix focuses on the cases of underprovision or overprovision, discussed in Section 1.3-II of the main text. In both these cases, there are no exogenous changes to any model parameter or any shifts in curves; the government simply decides to essentially move individuals along their demand or *MWTP* curves. A rightward movement – or an increase in G – must necessarily mean a lower *MWTP* (or user fee), and a higher G means a higher T. The converse is true if there is a leftward movement. The effect on utility depends on whether the economy is brought closer to or further from the socially optimal level.

Part 4

This portion of the Appendix focuses on an extension of the theoretical model to include two types of individuals – rich and poor (Section 1.3-III). For simplicity, the jurisdiction is assumed to comprise one representative individual of each type. The rich resident owns capital (and supplies a fixed quantity of this), but the poor does not. Utility, consumption and labor variables are denoted as before, but with the subscript (or superscript) "L" attached for the lower-income resident, and "H" for the higher-income one. The government maximizes a weighted sum W of the two utilities, with the weight h (which could be larger or smaller than one) denoting the emphasis placed on redistribution:

$$W = hU^L(C_L, G_L) + U^H(C_H, G_H) \qquad \text{...(A1.1-17)}$$

The production function is now:

$$C_L + C_H + b(G_L + G_H) + S = F(K, L_L, L_H) \qquad \text{...(A1.1-18)}$$

where labor supplied by the poor and by the rich are modeled as two different types of inputs in the production process. Profit maximization in the private sector now means that:

$$F_K = r \qquad \text{...(A1.1-19)}$$

$$F_{L_L} / F_K = w_L / r \qquad \text{...(A1.1-20)}$$

$$F_{L_H} / F_K = w_H / r \qquad \text{...(A1.1-21)}$$

where the income of the rich resident, $w_H L_H + rK$, exceeds that of the poor one, $w_L L_L$.

If the weight *h* is one, if the two utility functions are the same, and if there are no restrictions on lump-sum taxation or subsidization, then the government would equalize the two residents' marginal utilities of income. It would do so by raising taxes on the rich, and lowering them on the poor – or subsidizing the poor – until the two have the same after-tax incomes.

To remove the possibility of undesirable outcomes like this, it is assumed that the government would like to subsidize the poor to equalize after-tax incomes, but cannot do so; the tax on the poor is thus constrained to equal zero. Possible reasons for this include the feasibility only of capital but not labor taxation (or subsidization), and constraints on lump-sum handouts.

The individual budget constraints, thus, are now:

$$w_L L_L = C_L \qquad \text{...(A1.1-22)}$$

$$w_H L_H + rK = T + C_H \qquad \text{...(A1.1-23)}$$

Since L_L and w_L are fixed (see equations A1.1-19 and A1.1-20), C_L is constant; C_H, however, is variable.

The government maximizes *W* in equation (A1.1-17), subject to the production constraint (A1.1-18). Its choice variables here are G_L, G_H and C_H. From the resulting first-order conditions, the following are derived:

$$\frac{U^H{}_G}{U^H{}_C} = b \qquad \text{...(A1.1-24)}$$

$$hU^L{}_G = U^H{}_G \qquad \text{...(A1.1-25)}$$

Next, the effect of a change in *h* is analyzed. Totally differentiating equations (A18) and (A23) to (A25) gives:

$$dC_H + bdG_L + bdG_H = 0 \qquad \text{...(A1.1-26)}$$

$$dC_H = -dT \qquad \text{...(A1.1-27)}$$

$$\frac{1}{U^H{}_C} U^H{}_{GG} dG_H - \frac{U^H{}_G}{(U^H{}_C)^2} U^H{}_{CC} dC_H = 0 \qquad \text{...(A1.1-28)}$$

$$U^L{}_{GG} dG_L + U^L{}_G dh = U^H{}_{GG} dG_H \qquad \text{...(A1.1-29)}$$

After manipulation, it can be shown that:

$$-\left[U^H{}_{GG} + \frac{(U^H{}_{GG})^2}{b^2 U^H{}_{CC}} + hU^L{}_{GG}\right] dG_L = U^L{}_G dh \qquad \text{...(A1.1-30)}$$

$$dG_T = \frac{U^H{}_{GG}}{b^2 U^H{}_{CC}} dG_L \qquad \text{...(A1.1-31)}$$

$$dT = dG_T \qquad \text{...(A1.1-32)}$$

where G_T denotes total provision of the public good (G_L+G_H).

Equation (A1.1-30) shows that a rise in *h* causes a rise in G_L. But G_L. has a positive relationship with G_T and *T*, as shown by equations (A1.1-31) and (A1.1-32). So a larger *h* means a greater total supply of the public good, as well as higher taxes. The opposite results hold, of course, if *h* falls.

Theoretical Appendix 1.2

In this appendix, more details are given on the two-stage estimation procedure described in Section 1.4-IIa of the main text. Based on Heckman (1979) and described in Greene (1997), the two-stage procedure is used to jointly estimate the following equations, both given in the main text:

$$G_{ijk} = a_{0k} + a_{1k} y_{ij} + a_{2k} s_{ij} + a_{3k} D_{PS,ijk} + a_{4k} PP_{ijk}$$

$$+ a_{5k} E_j + a_{6k} p_{ij} + a_{7k} \dot{p}_{ij} + a_{8k} t_{ij} + \varepsilon_{ijk} \qquad \text{...(1.5)}$$

$$D_{PS,ijk} = 1 \text{ if } \quad b_{0k} + b_{1k} y_{ij} + b_{2k} E_j + b_{3k} p_{ij} + \mathbf{H}_k'\mathbf{z}_{ijk} + v_{ijk} > 0$$

$$D_{PS,ijk} = 0 \text{ if } \quad b_{0k} + b_{1k} y_{ij} + b_{2k} E_j + b_{3k} p_{ij} + \mathbf{H}_k'\mathbf{z}_{ijk} + v_{ijk} \le 0 \qquad \text{...(1.7)}$$

If equation (5) is estimated separately using ordinary least squares, there is endogeneity bias because in general $E(\varepsilon_{ijk} \mid D_{PS,ijk} = 1) \neq 0$ and $E(\varepsilon_{ijk} \mid D_{PS,ijk} = 0) \neq 0$. To correct for this bias, the first step is to derive expressions for $E(\varepsilon_{ijk} \mid D_{PS,ijk} = 1)$ and $E(\varepsilon_{ijk} \mid D_{PS,ijk} = 0)$.

Let the error term ε_{ijk} have a standard deviation of σ_k. As noted in the main text, the correlation between the two error terms ε_{ijk} and v_{ijk} is denoted ρ_k. The standard deviation of the error term v_{ijk} in the probit equation (1.7) can be estimated, together with the coefficients of the right-hand side variables in the equation, only up to a scaling factor. (The same is true in general when a probit equation is estimated.)

For simplicity, the scaling factor is chosen such that the standard deviation of v_{ijk} is normalized to one; this is the standard approach adopted when estimating probit equations.

Next, denote $\mathbf{B}_k$ as the vector of coefficients $\{b_{0k}, b_{1k}, b_{2k}, b_{3k}, \mathbf{H}_k\}$, and $\mathbf{x}_{ijk}$ as the vector of values of *all* right-hand side variables in equation (7) for any particular observation. Using the properties of truncated bivariate Normal distributions (as given in Greene, 1997), we find that:

$$E(\varepsilon_{ijk} \mid D_{PS,ijk}=1) \quad = E(\varepsilon_{ijk} \mid v_{ijk} > -\mathbf{B}_k'\mathbf{x}_{ijk})$$

$$= \rho_k \sigma_k \frac{\phi(\mathbf{B}_k'\mathbf{x}_{ijk})}{\Phi(\mathbf{B}_k'\mathbf{x}_{ijk})} \qquad \text{...(A1.2-1)}$$

Similarly,

$$E(\varepsilon_{ijk} \mid D_{PS,ijk}=0) \quad = E(\varepsilon_{ijk} \mid v_{ijk} \le -\mathbf{B}_k'\mathbf{x}_{ijk})$$

$$= -\rho_k \sigma_k \frac{\phi(\mathbf{B}_k'\mathbf{x}_{ijk})}{1-\Phi(\mathbf{B}_k'\mathbf{x}_{ijk})} \qquad \text{...(A1.2-2)}$$

Now define u_{ijk} as follows:

$$u_{ijk} = \varepsilon_{ijk} - E(\varepsilon_{ijk} \mid D_{PS,ijk}=1) \text{ if } D_{PS,ijk}=1$$

$$\text{and } u_{ijk} = \varepsilon_{ijk} - E(\varepsilon_{ijk} \mid D_{PS,ijk}=0) \text{ if } D_{PS,ijk}=0 \qquad \text{...(1.A2-3)}$$

Substituting (A1.2-3) into equation (1.5) above, and using (A1.2-1) as well as (A1.2-2), we obtain:

$$G_{ijk} = a_{0k} + a_{1k}y_{ij} + a_{2k}s_{ij} + a_{3k}D_{PS,ijk} + a_{4k}PP_{ijk}$$

$$+ a_{5k} E_j + a_{6k} p_{ij} + a_{7k} \dot{p}_{ij} + a_{8k} t_{ij} + a_{9k} Mills_{ijk} + u_{ijk} \qquad \text{...(A1.2-4)}$$

where $Mills_{ijk} = D_{PS,ijk} \dfrac{\phi(\mathbf{B}_k'\mathbf{x}_{ijk})}{\Phi(\mathbf{B}_k'\mathbf{x}_{ijk})} - (1 - D_{PS,ijk}) \dfrac{\phi(\mathbf{B}_k'\mathbf{x}_{ijk})}{1 - \Phi(\mathbf{B}_k'\mathbf{x}_{ijk})}$;

where $a_{9k} = \sigma_k \rho_k$;

and where $\phi(.)$ and $\Phi(.)$ represent the density and cumulative density, respectively, of the standard Normal distribution.

Following the argument above, $E(u_{ijk} \mid D_{PS,ijk} = 1) = 0$ and $E(u_{ijk} \mid D_{PS,ijk} = 0) = 0$, i.e. the dummy decentralization variable is not correlated with the error term u_{ijk}, and thus equation (A2-4) can be estimated – using ordinary least squares (OLS) – without endogeneity bias. Equation (A1.2-4) is presented in the main text as equation (1.5'), with estimated instead of actual values inserted for the coefficients $\mathbf{B}_k$. In what follows below, the coefficient estimates for a_{0k} to a_{9k} in equation (A1.2-4), derived via ordinary least squares, are denoted by the vector $\hat{\mathbf{A}}_k$.

Even though equation (A1.2-4) is estimated using ordinary least squares (OLS), the standard OLS formula for the variance covariance matrix of the coefficient estimates in (A1.2-4) – or (1.5') in the main text – cannot be used. One reason for this is that the error terms u_{ijk} are heteroscedastic; this an be seen from equation (A1.2-3), and from the expressions for $E(\varepsilon_{ijk} \mid D_{PS,ijk} = 1)$ and $E(\varepsilon_{ijk} \mid D_{PS,ijk} = 0)$ in (A1.2-1) and (A1.2-2).

To address this heteroscedasticity, it is necessary to derive and then estimate the variance of u_{ijk}. To do this, we first define:

$$F^1_{ijk} = \frac{\phi(\mathbf{B}_k'\mathbf{x}_{ijk})}{\Phi(\mathbf{B}_k'\mathbf{x}_{ijk})}$$

$$\text{and } F^2_{ijk} = \frac{\phi(\mathbf{B}_k'\mathbf{x}_{ijk})}{1-\Phi(\mathbf{B}_k'\mathbf{x}_{ijk})} \qquad \text{...(A1.2-5)}$$

Then, as shown in Greene (1997), using the properties of truncated bivariate Normal distributions we find that:

$$Var(u_{ijk} \mid D_{PS,ijk} = 1) = \sigma_k^2\left[1-\rho_k{}^2 F^1_{ijk}(F^1_{ijk} + \mathbf{B}_k'\mathbf{x}_{ijk})\right] \qquad \text{...(A1.2-6a)}$$

$$Var(u_{ijk} \mid D_{PS,ijk} = 0) = \sigma_k^2\left[1+\rho_k{}^2 F^2_{ijk}(F^2_{ijk} + \mathbf{B}_k'\mathbf{x}_{ijk})\right] \qquad \text{...(A1.2-6b)}$$

To estimate these variances, it is first necessary to estimate σ_k and ρ_k. As noted above, the coefficient a_{9k} in equation (A1.2-4) is in fact equal to $\rho_k\sigma_k$. When equation (A1.2-4) is estimated using ordinary least squares, this provides an estimate $\hat{a}_{9k}$, which is in turn a consistent estimate for $\rho_k\sigma_k$.

Using the estimate $\hat{a}_{9k}$, Greene (1997) shows that a consistent estimator $\hat{\sigma}_k$ for σ_k can be derived using the following expression:

$$\hat{\sigma}_k^2 = \frac{\Sigma\left[\hat{u}^2_{ijk} + \hat{a}^2_{9k}(\hat{\mathbf{B}}_k'\mathbf{x}_{ijk})\hat{P}_{ijk}\right]}{N} \qquad \text{...(A1.2-7)}$$

where N is the total number of observations; $\hat{u}_{ijk}$ are the residuals in the ordinary least-squares estimation of equation (1.5'); $\hat{\mathbf{B}}_k$ is the estimate for $\mathbf{B}_k$ derived from estimating the probit equation (1.7); and $\hat{P}_{ijk}$ is defined as follows:

$$\hat{P}_{ijk} = \hat{F}^1_{ijk} \quad \text{if} \quad D_{PS,ijk} = 1$$

$$\text{and} \quad \hat{P}_{ijk} = -\hat{F}^2_{ijk} \quad \text{if} \quad D_{PS,ijk} = 0$$

Note that $\hat{F}^1_{ijk}$ and $\hat{F}^2_{ijk}$ are given by substituting $\hat{\mathbf{B}}_k$ for $\mathbf{B}_k$ in equations (A1.2-5).

Next, the estimate $\hat{a}_{9k}$ (which is, as noted above, a consistent estimate for $\rho_k\sigma_k$) is divided by the estimate $\hat{\sigma}_k$. This gives a consistent estimate for ρ_k, denoted $\hat{\rho}_k$. The estimates $\hat{\sigma}_k$, $\hat{\rho}_k$ and $\hat{\mathbf{B}}_k$ are substituted inside equations (A1.2-6a) and (A1.2-6b) to obtain estimates for $Var(u_{ijk} \mid D_{PS,ijk} = 1)$ and $Var(u_{ijk} \mid D_{PS,ijk} = 0)$.

Define a diagonal NxN matrix with the estimated values of $Var(u_{ijk} \mid D_{PS,ijk} = 1)$ and $Var(u_{ijk} \mid D_{PS,ijk} = 0)$ for all N observations on the diagonal; let this matrix be denoted $\hat{\mathbf{V}}_k$. If heteroscedasticity were the only problem in estimating equation (A1.2-4), basic econometrics tells us that the following is a consistent estimator for the variance-covariance matrix for the coefficient estimates $\hat{\mathbf{A}}_k$ obtained via ordinary-least-squares estimation of equation (A1.2-4):

$$\hat{Var}(\hat{\mathbf{A}}_k) = \left(\mathbf{W}_k'\mathbf{W}_k\right)^{-1}\left(\mathbf{W}_k'\hat{\mathbf{V}}_k\mathbf{W}_k\right)\left(\mathbf{W}_k'\mathbf{W}_k\right)^{-1} \qquad \text{...(A1.2-8)}$$

where $\mathbf{W}_k$ is the matrix of values of *all* right-hand side variables in equation (A1.2-4), including the Mills ratio variable – with the estimated coefficient vector $\hat{\mathbf{B}}_k$ used to compute the latter.

However, this formula does not take into account the fact that the actual values of the parameters $\mathbf{B}_k$ cannot be used when estimating the second-stage equation (A1.2-4); the vector $\hat{\mathbf{B}}_k$, estimated from the first-stage regression, must be used instead. The additional variance introduced affects in turn the variances of the coefficient estimates $\hat{\mathbf{A}}_k$ in the second-stage estimation. Heckman (1979) has provided an alternative estimator for the asymptotic variance-covariance matrix of the coefficient estimates $\hat{\mathbf{A}}_k$:

$$\hat{Var}(\hat{\mathbf{A}}_k) = (\mathbf{W}_k'\mathbf{W}_k)^{-1}(\mathbf{W}_k'\hat{\mathbf{V}}_k\mathbf{W}_k + \hat{\mathbf{Q}}_k)(\mathbf{W}_k'\mathbf{W}_k)^{-1} \quad \text{..(A1.2-9)}$$

where:

(i) $\hat{\mathbf{Q}}_k = \hat{\rho}_k^2(\mathbf{W}_k'\hat{\mathbf{T}}_k\hat{\mathbf{B}}_k)\hat{\mathbf{J}}_k(\hat{\mathbf{B}}_k'\hat{\mathbf{T}}_k\mathbf{W}_k)$

(ii) $\hat{\mathbf{J}}_k$ is the asymptotic variance-covariance matrix of the coefficient estimates $\hat{\mathbf{B}}_k$ in the first-stage probit estimation.

(iii) $\hat{\mathbf{T}}_k$ is an N x N diagonal matrix with either: (a) $\hat{F}^1_{ijk}(\hat{F}^1_{ijk} + \hat{\mathbf{B}}_k'\mathbf{x}_{ijk})$ on its diagonal, if $D_{PS,ijk} = 1$; or: (b) $-\hat{F}^2_{jk}(\hat{F}^2_{ijk} + \hat{\mathbf{B}}_k'\mathbf{x}_{ijk})$ on its diagonal, if $D_{PS,ijk} = 0$.

This formula provides consistent estimates for the standard errors of the coefficient estimates $\hat{\mathbf{A}}_k$ in equation (A1.2-4), and is used to obtain the t-ratios for the coefficients when estimating this equation.

The discussion so far has focussed on the two-stage estimation with equation (1.5) in the main text as the second-stage equation (with the "Mills ratio" variable included). Exactly the same comments apply to the two-stage estimation involving (1.6), the child mortality equation (See Section 4.2c). The only difference here is that the dependent variable in the second-stage equation is now child mortality M_{ijk}, and there is an additional regressor in the second-stage equation: r_{ij}^{MAL}, the variable for endemic malaria risk. Otherwise, the same techniques and formulae as outlined above apply.

Data Appendix 1

This appendix provides additional information on the variables in the empirical analysis, other than what is already given in the main text (Section 1.4).

All data for the city-level variables are taken from the *United Nations Global Urban Indicators* Database (UNGUI; United Nations, 1999), except for the data on school enrolment rates. Data on school enrolment rates are taken from Tokyo Metropolitan Government (1994 and 1997) and NUREC (2000).

The "ethnolinguistic fractionalization" variable is a country-level variable that is taken from Easterly and Levine (1997). It is the average of five different indices of fractionalization (or ethnic diversity); one of these indices, as an example, is the probability that any two randomly chosen individuals do not belong to the same ethnolinguistic group. Data on country populations was taken from the World Bank's *World Development Indicators*.

The "Three-Sector Decentralization Index" $DecIndex_{PS}$ is a weighted combination of 3 dummies: the decentralization variables ("D_{PS}") for each of the three public good sectors:

$$DecIndex_{PS} = \frac{0.4 * D_{PS,W} + 3.9 D_{PS,E} + 4.6 * D_{PS,H}}{0.4 + 3.9 + 4.6}$$

where the subscripts "W", "E" and "H" are used for the water, education and health sectors respectively. The weights 0.4, 3.9 and 4.6 are proxies whose ratios reflect the approximate contribution of each sector to the total government budget. The 0.4 figure is the percentage of national GDP that goes towards expenditure on water services, based on a global average figure given in Serageldin (1994). The 3.9 and 4.6 figures are averages for the sample of national education and health expenditures as a percentage of GDP; these are calculated using data from the World Bank's *World Development Indicators* database.

The "Three-Sector Private-Sector Involvement Index" $PvIndex_{PS}$ is calculated in a similar way, using the partial private-sector involvement dummy variable (PP) for each sector:

$$PvIndex_{PS} = \frac{0.4 * PP_W + 3.9 PP_E + 4.6 * PP_H}{0.4 + 3.9 + 4.6}$$

where the subscripts "W", "E" and "H" are used for the water, education and health sectors, as before.

Finally, some details are provided on the countries for which the "fought for independence in modern times" dummy variable takes the value 1. These countries are: Bangladesh, Bolivia, Chile, Colombia, Ecuador, El Salvador, Greece, Guatemala, Paraguay and Peru. Most are ex-Spanish colonies, that gained their liberation after wars of independence against the Spanish in the early 1800s. Also included are Bangladesh and modern Greece, which gained independence after fighting Pakistan (in 1971) and the Ottoman Turks (in 1830), respectively. Brazil is not included since it gained its independence peacefully, in contrast to the ex-Spanish colonies. The European countries besides Greece are also excluded, since they were not occupied in modern times – defined as 1750 onwards, the period considered as the epoch of modern nation-building (see main text).

Chapter 2

Fiscal Effects of Foreign Aid in a Federal System of Governance: The Case of India

co-authored with Vinaya Swaroop and Shikha Jha

Chapter Abstract

This paper models fiscal effects of foreign aid in a federal system of governance. Our main innovation is to incorporate the inter-governmental fiscal link in examining economic fungibility of foreign aid. The model is applied to the expenditure decisions of the central government of India. The two main findings are: (i) Foreign aid intended for development purposes merely substitutes for spending that the government would have undertaken anyway; the funds freed by aid are spent on non-development activities, and (ii) In passing earmarked external assistance to states, the central government makes a reduction in its transfers to states. These findings indicate that the central government's expenditure choices are unaffected by external assistance. The implication for donors is that even though their projects may be associated with very high rates of economic return, they could be assisting the central government in financing something very different at the margin. For the state governments, the finding indicates that they may not be reaping the full benefits of externally procured assistance.

2.1 Introduction

An important objective of foreign aid earmarked for development purposes is to improve development outcomes in the targeted area in the recipient country. If, however, the preferences of the recipient government are different from those of the donor agency, the former can make aid "fungible" by reducing its own resources going to the activity which receives aid and using it for other purposes. If the structure of government is federal in the recipient country, this fungibility may also take the shape of changes in inter-governmental fiscal transfers. For example, knowing that a subsidiary government is receiving external assistance, the federal government could reduce its fiscal transfers to that lower level of government. There are a number of studies that have looked at the issue of foreign aid fungibility.[1] On the inter-governmental front an extensive literature has studied the fiscal effects of inter-governmental grant subsidy programs (see Gramlich, 1977; McGuire, 1977; Mieszkowski and Oakland, 1979; Rosen, 1988; Zou, 1996; and others). However, no study has looked at the inter-governmental fiscal link in examining foreign aid fungibility. Our main innovation in this paper is to study the fungibility of foreign aid created through this link.

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[1] In a mix of cross country and individual country experiences, Cashel-Cordo and Craig (1990), Feyzioglu et al (1998), Gang and Khan (1991), Gupta (1993), Heller (1975), Pack and Pack (1990, 1993, 1996), and Khilji and Zampelli (1994), among others, have analyzed whether foreign assistance provided for specific purposes is shifted (contrary to the wishes of donors) by the recipient government. World Bank (1998) provides a good summary of the existing empirical studies on this topic.

We model fiscal effects of foreign aid in a federal structure of government. The model is then applied to the expenditure decisions of India's central government. In the past, several country studies have carried out econometric analyses of effects of aid on public expenditure, but in most cases the explanatory variables used are based on casual empiricism. Some researchers (e.g., Pack and Pack, 1996) have acknowledged that there is an economic behavior underlying their estimations, but they do not explicitly incorporate it in their analysis. In this paper, we develop a model of government behavior which yields estimable equations that can be compared with those in the literature. Using time-series data, we first estimate the influence of foreign aid on the level and composition of central government's spending in India. Our main inquiry is: Has aid been spent on the purposes intended by the donors? In India, almost all external assistance (including funds earmarked for state governments) accrues to the central government, which is also liable for any repayments.[2] Concerns have been raised that states that procure externally aided projects are not able to reap the full benefits; central-government transfers to states are reduced when foreign aid is secured for states. In tracing the fiscal effects of foreign aid in India, it is therefore important to analyze the fiscal link between the central and state governments. Using a panel of time-series data across different states, we next examine the impact of aid resources acquired for state governments, on fiscal transfers from the central to the state

[2] The average annual disbursement of aid–defined as grants and concessionary loans from all official bilateral and multilateral sources–to India in the 1990s has been close to 3 billion U.S. dollars, which is equivalent to roughly 4 percent of the combined spending of the central & state governments and public sector enterprises.

governments.

In Section 2.2 of the paper we first define aid fungibility. We then develop an analytical framework in a federal system of governance that links foreign aid with various components of public expenditure and with inter-governmental transfers. In Section 2.3 we empirically examine the fiscal effects of foreign aid. Section 2.4 presents our concluding remarks.

2.2 A Model of Aid Fungibility

To study the fiscal effects of foreign aid it is important to understand the concept of aid fungibility. Before formally developing the model, therefore, we briefly discuss what it means for aid to be fungible.[3]

2.2-1 Foreign aid fungibility: A definition

Suppose a developing country spends its total resources on a single private good, C_p, and two public goods, G_1 and G_2. All three goods are assumed to be normal (non-inferior). Spending on G_1 and G_2 are characterized as non-development (consumption type) and development (investment type). In addition to its own resources, the country receives earmarked assistance towards the purchase of good purchase of good G_2 from a donor agency. This delineation of public spending reflects a functional distinction found in the budgets of most developing countries. Moreover,

[3]The concept of foreign aid fungibility has been described in detail, among others, in Feyzioglu et al [1998] and Pack and Pack [1993].

aid to developing countries is mostly earmarked for capital related investment type expenditure. Figure 2.1 captures this scenario. *BB'* represents allocation choices that can be financed from domestic resources, and given the preferences of the recipient country, point *A* represents the preferred resource allocation. Now suppose a foreign agency gives aid for the exclusive purchase of the development good, G_2, which at the given price would purchase an amount *F*. While the donor agency would like the aid funds to be spent on G_2 at the margin, for a variety of reasons, it is unable to determine the amount of good G_2 that the recipient would have purchased in the absence of aid (i.e., the donor agency does know the allocation represented by the point *A*.) Upon receiving aid, therefore, the recipient country could make it fungible by changing the level and composition of its public expenditure program.

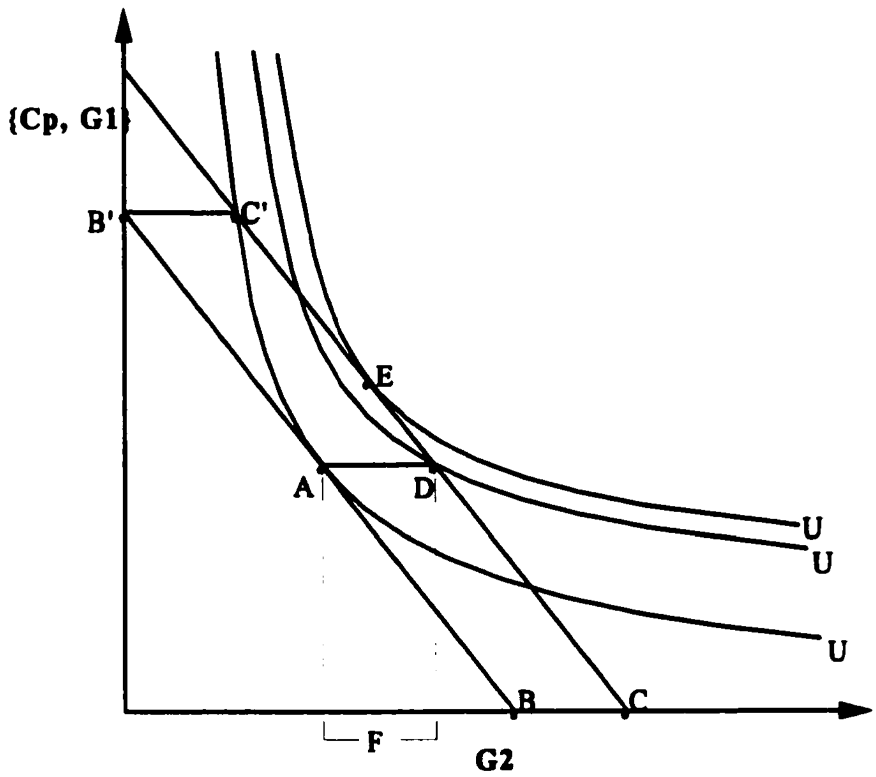

Figure 2.1

If the recipient country can treat the entire aid amount as a pure supplement to its domestic resources, then aid is fully-fungible. As illustrated in Figure 2.1, the post-aid resource constraint is *B`C`C*; the horizontal segment, *B`C`*, indicates that at least the aid amount has to be spent on G_2. The new optimal resource allocation is given by the point *E*. The latter indicates that in spending the acquired aid resources on good G_2, the country diverts some of its own resources from G_2 to C_p and/or G_1. A diversion to G_1 means that aid changes the composition of spending while an increase in C_p implies that aid has a level effect on the budget, i.e., it leads to a reduction in taxes and a commensurate increase in private sector consumption. Suppose, on the other hand, the recipient country does not divert any of its resources away from the aided good while spending the earmarked aid on it. This could be due to the donor agency's effective public expenditure monitoring process particularly if the size of aid in relation to the country's total domestic resources is large. In such a case, aid is fully non-fungible. The optimal allocation mix of the country's own resources is not influenced by the aid amount and point *A* (in Figure 2.1) continues to be the country's preferred mix. More of G_2 purchased from aid, however, increases the overall utility. The post-aid consumption point, *D*, is on a higher indifference curve U_2. Finally, if the country can treat a portion, φ ($0<\varphi<1$), of the aid as a resource supplement, then aid is said to be partially fungible and the fungible portion of the aid is given by φ. In such a case, the post-aid resource line (not drawn in Figure 2.1) moves out by the fungible amount. In choosing the optimal resource mix, the country includes the fungible amount as an additional resource supplement to be spent but disregards the non-fungible portion, $1-\varphi$. Depending on the value of φ, the final consumption point lies between points *E* ($\varphi=1$) and *D* ($\varphi=0$) in Figure 1. Thus, economic fungibility of aid is defined as the recipient's ability to treat earmarked aid as if it was a pure supplement to its domestic resources.

2.2-II Foreign aid in a federal framework

Consider an economy which has a federal system of governance: a central government and a number, *S*, of state governments. At both levels–central and state–

governments spend on each of the two categories of public good. As discussed above, spending on these goods can be characterized as non-development (consumption type) and development (investment type) spending at the national and state levels. Foreign aid enters the model in the form of earmarked donor funds given to the central as well as the state governments for development programs.[4] All assistance including funds earmarked for state programs, however, goes through the central government. Funds received for state projects by the central government are expected to be passed-on to the respective state governments.

Resource allocation choice of the central government

The central government buys the two public goods–non-development (G_1) and development (G_2)–at prices p_1 and p_2, respectively, and provides them to all of its citizens. In addition, it transfers to state *s* $\{s=1,2,\ldots,S\}$ an amount $p_2G_2^s$ earmarked for the purchase of G_2. This constitutes the total spending of the central government. In making these resource allocation decisions, it takes the prices, p_1 and p_2, as given.

Earmarked for development spending, let a^c and a^s be the amounts of foreign aid given to the central government and the s^{th} state government, respectively. Using our definition of fungibility, the central government can make foreign aid fungible by treating a portion φ^c $(0 \leq \varphi^c \leq 1)$ of a^c as its own revenue supplement and spending the proportion accordingly. Similarly, the central government can treat a portion φ^s

[4]Foreign aid could be given for non-development purposes also (e.g., assistance given for natural disasters such as cyclone, earthquake). In this paper, however, we only consider developmental aid.

($0 \leq \varphi^s \leq 1$) of a^s as fungible by making adjustments in the amount of earmarked transfer it gives to state *s* for the development good. The choices of φ^c and φ^s are determined by some strategic behavior of the central government which takes into account the penalty of being "caught" redirecting funds. We, however, do not model this strategic behavior in this paper and take the φ's as given. Thus, the central government finances its total purchases by the fungible portion of foreign aid as well as its own domestically generated revenue, *R*. The budget constraint faced by the central government can be written as

$$p_1 G_1 + p_2 G_2 + \sum_{s=1}^{S} p_2 G_2^s = R + \phi^c a^c + \sum_{s=1}^{S} \phi^s a^s \qquad \ldots(2.1)$$

The left-hand side of eq. (1) is total spending of the central government. The right-hand side is its total fungible funds. As explained above in Section 2.1, the non-fungible portions of aid, $(1-\varphi^c)\, a^c$ and $\Sigma\,(1-\varphi^s)\, a^s$, do *not* augment government's discretionary resources, but are used to purchase G_2. Also, while G_2–purchased from the non-fungible part of aid–increases overall utility, it does not affect the marginal choices of the central government. Subject to its budget constraint, the central government chooses G_1, G_2 and G_2^s to maximize the social welfare given by:

$$W = W(U^1, U^2, \ldots, U^S) \qquad \ldots(2.2)$$

where U^s is the utility of the representative agent living in state *s*. In considering the resource allocation choice, we assume that the fiscal effects of foreign aid, if any, are restricted to changes in the composition of the government's expenditure program but there are no level effects, i.e., aid has no impact on *R*. We later relax this assumption and model the level effects of aid through changes in *R*.

The utility, U^s, is defined on the single private good, C_p^s, two categories of central (national) public goods and the two public goods (g_1^s and g_2^s) provided by state

$$U^s = U^s(C_p^s, G_1, G_2, g_1^s, g_2^s, G_2^s) \qquad \ldots(2.3)$$

s.

In choosing G_1, G_2 and G_2^s, the central government takes as given *R*, g_1^s and g_2^s. Maximization of the social welfare function, W (.) subject to the budget constraint yields the first-order conditions, which with simple manipulation can be written as:

$$U^s_{G_1} = \left(\frac{p_1}{p_2}\right) U^s_G \ , \qquad \ldots(2.4)$$

$$U^m_{G_2^m} = (\frac{\alpha^n}{\alpha^n}) . U^n_{G_2^n} \quad \forall\ m, n \in S$$

$$\text{where } \alpha^s (= \partial W / \partial U^s) > 0 \text{ and } \sum_{s=1}^{S} \alpha^s = 1. \qquad \text{...(2.5)}$$

and where α^s is the weight of state *s*'s utility in the social welfare function. Condition (2.4) implies that in determining the choice of G_1 and G_2, the marginal rate of substitution between the two public goods must be the same as the economic rate of substitution (given by the price ratios). On the other hand, condition (2.5) equates at the margin, across states, the change in social welfare due to the change in the utility of the representative agent that results from a unit increase in centrally provided assistance towards the purchase of G_2.

By specifying the functional form of the utility, equations (2.1), (2.4) and (2.5) can be solved to obtain demand equations for G_1, G_2 and G_2^s. Given data, the parameters of the demand function and fungibility (included in the budgetary constraint relationship) can then be estimated to assess the fiscal impact of foreign aid. More specifically, we can estimate the impact of earmarked foreign aid on the level and composition of the central government's public spending. In the next sub-section, we discuss an econometric application of this model.

2.2-III Econometric application of the model

We shall now use the fungibility model outlined above to derive equations to estimate the fiscal impact of foreign aid in a federal framework. The degree of difficulty in estimation depends mainly on two things: (a) the availability of data; and (b) the specific form of the utility function. Budgetary data in most developing countries are available on non-development and development spending (i.e., on p_1G_1 and p_2G_2 in our model), but not separately on prices and quantities. Similarly, information is available on central transfers (development grants) to states, i.e., data on $p_2G_2^s$. Thus, data constraints require that the demand equations for the development and non-development goods derived from the fungibility model be transformed and estimated as expenditure equations. With most functional forms of utility function (e.g., a constant elasticity of substitution form), the associated demand equations are non-linear in both parameters and variables, and/or the key parameters of interest–φ^c and φ^s–are not identifiable. One utility function–the Stone-Geary form–however, yields estimable linear expenditure functions with identifiable parameters. We take this functional form for our empirical analysis. Our results will not be sensitive to the specification of the utility function so long it leads to linear demand functions. Appendix 2.1 provides the linear expenditure functions derived from maximizing the Stone-Geary specification of the utility function given in equation (2.3), subject to the budget constraint in equation (2.1).

In modeling the effect of aid on the central government's optimal mix of spending we have taken R, the domestically generated revenue, as fixed. We now allow the possibility that foreign aid could have revenue effects too. Let R be a linear function of the country's gross domestic product (GDP) and foreign aid. It then can be written as

$$R = \mu_0 + \mu_1 GDP + \mu_2 a \quad where \;\; a = a^c + \sum_{s=1}^{S} a^s \qquad \ldots(2.6)$$

Using data, the linear expenditure functions (derived in Appendix 2.1) can be estimated along with equation (2.6) to examine the fiscal effects of foreign aid in a federal system.

2.3 An empirical analysis of fungibility of foreign aid to India

In an empirical application of the model developed in Section 2.2, we first estimate the impact of foreign assistance given to India on its central government's development and non-development spending. As stated in one of the official documents (*External Assistance*, Ministry of Finance, Government of India), the external assistance made available by the donor countries/institutions is mainly used for financing development projects which involve capital investment of a high magnitude. To inquire whether such assistance has funded specific non-development spending categories (e.g., defense, interest, general administrative services), we examine the link between foreign aid and the various non-development spending activities of the central government. The impact of earmarked sector-specific aid on sectoral components of development spending is estimated next. Finally, we examine whether central assistance to states on account of foreign aid crowds out other types of central assistance, i.e., do states have any real incentives to seek external funding?

2.3-1 Data and analysis

The method of least squares is used to estimate the following two regression models:

$$G_{c,t} = \pi_{c,0} + \pi_{c,1} GDP_t + \pi_{c,2} Aid_t + v_{c,t}$$

where c in $G_{c,t}$ *denotes central governments spending categories.*

$$\ldots(2.7)$$

$$F^d_{t,s} = \omega_0 + \omega_1 g^d_{t-1,s} + \omega_2 Aid_{t,s} + \omega_3 \left(\sum_{j\_s}^{S} [\, g^d_{t-1,j} + F^d_{t,j}]\right) + \omega_4 \sum_{j\_s}^{S} Aid_{t,j} + \eta_{t,s}$$

$$(2.8)$$

Equation (2.7)–in a simplified and estimable form–is derived from equations (A1-3), (A1-4) and (A1-6) described in Appendix 2.1. It estimates the impact of foreign aid on the budget composition, taking into the account that aid could also affect domestic revenue, R. Similarly, equation (2.8) is a variant of equation (A1-5) described in Appendix 2.1. Measured in per capita 1995 rupees, the variables in the above two equations are:

G_t^c = Categories of central government's expenditure at time t;

GDP_t = Gross domestic product;

Aid_t = Total foreign aid;

$Aid_{t,s}$ = Central assistance passed on to state *s* on account of foreign aid;

$F_{t,s}{}^{d}$ = Central government transfers (net of assistance on account of foreign aid) to state *s* for development purposes;

$g_{t,s}{}^{d}$ = Development spending of state *s* financed from its own sources;

$v, \& \ \eta$ = White noise error terms for the two sets of equations.

At both levels of government (federal and state), total expenditure is divided into two broad groups: development and non-development expenditures, with each having components of caital and revenue (recurrent) categories. Within the development expenditure category, classification is done on account of economic and social services. The non-development expenditure includes general services, defense expenditure (for central government only), interest payments and transfers to subsidiary governments. Our main aid variable, Aid_t, is the total disbursement of grants and concessionary loans by all bilateral and multilateral sources, reported in the Government of India's publication Economic Survey. To analyze fungibility at the inter-governmental level, we use the data on transfers from the central to state governments on account of external assistance. In Indian public finance statistics this is labeled as 'Additional Central Assistance (ACA).'

To estimate the impact of foreign aid on central government's development and non-development spending, we use annual time-series data from 1970 through 1995. The choice of the time period is based on data availability for all the relevant variables in the analysis. In addition, a panel database was constructed over the period

1980 to 1992 on 16 major states of India to look at the intergovernmental fiscal links. (Details on data are provided in Appendix 2.2.)

2.3-II How does foreign aid affect the level and composition of central government's budget?

During the period 1970 through 1995, the central government spent, on an average annual basis, roughly 18 percent of the country's resources (GDP). The total was equally divided between the non-development and development categories.[6] Moreover, the country, on average, received aid from all foreign sources amounting to a little over 1.5 percent of its GDP with a range from a little over one to 2.7 percent. All in all, during this period, foreign aid financed roughly 8.3 percent of the central government's budget.

Table 2.1 (behind) has the estimates of equation (2.7). The first two regressions reported in this table examine the link between total foreign aid and the central government's spending on non-development and development categories, respectively.

Regression (1.1) shows a positive and statistically significant relationship between non-development expenditure and foreign aid. A unit increase (measured in per-capita real rupee) in external assistance increases the share of non-development expenditure by 0.9. On the other hand, regression (1.2) suggests that there is no relationship between aid and development related spending of the central government; the coefficient is negative but insignificantly different from zero. In both equations, the

[6]See Appendix 2.2 for details.

coefficient on the variable *GDP* indicates how much of an additional resource unit to the country is spent on goods and services provided by the central government. In regression (1.1), the coefficient on this variable is positive and statistically significant. It shows that at the margin, eight percent of an extra unit of country's GDP is spent on non-development related activities of the central government. However, the relationship between GDP and the central government's development spending is unclear; the estimate is positive but statistically insignificant. One reason for the statistical insignificance could be that a number of structural shifts took place in this spending category during the sample period. Also included in the two regressions is a dummy variable for the 1991 fiscal crisis in the country when government spending was cut across the board. The coefficient on the fiscal crisis dummy is negative and statistically significant in both the equations though reduction in development spending was much more than in non-development spending. Separately, in regression (1.3) we report whether foreign aid is associated with any tax relief effect. The results indicate that the data for the sample period do not support any link between aid and the country's revenue receipts.

What do these results indicate? The documents of the Indian Ministry of Finance assert that external assistance is used for financing development related projects. This may certainly be the case. But what we see is not always what happens. The true effect of external aid depends on whether the recipient country is able to reallocate its other expenditure. Our findings suggest that external assistance to India, at the margin, is not being spent on purposes intended by the donors; instead, the money is being used to finance non-development related activities of the country.

How do these results compare with the rest of the literature on aid fungibility? Most studies indicate that foreign aid finances the government in general and not the development expenditures that donors typically target. In a sample of 14 countries, Feyzioglu et al. (1998) find that a dollar in foreign aid typically results in 29 cents of public investment (or development expenditures as listed in the country budgets). In this sample 29 cents was the exact amount of a typical dollar of government spending from all sources (aid and non-aid) that goes into investment. Thus, Feyzioglu et al. conclude that an aid dollar has exactly the same effect on public investment as one from any other source of government revenue. Examining the fiscal behavior of 11 African countries, Heller (1975) found that while foreign aid increases public investment, it also facilitates a reduction in the level of domestic taxes and borrowing. In a study of the Dominican Republic, Pack and Pack (1993) find that contrary to donor objectives, an additional dollar of foreign aid stimulates no net development expenditures. In a separate study of Indonesia (Pack and Pack, 1990), however, they found that a dollar's worth of aid raised total public spending by $1.58, of which development expenditures accounted for 89 cents. A quite plausible explanation–offered by Pack and Pack–of such divergent behavior is that the size of foreign aid (in relation to the budget) matters. As the share of aid in budgetary finance increases, it becomes difficult for the country to make aid resources fungible. In the fully-fungible case of the Dominican Republic, foreign aid was roughly 8 percent of the budget. In Indonesia, where the evidence suggests that aid stimulates development expenditures, it was nearly 20 percent of the budget. If one believes that the size of aid matters for fungibility, then our result in the Indian context has a perfect explanation. Foreign aid to India during the sample period was quite small; it financed roughly 8 percent of the central government's budget!

What specific activities in the non-development budget are being financed from foreign aid? Figure 2.2 shows the composition–the main sub-categories–of non-development expenditure over the sample period.

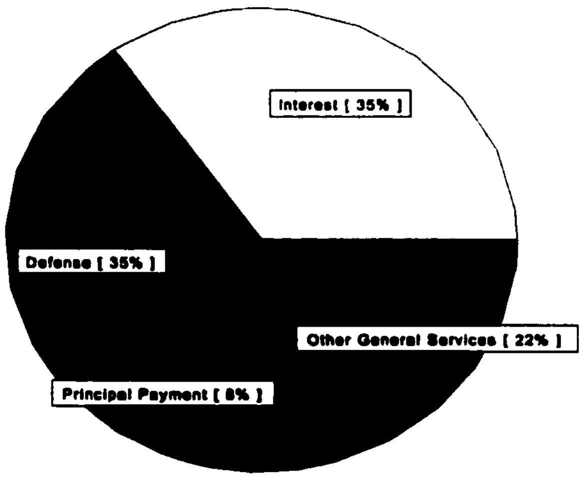

Figure 2.2

To inquire which activities among the non-development category could be benefitting from foreign aid, we regress these sub-categories–interest and principal payments, defense spending and other general services–on the aid variable. The results are reported in Table 2.2 (behind).

In receiving foreign aid, if the Indian government was diverting its own resources from development related activities–for which most of the assistance is earmarked–to fund its debt related spending, one could argue that this may not be a totally undesirable outcome. The average annual interest spending and principal repayment on all domestic and foreign debt over the sample period was 3.4 and .84 percent of GDP, respectively. Regression (2.2) reported in Table 2.2, however, indicates no discernible relationship between foreign aid and interest spending. Similarly, no such link seems to exist with the principal payments on loans (regression (2.3)).

The other major item in the central government's non-development spending is defense. The donor community is increasingly concerned that assistance to developing countries is directly or indirectly financing military expenditures. Could India have maintained the level of its defense spending in the absence of development assistance? Over the sample period–1970 through 1995–of our analysis, the share of India's defense expenditure in GDP averaged 3.3 percent. The statistical analysis reported in regression (2.4) shows a positive but statistically insignificant relationship between defense spending and foreign aid. Landau (1994) has argued that an important determinant of a country's defense spending is the defense spending of its neighboring countries. Since 1947, India and its neighbor, Pakistan, have fought three major wars and the last one in 1971 led to the creation of Bangladesh. Lately, there has been an arms race between the two countries. To control for any such effects, we include in our regression model a dummy variable for India's 1971 war with Pakistan. Moreover, we add Pakistan's defense expenditure as an explanatory variable. Even with this new specification (see regression (2.5)), we do not find any (statistically significant) association between India's defense spending and foreign aid. Finally, in regression (2.6) we report the link between foreign aid and the remainder of non-development related spending which is mostly general service and administration. This equation indicates that at the margin, almost three-quarters of the foreign aid given to India finances its administrative and general service expenditures.

Our analysis of the impact of earmarked sector specific aid on development spending components is restrictive due to non-availability of data. First, data are available on sector specific concessionary loans but not on grants. Moreover, while grants were roughly 15 percent of the total aid on an aggregate basis during the sample period, no systematic information is available on the mix of loans and grants by sectors. Yet another limiting factor in this analysis is that data on sector specific central transfers (on account of foreign aid) to the states are only available for the period 1970 through 1988. Finally, consistent time-series data on sectoral spending are only available from 1974 onwards. Figure 2.3 shows the major components of development spending of the central government. Figure 2.4 shows the composition of earmarked concessionary loans given to support these activities.

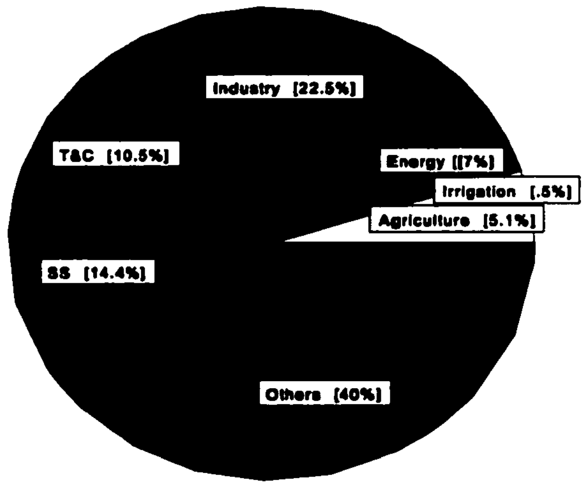

Figure 2.3

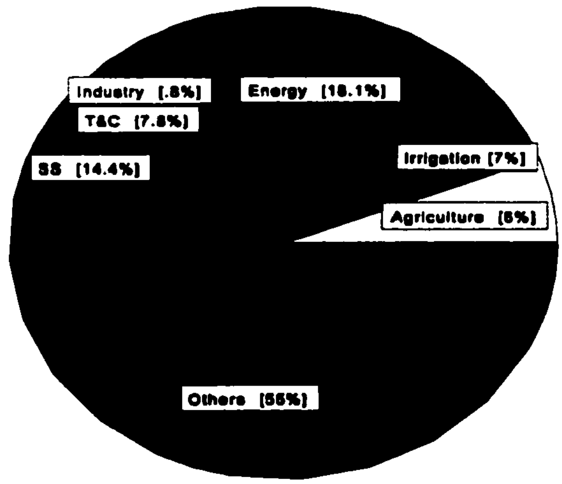

Figure 2.4

Table 2.3 (behind) reports the results from regressions of these sub-categories of the development expenditure on sector specific earmarked concessionary loans.

Among the seven sub-categories of development expenditure–agriculture, irrigation, energy, industry, transport and communication, social sectors, and others–that we examine, we find that in all of the sectors we can reject the null hypothesis that the coefficient on the aid variable is different from zero. Notwithstanding the data limitations, these results are not altogether surprising for we also do not find any statistically significant relationship between the overall development expenditure and total foreign aid.

2.3-II Does foreign aid earmarked for state projects affect inter-governmental fiscal transfers?

The Indian Constitution mandates that all external assistance–including funds earmarked for state projects–accrue to the central government. In turn, these funds are pooled with a portion of domestic resources to finance 'Plan Outlays,' which are various developmental projects, programs and schemes included in the country's annual plan. Part of this pool of resources is retained by the central government for its own plan expenditure and the remaining is allocated to the states in a mix of grants and loans to finance their plan outlays. Transfers through this channel are mediated by the country's Planning Commission on the basis of the 'Gadgil formula,' which is a weighted average of population, per capita income, fiscal performance and special problems of the states.[7] The other important source of transfers from the center to

[7]Prior to any disbursement, however, 30 percent of the total allocable amount through this channel is earmarked for the generally poor and resource constrained states which are Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The formula is then applied to the fifteen "General Category" states–Andhra Pradesh, Bihar, Goa, Gujrat, Haryana, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal–which receive the remaining 70 percent.

states consists of tax shares and statutory grants recommended every five years by the Finance Commission, which is a constitutionally mandated body.

As mentioned by Bajaj (1992), a notable feature of this disbursement mechanism is that not all earmarked external assistance to the states is transferred to them in full.[8] Moreover, the assistance on account of externally aided projects is given (excepting to the special category poor states) on the same terms as normal central assistance, i.e., 70 percent in the form of loans and 30 percent as grants. At the outset, this system of foreign aid management at the central level appears to be designed to make foreign resources fungible. In Bajaj's words "...this arrangement [of allocating foreign aid] preserved an internally determined pattern of inter-sectoral and inter-regional distribution of plan resources. The additional resources generated by external flows were therefore shared among all states, not only those that undertook and implemented externally aided projects" (p. 194).

The increase in recent years in the proportion of earmarked external assistance transferred to the states does not necessarily imply that the funds are truly additional. To examine whether central transfers on account of foreign aid are additional, we estimate the regression model outlined in equation (2.8).

The regressions presented in Table 2.4 are based on our sample panel data from fourteen general category states. Together, these states account for nearly 98 percent of

[8]In fact, prior to 1976 there was no identifiable transfer from the center to the states on account of external aid; earmarked aid for state projects only augmented the total plan resources in the country. In recent years, however, the proportion of earmarked external assistance transferred to the states has increased to nearly 100 percent in most sectors in order to ease their resource constraint and thereby, improve aid utilization.

the assistance given to all states on account of foreign aid over the sample period (1980 through 1992). As a share of total, central transfers to states on account of foreign aid have been small; the average share of ACA in total transfers over the sample period was 6 percent. Results presented in Table 2.4 show that at the margin, states do not benefit on account of externally aided projects. For example, regression (4.1) indicates that a rupee increase in central transfers on account of foreign aid to a state is associated with a reduction of Rs 1.62 in other transfers to that state. (The reduction is Rs. 1.41 if other transfers for development purposes are considered. See regression (4.3)). The more than a rupee reduction in other transfers suggests that not only the state is losing out for acquiring external resources but is also being penalized for it. Though we do not have enough data to test the hypothesis, it is likely that at the margin some of these resources are being transferred to the special category poor states, which do not get any significant external assistance. Regression (4.1) also indicates that a rupee increase in state government's spending financed by its own resources in the previous year leads to a 12 paise increase in central transfers in the following year. The latter link suggests some evidence of rewarding past revenue efforts of states. The regression reported as (4.3)–development transfers on ACA–has similar results. In regressions (4.2) and (4.4) we control for two additional factors: foreign aid to other states and spending by other states. In both cases, the coefficient on 'aid to other states' is negative and statistically significant. It shows that a rupee increase in external aid for all other states is associated with a 39 paise reduction in central transfers. Moreover, the own foreign aid variable in the specification, which was previously significant, now becomes insignificant. Evidently, central transfers to the general category states are reduced with an overall increase in foreign assistance to states.

2.4 Conclusion

In this paper we model two dimensions of foreign aid fungibility–one at the federal level and the other at the inter-governmental level. We use the model to test whether foreign aid to India, a federal country, is being spent for purposes intended by the donor agencies. This involves asking the question: what would have happened to the government budget in the absence of donor financing? Our empirical results suggest that the central government converts most foreign funds–including those earmarked for state governments–into fungible monies, and spends on activities that would have been undertaken anyway. Foreign aid merely softens its budget constraint.

What are the implications of these results? The finding that foreign aid does not influence the internally determined pattern of resource allocation would be good news for policymakers in India. For the donors, however, the fungibility results indicate that what one sees is not always what happens. If aid is fungible, it simply does not matter what donors finance–be it feeder roads or power plants or family planning clinics–and how well their projects perform. A better approach to make aid effective in terms of the overall development impact is to link aid with an overall public expenditure program that provides adequate resources to crucial sectors. Indeed, this is the main message of the paper.

Table 2.1 **Regression Analysis: Central government expenditure on foreign aid**			
Equation	*(1.1)*	*(1.2)*	*(1.3)*
Dependent Variable	*Non-Development Expenditure*	*Development Expenditure*	*Revenue Receipts*
Constant	243.4 (2.22)	151.9 (1.09)	94.75 (0.66)
GDP	0.08 (2.47)	0.06 (1.21)	0.07* (1.75)
Foreign Aid	0.90 (1.99)	-0.36 (-.49)	-0.30 (-0.51)
Fiscal crisis (1991) dummy	-993.5 (-1.93)	-1733.8 (-2.23)	518.95 (0.76)
R^2	.35	.37	.15
D-W statistic	1.77	1.88	1.96

Notes: 1. The regressions are based on 25 annual observations from 1970-95; to correct for autocorrelation, they were done in first differences. Applying the AR (1) correction (in levels) also gives similar estimates. Given the small size of the sample, however, the estimate of ρ is subject to sampling errors. In such cases, a recommended alternative (see Maddala, 1992) is to run the regressions in first differences.
2. The foreign aid variable is total disbursement of external assistance–concessionary loans and grants from all sources–bilateral and multilateral. All variables are in per-capita 1995 rupees.
3. T-statistics are in parentheses.

Table 2.2 **Regression Results: Central government non-development expenditure on foreign aid**						
Equation	*(2.1)*	*(2.2)*	*(2.3)*	*(2.4)*	*(2.5)*	*(2.6)*
Dependent Variable	G_1	G_2	G_3	G_4	G_4	G_5
Constant	243.4 (2.22)	144.2 (3.05)	140.8 (1.58)	28.7 (0.60)	.02 (3.48)	6.25 (0.12)
GDP	.08 (2.47)	.03 (3.55)	-0.01 (-1.34)	.01 (0.63)	-.006 (-0.05)	0.03 (1.66)
Foreign aid	.90 (1.93)	-.02 (-0.21)	-0.10 (-0.88)	.22 (1.09)	.22 (1.23)	.74 (2.59)
Fiscal crisis (1991) dummy	-993.5 (-1.83)	134.7 (1.13)	75.1 (0.53)	-428.9 (-1.83)	-448.5 (2.21)	-742.0 (-2.48)
War dummy (1971)					141.0 (1.15)	
Pakistan's defense expenditure					1.13 (3.25)	
R^2	.37	.40	.14	.17	.48	.34
D-W Statistic	1.77	2.23	2.16	1.99	1.94	1.81

Notes: 1. to 3. See Table 2.1.
4. G_1 is non-development expenditure; G_2 is interest expenditure t; G_3 is principal payments on all debt; G_4 is defense expenditure; and G_5 is: non-development expenditure - interest expenditure - principal payments on all debt - defense expenditure. Data on Pakistan's defense expenditure are from US Arms Control and Disarmament Agency (various issues).

Table 2.3
Regression Results: Central government development expenditure (sub-categories) on sectoral foreign aid

Equation *Dependent Variable*	*(3.1)* *Agriculture*	*(3.2)* *Irrigation*	*(3.3)* *Energy*	*(3.4)* *Industry*	*(3.5)* *T&C*	*(3.6)* *SS*	*(3.7)* *Others*
Constant	15.80 (1.53)	13.41 (1.39)	11.50 (0.70)	40.93 (0.34)	14.59 (0.47)	44.42 (1.92)	136.81 (2.48)
GDP	-0.001 (-0.33)	-0.003 (-1.23)	0.01 (2.51)	-0.04 (-1.18)	.002 (0.19)	0.01 (1.18)	0.02 (0.87)
Sectoral aid	-0.37 (-0.82)	0.01 (0.03)	0.11 (0.78)	1.95 (0.27)	-0.79 (-0.51)	1.52 (1.31)	-0.01 (-0.02)
Other aid	0.02 (0.24)	0.01 (0.14)	.04 (0.67)	-0.30 (-0.67)	-0.13 (-0.83)	0.21 (1.99)	-0.40 (-0.95)
R^2	.08	.16	.50	.23	.17	.54	.17
Observations	15	15	15	15	15	15	15

Notes: 1. The regressions are in first differences and are based on 15 annual observations from 1974-88; The foreign aid variable is total disbursement of concessionary loans from all sources -- bilateral and multilateral.
2. T&C is Transport and communication; and SS is Social sector expenditure.

Table 2.4
Regression Results: Central-transfers to states on Additional Central Assistance (ACA)

Equation	*(4.1)*	*(4.2)*	*(4.3)*	*(4.4)*
Dependent variable	$F_{t,s}$	$F_{t,s}$	$F_{t,s}^{d}$	$F_{t,s}^{d}$
Constant	9.10 (1.01)	2.85 (0.21)	9.97 (1.24)	19.09 (1.68)
$g_{t-1,s}$	0.12 (2.78)	0.12 (3.02)		
$\Sigma_{j \neq s} (g_{t-1,j} + F_{t,j})$		0.04 (1.79)		
$g_{t-1,s}^{d}$			0.09 (2.03)	0.09 (1.89)
$\Sigma_{j \neq s} (g_{t-1,j}^{d} + F_{t,j}^{d})$				0.02 (1.36)
$aid_{t,s}$	-1.62 (-2.41)	-0.92 (-1.39)	-1.41 (-2.36)	-0.77 (-1.13)
$\Sigma_{j \neq s} aid_{t,j}$		-0.39 (-3.44)		-0.39 (-3.42)
R^2	.08	.20	.05	.14
Observations	154	154	154	154
Model	Random	Fixed	Random	Fixed

Notes: 1. The regressions are based on annual data from 1980-92 on 14 states and are in first differences (for time-series data); ACA is transfers on account of foreign aid that are passed-on by the central government to state governments.
2. The number in parenthesis is the t-statistic for fixed-effects models and z-values for random-effects models. R-square is 'within' for fixed-effects model and 'overall' for random-effects model. 'Model' indicates whether the state dummies in the regression represent a Fixed effects or a Random effects model. The test is based on Hausman (1978).

Appendix 2.1

With the Stone-Geary specification, equation (2.3) of the fungibility model of Section 2 can be written as:

$$U^s = (C_p^s - \gamma_{C_p^s})^{\beta_{C_p^s}} . (G_1 - \gamma_{G_1})^{\beta_{G_1}} . (G_2 - \gamma_{G_2})^{\beta_{G_2}} . (g_1^s - \gamma_{g_1^s})^{\beta_{g_1^s}} . (g_2^s + G_2^s - \gamma_{g_2^s})^{\beta_{g_2^s}} .$$

...(A1-1)

where γ's are the subsistence quantities and are positive. A restriction imposed by this functional form is that all choice variables of the central government–G_1, G_2 and G_2^s– are independent of each other at the margin and the only link they have is through the budget constraint. Thus, while our Stone-Geary functional form gives us an estimable linear expenditure system (see below), it comes at a cost.

Maximization of U^s subject to the budget constraint

$$p_1 G_1 + p_2 G_2 + \sum_{s=1}^{S} p_2 G_2^s = R + \phi^c a^c + \sum_{s=1}^{S} \phi^s a^s . \qquad \text{...(A1-2)}$$

yields the following estimable linear expenditure equations:

(i) *Expenditure on* G_1 :

$$p_1 G_1 = p_1 \gamma_{G_1} + \tilde{\beta}_{G_1} \phi^c a^c + \tilde{\beta}_{G_1} [R + \sum_{s=1}^{S} (\phi^s a^s - p_2 G_2^s) - \sum_{j=1}^{2} p_j \gamma_{G_j}].$$

$$\textit{where} \quad \tilde{\beta}_{G_1} = \beta_{G_1} / (\beta_{G_1} + \beta_{G_2})$$

...(A1-3)

(ii) *Expenditure on* G_2 :

$$p_2\tilde{G}_2 = p_2\gamma_{G_2} + (1-\phi^c+\tilde{\beta}_{G_2}\phi^c)a^c + \tilde{\beta}_{G_2}[R+\sum_{s=1}^{S}(\phi^s a^s - p_2 G_2^s) - \sum_{j=1}^{2} p_j\gamma_{G_j}]$$

$$\text{where} \quad \tilde{G}_2 = G_2 + amount of\, G_2\, purchased from the non-fungible part of\, a^c.$$

...(A1-4)

(iii) *Expenditure on* G_2^s :

$$p_2\tilde{G}_2^s = -\,p_2(g_2^s-\gamma_{g_2^s}) + (1-\phi^s)a^s + \frac{\delta_2^s}{1-\delta_2^s}\sum_{j\_s}^{S}[\,p_2(\,g_2^j+\tilde{G}_2^j-\gamma_{g_2^j}) - (1-\phi^j)a^j\,],$$

$$\text{where} \quad \delta_2^s = (\alpha^s\beta_{g_2^s}) / \sum_{j=1}^{S}\alpha^j\beta_{g_2^j} \quad \text{and}$$

$$\text{where} \quad \tilde{G}_2^s = G_2^s + amount of\, G_2^s\, purchased from the non-fungible part of\, a^s.$$

...(A1-5)

Using data, these linear expenditure functions can be estimated along with the following equation, which models endogeneity of domestic revenue revenue with respect to foreign aid:

$$R = \mu_0 + \mu_1 GDP + \mu_2 a \quad \text{where} \quad a = a^c + \sum_{s=1}^{S} a^s. \qquad \text{...(A1-6)}$$

Appendix 2.2

As part of this research, we put together a data set on the major fiscal variables of the central and state governments as well as on external assistance to India.

1. Data on foreign aid

Data on aggregate external assistance to India–total disbursement of grants and loans from all bilateral and multilateral sources–were obtained for the period 1970-1995 from the Government of India's publication, *Economic Survey* (various issues). These data are not available by sectors. To do the sector-specific analysis for the central government, we use concessionary loans as the aid variable. The latter information–previously unavailable–was collected from World Bank sources. On average, concessionary loans account for nearly 85 percent of all external assistance for the sample period. Data on external resource transfer from the central government to states over the period 1980 through 1988 were taken from Bajaj (1992). Information on later years was taken from "External Assistance," an annual publication of the Aid Accounts & Audits Division, Department of Economic Affairs in the Ministry of Finance, Government of India.

2. Budgetary data at different levels of government

Two different sources were used to compile the data on the central government's fiscal variables: Chandhok and the Policy Group (1990) and *Indian Public Finance Statistics* (various issues), Government of India. Data were collected on public spending (aggregate as well as by sectors, purposes etc.), revenue receipts and fiscal deficits for the period 1970-1995. Full sample (26 annual observations) was used for all the central government analysis excepting the sectoral analysis for which data for 1974-1995 were used. This was done due to a change in sectoral classification systems between 1973 and 1974, making comparisons of pre-1973 and post-1973 data (on individual sectors) almost impossible. Moreover, the following modifications were made in the original expenditure data to conform to our research needs:

First, loans and grants (from the center to states) were re-classified to put them in the development or non-development expenditure categories. In the original data, loans and grants are included as transfer payments and are listed under two categories: "plan" and "non-plan." We put loans of both types and "plan" grants in the central government's development expenditure; "non-plan" grants were included in the non-development expenditure category. Second, we included principal payments on all foreign debt in the non-development expenditure category. In the Indian accounting system, principal payments are netted out from loans received, the latter being an entry in the Capital Receipts Accounts. Finally, we included the external assistance given by the center to the states, in the development expenditure category. In the original data, this item is listed as part of the central transfers to states.

Data on spending and receipts by the state governments, including loans and grants received from the center, were obtained from the *Reserve Bank of India Bulletin on State Finances* (various issues). The database for states covers the period 1980 to 1992 and includes 16 major states of India (out of a total of 25)–Andhra Pradesh, Assam, Bihar, Gujrat, Haryana, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

3. Other data

Information on Gross Domestic Product, Exchange Rates (Official) and Consumer Price Index were obtained from *Economic Survey* (various issues). Population figures for the country and for individual states are from the *Census of India* (various issues).

Chapter 3

What Does Aid to Africa Finance?[1]

Co-authored with Shantanayan Devarajan and Vinaya Swaroop

Chapter Abstract

If a donor gives aid for a project that the recipient government would have undertaken anyway, then the aid is financing some expenditure other than the intended project. The notion that aid in this sense may be "fungible," while long recognized, has recently been receiving some empirical support. This paper focuses on Sub-Saharan Africa—the region with the largest GDP share of aid—and presents results that indicate that aid may be partially fungible, and suggests some reasons why.

[1] The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. The authors acknowledge helpful comments they received from Maureen Cropper, Alan Gelb, Howard Pack, Lant Pritchett, Rino Schiavo-Campo, and seminar participants at AERC, IFPRI and the World Bank.

3.1 Introduction

Suppose an aid donor gives money to build a primary school in a poor country. If the recipient government would have built the school anyway, then the consequence of the aid is to release resources for the government to spend on other items. Thus, while the primary school may still get built, the aid is financing some other expenditure (or tax reduction) by the government. This could be problematic, especially from a donor's perspective, if the released resources of the government end up financing "unproductive" public expenditures.

That foreign aid is in this sense "fungible" has been recognized for a long time. In 1947, Paul Rosenstein-Rodin, then Deputy Director of the World Bank's Economics Department, noted: "When the World Bank thinks it is financing an electric power station, it is really financing a brothel." In the mid-1950s, some of the Bank's member countries asked for a revision of its policy of lending only for infrastructure because they wanted to borrow for health and education projects. The World Bank's president responded that they could finance their health and education projects with the funds that were released by the Bank's financing of infrastructure.

In light of the recent re-thinking of foreign aid, brought on by "aid fatigue" in donor nations and questions of aid's effectiveness, this paper examines the extent of aid fungibility in Sub-Saharan Africa. Before proceeding, we note that the two anecdotes illustrate some important aspects of fungibility. First, the question of what aid ultimately finances is interesting only if the preferences of the donor are different from those of the recipient. If they had identical preferences, then it would not matter if the aid were given to a specific project or as budgetary support. Second, when donor and recipient preferences differ, it is still not clear whether the presence of fungibility is good or bad. It all depends on what the government does with the resources that are released by the aid projects—whether it builds pyramids or health clinics. Third, regardless of what the government does with the released resources, aid fungibility has important implications for how donors evaluate the impact of their aid. To the extent that aid is fungible, the development impact of the electric power station loan is not captured by the rate of return of that project (Devarajan et al., 1997).

Despite its importance to policy, the question of the fungibility of aid remained at the level of anecdotes for over four decades. Recently, however, there has been a flurry of quantitative work, triggered on the one hand by heightened concern over the effectiveness of foreign aid (Boone, 1995; World Bank, 1998), and on the other hand by the availability of data (Cashel-Cordo and Craig. 1990; Gang and Khan, 1991; Pack and Pack, 1990, 1993, 1996; Khilji and Zampelli, 1994; Feyzioglu et al. 1998).

The recent work has shown that foreign aid is fungible in certain countries and in certain sectors. For instance, Pack and Pack find that aid is totally fungible in the Dominican Republic, non-fungible in Indonesia and partially fungible in Sri Lanka. Using a panel data set, Feyzioglu et al. (1998) find that foreign aid is fungible in agriculture, education and health, partially fungible in power and non-fungible in transport and communication. None of these authors has offered an explanation for their results.

No region will be more affected by these changes than Sub-Saharan Africa, which receives three times more foreign aid per capita than other developing countries. Some of the disappointing results on the effectiveness of aid in Africa may be due to its fungibility. Yet, none of the studies on aid fungibility has focused on Africa.

The purpose of this paper is to fill these two lacunae in our understanding of the fungibility of foreign aid: why aid is fungible or non-fungible, and the extent of aid fungibility in Africa. In section 2, we present a model of aid fungibility. In section 3, we estimate the model using data from Africa. Our estimates permit us to compare the extent of aid fungibility in Africa with respect to other countries, as well as identify some of the reasons why aid may or may not be fungible in Africa. Section 4 presents some concluding remarks about the implications of our results for policy and future research.

3.2 A Model of Semi-fungible Aid

In this section, we present a simple model that illuminates why aid may or may not be fungible. A variant of the models in Pack and Pack (1993) and Feyzioglu et al. (1998), the model incorporates the essential element in any discussion about fungibility, namely, a difference in the objective functions of the recipient and donor.

Consider, therefore, an aid recipient with an objective function over two types of expenditure, g_1 and g_2, and domestic revenue R. In the absence of aid, the recipient's problem is to maximize

$$U(g_1, g_2) = g_1^{\alpha} g_2^{1-\alpha} \text{ subject to}$$

$$R = p_1 g_1 + p_2 g_2.$$

The recipient's problem gives rise to the standard optimal solutions, g_1^* and g_2^*. Now suppose the donor has a different objective function over the recipient's expenditure on g_1 and g_2:

$$U(g_1, g_2) = g_1^{\beta} g_2^{1-\beta} \quad \text{with } \beta > \alpha > 0.$$

Thus, the donor would like the recipient to spend more on good 1 than the recipient would otherwise. For example, good 1 could be education, which the donor has targeted as a priority sector. The donor's aid policy, then, is to give the recipient $(\beta - \alpha) R$ to spend on g_1.[2]

Given the difference in objective functions, the recipient would like to treat this aid as budgetary support. But there are costs to treating earmarked aid as fully fungible. For instance, it could lead to a cutback in aid the following year. We assume these costs (or, equivalently, the donor's ability to monitor expenditures) are a function of the deviation between the donor's desired total expenditure on good 1,

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[2] As noted above, we are only modeling foreign aid in the case when there is a difference in the objective functions of the recipient and the donor. Thus, $\beta \neq \alpha$. Note that even with this aid, the recipients' expenditure on good 2 may not be optimal from the donor's perspective. However, what we are modeling here is the fact that we observe aid directed at particular sectors, that is, projects.

$p_1 g_1^{**}$, and the actual amount spent on that good. The recipient's new optimization problem, therefore, is to maximize

$$U(g_1, g_2) = g_1^{\alpha} g_2^{1-\alpha} \text{ subject to}$$

$$R + (\beta - \alpha)R = p_1 g_1 + p_2 g_2 + \theta(p_1 g_1^{**} - p_1 g_1)$$

where θ is the cost of treating earmarked aid as fully fungible. Although this cost is probably borne in the future (in terms of less foreign aid than would otherwise have been given), we incorporate it as a charge today by considering the present value of this future cost.

An interior solution to the above problem exists if $\theta < (\beta - \alpha)/\beta$:

$$p_1 g_1^{***} = \frac{\alpha(1 - \beta\theta)}{1 - \theta} R + \frac{\alpha}{1 - \theta} AID \qquad \text{...(3.1)}$$

where AID = $(\beta - \alpha)R$. If $\theta \geq (\beta - \alpha)/\beta$, the cost of treating earmarked aid as fully fungible is so prohibitively high that $p_1 g_1^{***} = p_1 g_1^{**} = \alpha R + (\beta - \alpha) R$, i.e., aid is spent on g_1 as desired by the donor. On the other hand, when $\theta = 0$, there is no penalty for treating aid as budgetary support, so the coefficient for R becomes the same as that for AID. These two scenarios are illustrated in Figure 3.1 behind.

The most important feature, however, is that equation (3.1) lends itself to econometric estimation, since the variables R and AID are in principle observable. By estimating a variant of equation (3.1), in the next section, we attempt to figure out how fungible aid is in different sectors.

Before proceeding to the empirical estimation, we treat one other issue that is often raised in discussing aid fungibility. That is the possibility that aid does not release resources for other expenditures but that it does reduce tax effort. From the reasoning of the previous section, if the aid were earmarked for some expenditure that would have taken place anyway, the recipient government could use the funds released for some other spending or to reduce the amount of taxes it collects. In fact, if the marginal cost of taxation is high, this may be a prudent strategy for the recipient. To capture this possibility, we rewrite the recipient's utility function as

$$U(g_1, g_2, 1\text{-}R)$$

where the $(1\text{-}R)$ term represents the share of gross domestic product (GDP) available to the private sector. The recipient's problem now is to maximize

$$U(g_1, g_2, 1-R) = g_1^{\alpha_1} g_2^{\alpha_2} (1-R)^{\alpha_3} \quad \text{subject to}$$

$$R = p_1 g_1 + p_2 g_2 .$$

The first-order conditions to this problem yield $R = 1 - \alpha_3$. When the country receives aid in the amount a (assume it is intended for budgetary support), the solution to the new maximization problem yields $R = 1 - \alpha_3 - \alpha_3 a$. Thus, the amount of aid that is diverted for reducing tax effort will be a function of the relative weight of the tax distortion (α_3) compared with the productivity of the other two expenditures in the utility function. In short, the recipient has the same incentive to divert aid toward tax reduction as towards other expenditures: the amount of diversion depends on the productivity of expenditures and the costs of taxation.

The above model describes fairly closely the situation of several African countries. In the past several decades, Sub-Saharan Africa has received more foreign aid—both in gross as well as net terms—than any other region. Between 1970 and 1995, average per capita aid to all Sub-Saharan African countries was US$23 (measured in current dollars); the average for all other developing countries was less than US$8. A number of studies have documented the aid experience of Africa.[3] In analyzing the growth performance of Sub-Saharan Africa, Easterly and Levine [1993] looked at, among other variables, the impact of external income. Their main finding was that an annual increase in external income—from better terms of trade and transfers (grants and loans)—equal to 1 percentage point of GDP raises growth by 0.6 percentage points. Helleiner (1992) and Demery and Husain (1993) have argued that during the 1980s foreign aid to Sub-Saharan Africa financed real imports and aid was instrumental in allowing several countries to move out of the import-compression phase. Were aid flows to Africa financing expenditures that would otherwise not be made? Were aid-financed imports truly marginal? Has aid to Sub-Saharan Africa been fungible? If so, why, and if not, why not? These are the issues to which we now turn.

3.3 Empirical Analysis

The model in section 3.2 develops links between foreign aid and fiscal variables. In our empirical analysis, we examine these links. Using a panel database from 18 Sub-Saharan African countries (more on this below), we first estimate the

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[3] See World Bank (1994) for a review.

statistical relationship between foreign assistance, measured in gross terms, and total public spending. To determine which expenditure items were funded by foreign aid, we examine the link between total foreign aid and various public-spending activities. The impact of earmarked sector-specific aid on sectoral spending is estimated next. Finally, we examine whether the "fungibility coefficient" is affected by donors' monitoring costs. Specifically, we assess whether the number of aid donors in a particular country—a proxy for monitoring costs—affects the fungibility analysis.

3.3-1 Empirical research on aid fungibility

Empirical research on the fungibility of aid has been done in individual countries using time-series data. Gang and Khan (1991), Gupta (1993), McGuire (1978), Pack and Pack (1990, 1993, 1996), among others, have analyzed aid fungibility across the sectoral classification of expenditures. In a study of foreign aid to Indonesia, Pack and Pack (1990) did not find any evidence of fungibility across sectoral expenditures. On the other hand, in the Dominican Republic they (Pack and Pack, 1993) found evidence of substantial diversion of foreign aid away from its intended purposes.

The individual country studies, while important, do not allow any cross-country generalization, which could be useful information to the donor community. The study by Feyzioglu et al. (1998) uses a cross-country panel data set to analyze the relationship between sector-specific foreign aid and government expenditure on the agriculture, defense, education, energy, health, and transport/communications sectors.

They find that developing country governments receiving earmarked concessionary loans for agriculture, education and energy, reduce their own resources going to these sectors and use it elsewhere; only loans to the transport and communication sector are fully spent on purposes intended by donors. There are a few other cross-country studies that have analyzed the issue of fungibility. Cashel-Cordo and Craig (1990) used a sample of 46 developing countries to analyze whether or not foreign aid changes the composition of government expenditure. The expenditure components in their analysis are, however, limited to defense and nondefense spending. The study by Khilji and Zampelli (1994) also looks at defense and nondefense expenditures in examining the fungibility of U.S. aid among eight major aid recipient countries.

3.3-II Data, choice of variables and sample statistics

Our empirical analysis is based on a panel database that has annual observations on 18 Sub-Saharan African countries from 1971 to 1995. The countries included in the sample are: Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, The Gambia, Kenya, Liberia, Lesotho, Madagascar, Malawi, Mauritius, Nigeria, Sudan, Swaziland, Zaire, Zambia, and Zimbabwe. The sample choice—number of countries and time period—was based on data availability for all the relevant variables, subject to the constraint that at least 10 years of complete data had to be available for each country in the sample. (For more information on the sample selection method and data sources, see the Data Appendix.) The panel data are organized along three dimensions: (i) foreign aid variables; (ii) fiscal variables (public spending and revenue); and (iii) income and control variables.

(i) Foreign aid data. Our main aid variable is the total annual gross disbursement of Official Development Assistance (ODA) by all bilateral and multilateral sources, reported in an aid publication of the Organisation of Economic Co-operation and Development (OECD). ODA has two components: grants and concessionary loans. To examine the impact of sector specific aid on sectoral spending, we had to use concessionary loans as the aid variable since no sector-specific information on grants is available. The data on sector-specific concessionary loans are available from the World Bank database. Data on total aid were also used to derive the variable we used as a proxy for the level of monitoring exerted on aid recipients.

(ii) Fiscal data. Our main source of fiscal data (public spending and revenue) is the International Monetary Fund's (IMF) database on Government Finance Statistics. In the definition of total public spending, we have included principal payments on concessionary loans. This adjustment was made because we were interested in finding out how much, if at all, aid was being used to finance principal payments due on past loans. For this reason, we also measure foreign aid in gross (as opposed to net) terms though we do not know if part of the aid was given for debt rescheduling or was an untied budgetary support. In terms of the composition of public spending we collected data for our sample countries on current, capital, and loan repayments on the one hand, and sectoral (agriculture, education, energy, health, industry, transport and communication) spending on the other. We were also interested in finding out if any of the aid money was channeled towards interest payments on foreign debt. We therefore obtained information on this variable for each country from the OECD database.

(iii) Data on income and control variables. The database includes data on GDP, infant mortality, gross primary and secondary school enrollment rates, population and the share of agriculture in national income.

Table 3.1 (behind) shows the summary statistics for the 18-country sample. Measured in 1995 U.S. dollars the mean per capita GDP over the period 1970 through 1995 is US$837. Over this period, the cross-country means range from a low of $178 (Ethiopia) to $1,951 (Mauritius).

The mean size of government (measured as the share of total government spending in GDP) in these countries is close to 28 percent. Once again we see a large variation in terms of cross-country means: The range is from 11.2 percent for Burkina Faso to 52.7 percent for Lesotho. The average share of foreign aid in GDP for this group of Sub-Saharan African countries is 10 percent. Nigeria, a major oil producer and exporter, is at the lower end (0.2 percent of GDP). When aid is measured as a percentage of GDP, The Gambia is the largest recipient. However, in per capita terms, Botswana is the country in the sample that received the highest foreign aid. Finally, roughly two-thirds of total aid is in the form of grants for this group of countries.

Figures 3.2 and 3.3 (behind) show the sectoral breakdown of concessionary loans and government expenditure, respectively.[4] Almost 40 percent of the concessionary loans have gone to four sectors: agriculture, energy, industry, and transport and communications. It is clear from the figure that there were not too many concessional loans to education and health.[5] Among the six sectors, education accounts for most of the public spending. Next are transport and communication and agriculture. As a crude indicator, these figures signal that donor and recipient preferences may not be identical.

3.3-III Regression analysis

Foreign aid fungibility is analyzed by estimating the following three equations:

$$G_{i,t} = \alpha_{0,t} + \alpha_1 Aid_{i,t} + \alpha_2 GDP_{i,t-1} + \varepsilon_{i,t}$$

for country i (i=1,...,I) at time t (t=1,....,T);

$$\ldots(3.2)$$

$$G_{i,t}^{E_j} = \delta_{0,t} + \delta_1 GDP_{i,t-1} + \delta_2 Aid_{i,t} + \delta_3 (G_{i,t}^N - \hat{G}_{i,t}^N) + v_{i,t} \qquad \ldots.(3.3)$$

where E_j {j=1,2,3} are current, capital and principal repayment expenditures and G^N is total domestic resources defined as total expenditures net of foreign aid. $G_{i,t}^N$ is estimated as

[4] Concessionary loans to "other" sectors includes multisector loans, balance of payments support, administrative budget support, and loans to sectors that cannot be identified.

[5] It is possible that a lot of assistance was given to education and health sectors in the form of grants. Lack of data precludes us from analyzing the composition of grants.

$$\hat{G}^N_{i,t} = \beta_{0,t} + \beta_1 Aid_{i,t} + \beta_2 GDP_{i,t-1}.$$

...(3.3′)

This two-stage estimation procedure is used because foreign aid affects the composition of public spending directly as well as indirectly (more on this below). Similarly, for each sector *s (s =1,...,S)* we have:

$$G_{i,s,t} = \lambda_{0,t,s} + \lambda_{1,s} GDP_{i,t-1} + \lambda_{2,s} Cloan_{i,s,t} + \lambda_{3,s}(G^N_{i,s,t} - \hat{G}^N_{i,s,t})$$
$$+ \lambda_{4,s}(Tloan_{i,t} - Cloan_{i,s,t})$$
$$+ \lambda_{5,s} TGrants_{i,t} + \eta_{i,s,t}$$

...(3.4)

where $G^N_{i,s,t}$ is estimated as:

$$\hat{G}^N_{i,st} = \phi_{0,t,s} + \phi_{1,s} GDP_{i,t-1} + \phi_{2,s} Cloan_{i,s,t} + \phi_{3,s}(Tloan_{i,t} - Cloan_{i,s,t})$$
$$+ \phi_{4,s} TGrants_{i,t}$$

...(3.4′)

Eq. (3.2) examines the impact of total foreign aid on the government's budget. This model incorporates the possibility that if the aid was earmarked for some expenditure that would have taken place anyway, the recipient government could use the funds released for some other spending or to reduce the amount of taxes it collects.

In section 3.2, we derived the condition that links public spending on good *i* with domestic revenue *R* and foreign aid (for example, see eq. 3.1). Equations (3.3) and (3.4) estimate this relationship for various types of public expenditure. However, we know that domestic resources may change with a change in foreign aid. Since we are interested in the effects on public expenditure of domestic resources and foreign aid, independently of each other, we control for the impact of aid on total domestic resources. This is done using a two-stage estimation process. Eq. (3.3′) indicates the first stage estimation for capital and current expenditure, and for principal repayments. The residuals from eq. (3.3′) are then used in place of in eq. (3.3), which is the second-stage estimation. Similarly, the residuals from eq. (3.4′) are used in place of G^N in eq. (3.4), which estimates the impact of sector aid and domestic resources on sector expenditure.

The variables in the above mentioned three regressions are (all measured in 1995 US$, per capita terms):

$GDP_{i,t}$:	Gross domestic product for country *i* at time *t*
$G_{i,t}$:	Total government expenditure
$G_{i,t}^{N}$:	Total government expenditure (net of foreign aid)
$G_{i,t}^{Ej}$:	Government expenditure for current, capital or principal repayment purposes, where E_j {j=1,2,3} is current, capital or principal repayment expenditure, respectively
$G_{i,s,t}$:	Government expenditure in sector *s*
$Aid_{i,t}$:	Total gross ODA disbursement
$CLoan_{i,s,t}$:	Gross concessionary loan disbursement to sector *s*
$TLoan_{i,t}$:	Total concessionary loans to all sectors
$TGrants_{i,t}$:	Total grants to all sectors
$\varepsilon_{i,t}$, $v_{i,t}$ & $\eta_{i,s,t}$:	White noise error terms for the three equations.

We would ideally like to include sector-specific grants in equation (3.4). However, data on grant disbursements are available only at the aggregate level, and not by sector (see subsection 3.3-II above). Thus we have to use concessionary loans as our sector-aid variable.

Loans to a particular sector may be correlated with loans to other sectors and with grants. To avoid bias in our estimates, we include the latter as additional right-hand-side variables in eqs. (3.4′) and (3.4), although these are not the variable coefficients we are primarily interested in.

Table 3.2 (behind) presents the estimates of eqs. (3.2), (3.3) and (3.3') which are all estimated under the null hypothesis that the coefficient of the country dummy variable, $\alpha_{0,I}$, is a fixed parameter. If, however, the Hausman test rejects the null hypothesis that the appropriate model is fixed effects then the random effects model is estimated.[6]

Regression (2.1) shows a positive and statistically significant relationship between total public spending and the total gross disbursement of ODA. The regression shows that a dollar increase in foreign aid leads to an increase of 0.89 cents in total government spending; the remaining aid is used for tax relief.[7] Moreover, a dollar increase in last year's GDP leads to an increase of 11 cents in government expenditures. This evidence suggests that in this sample of 18 Sub-Saharan African

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[6] 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, i.e., $\alpha_{0,i} = \alpha_0 + \varepsilon_i$. Hausman has developed a test, which shows that under the null hypothesis the fixed effects model is appropriate and the preferred estimator is least squares with dummy variables. If, however, 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).

countries, very little aid, if any, is being used for tax relief. At the margin, most aid is associated—in a statistical sense—with an increase in government spending.

Regression (2.2) is estimated to control for the effect of foreign aid and GDP on the domestic resources of the government. The residuals of this equation are used as an exogenous variable in the subsequent equations reported in this table. In turn, this variable represents the true exogenous shock to a country's domestic resources. Regression (2.3), which includes expenditure according to the economic classification of IMF's Government Financial Statistics, indicates that roughly 28 cents of an additional dollar in ODA is spent on government's capital expenditure. Moreover, the coefficient of ODA in regression (2.4) shows that 30 cents of the dollar increase in aid goes toward current expenditure. These findings may not be necessarily bad for at least two reasons. First, parts of foreign aid could be designed for current expenditure related activities. Second, several components of current expenditure, such as operations and maintenance, may have higher rates of return than capital expenditure.[8] Finally, the aid coefficient in regression (2.5) shows that 31 cents of the marginal dollar are being used to finance principal repayments on the foreign concessionary loans. A comparison of the coefficients on the aid variable with the coefficients on the variable "residuals of total spending net of aid" suggests that at the margin more money is spent on current expenditure if the financing is from own domestic sources.

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[7] In some developing countries, not all foreign aid goes through the budget. Our aid data (from OECD sources) are likely to be different from that of budgetary aid receipts of the Sub-Saharan African governments. It is therefore possible that some of the other 11 cents of the marginal dollar in aid represents extra-budgetary aid.

For capital spending, however, the source of additional resources do not matter; be it foreign or domestic, 28 cents of an additional dollar is spent. Regression (2.5) indicates that none of the additional domestic resources is used to finance debt repayments.

Table 3.3 provides the estimates of the same equations as reported in table 3.2 except that the aid variable in these equations is broken in its two components: concessionary loans and grants. As indicated in regression 3.1, the impact of the two aid variables on total public expenditure is remarkably identical. In their analysis of 14 developing countries (of which four were in Sub-Saharan Africa), Feyzioglu *et al.* [1998] found that disbursement of concessionary loans were far more stimulative of total government expenditures than was total aid. As conjectured in their paper, however, the difference in the two coefficients could be due to the bias introduced in the estimate of concessionary loans for not including data on grants. An important finding reflected in regression 3.5 of our table 3 is that it is only grants and not loans that are used to repay the principal on loans. Moreover, concessionary loans are used more for current than capital purposes (Regressions 3.3 and 3.4).

Table 3.4 has the estimates of regression (3.3). Regressions reported in this table examine the link between the gross disbursement of concessionary loans to a particular sector and public spending in that sector.

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[8] In a study of 43 developing countries over 20 years, Devarajan, Swaroop and Zou [1996] show that the only broad public expenditure category that is associated with higher economic growth is the current expenditure.

In each of the six sectoral regressions—one each for agriculture, energy, industry, transport and communication, education and health—the coefficient on the variable "residuals of total spending net of aid" indicates how the government distributes an additional dollar that it gets from all resources net of concessionary loans. Comparing these coefficients with the coefficients on the sectoral-aid variable (loans to sector) indicate the level of fungibility at the sectoral level. Only concessionary loans to the education, energy, and transport and communication sectors[9] show a positive and statistically significant relationship with their respective sectoral spending. The regression on the energy sector shows that a dollar increase in sectoral aid leads to an increase of 13 cents in energy sector spending; the remaining aid is used elsewhere. Moreover, when governments get an extra dollar in domestic resources they only spend, on average, 1 cent on the energy sector. Comparing the two coefficients suggests that aid to the energy sector is partially fungible. Evidence from the transport and communication sector (T&C) reveals a similar story. The increase in sectoral spending from own resources is 13 cents but it jumps to 36 cents from aid resources, thus indicating a case of partial fungibility. Aid to education, however, is being spent almost fully in the sector. Since in education, teacher wages are nearly 95 percent of the budget, it is likely that aid finances nearly everything else at the margin. Other sectoral regressions—agriculture, health, and industry—indicate that there is no evidence from this group of countries that aid to these sectors is increasing spending in the sectors for which it was intended.

[9] As noted at the bottom of Table 3.4, Botswana is evidently an outlier for the education regression. The analysis in the text focuses on regression (4.7), without Botswana in the

3.3-IV Regression analysis: What determines the level of fungibility?

The sector regressions in the previous section assume that the level of fungibility, which is captured by the parameter θ in eq. (3.1), is the same across countries. A more realistic approach may be to allow the coefficient of the sector-aid variable in the regressions—which is positively related to θ (see eq. 3.1)—to be a function of the degree of monitoring exerted by aid donors on the recipient country. Since we cannot observe this degree of monitoring, we use a proxy for it: the total number of aid donors. A donor would have greater difficulty monitoring his aid program if he is one of several donors in the country, compared with the case if he is the only donor. Given a particular level of aid to a country (for any given sector), we would expect the number of donors to be inversely correlated with the level of monitoring, and hence with the coefficient of the sector aid variable in the regressions.

To test this hypothesis, we modify eq. (3.4), allowing the coefficient of our sector-specific aid variable, $\lambda_{2,i,s,t}$ [10], to be a linear function of the total number of aid donors to country i, $Nd_{i,t}$:

$$\lambda_{2,i,s,t} = h_{0,i,s} + h_{1,s} Nd_{i,t} \qquad \text{...(3.5)}$$

In this flexible specification, $h_{0,i,s}$ is allowed to vary across the 18 countries. However, $h_{1,s}$ is the same for all countries (for any given sector).[11] The parameter $h_{1,s}$

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sample.

[10] In eq. (3.3) this coefficient only had the subscripts 2 and s. Now it is allowed to vary across countries and across time (see eq. 3.4). Thus we add i and t as subscripts.

measures the relationship between *changes* in the number of donors ($Nd_{i,t}$) and changes in the coefficient of sector aid ($\lambda_{2,i,s,t}$).

Using eq. (3.5) to substitute into (3.4) we get the following estimable equation:

$$G_{i,s,t} = \lambda_{0,i,s} + \lambda_{1,s} GDP_{i,t-1} + \sum_{j=1}^{18} h_{0,i,s}(CDummy_j Cloan_{i,s,t}) + h_{1,s}(Nd_t . Cloans_{i,s,t})$$

$$+ \lambda_{3,s}(G_{i,s,t}^N - \hat{G}_{i,s,t}^N) + \lambda_{4,s}(Tloan_{i,t} - Cloan_{i,s,t}) + \lambda_{5,s} TGrants_{i,t} + \eta_{i,s,t}$$

...(3.6)

where $CDummy_j$ is a country dummy for country j. [12] This equation includes 19 interaction terms on the right-hand side: (i) $CDummy_j$ x $Cloan_{i,s,t}$ (country dummy x concessionary loans to sector), using in turn each of the 18 country dummies; and (ii) $Nd_{i,t}$ x $Cloan_{i,s,t}$ (number of donors x concessionary loans to sector). The other right-hand side variables in eq. (3.6) also appear in eq. (3.4).

Eq. (3.5) was estimated for each of the defined sectors. The key results are shown in table 3.5. Given the large number of regressors, we only report the estimated value (with *t*-statistic) of the coefficient we are mainly interested in, that of $Nd_{i,t}$ x $Cloan_{i,s,t}$ (number of donors x concessionary loans to sector). We thus present estimates for $h_{1,s}$ in eqs. (3.4) and (3.5), for each sector.

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[11] Alternatively, $h_{0,i,s}$ could be made constant across countries, dropping the *i* subscript. However, this does not allow for the possibility that $\lambda_{2,i,s,t}$ is affected by other country specific factors besides the number of donors.

[12] The country dummies operate in the usual way: $CDummy_j$ takes the value 1 for country j, and 0 otherwise.

There is evidence that the number of donors has an impact on the level of fungibility (i.e., that $h_{1,s}$ is different from zero), but only for the transport and communications (T&C) and education sectors[13]. The regression results in the previous sub-section showed that: (i) aid is fully fungible ($\hat{\lambda}_{2,s} = 0$) in the agriculture, industry and health sectors, and: (ii) aid is partially fungible ($0 < \hat{\lambda}_{2,s} < 1$) in the energy, transport and communications (T&C) and education sectors. According to the results shown in table 3.5, the partial fungibility of aid in the T&C and education sectors is negatively related to the number of aid donors to a recipient country. This supports our hypothesis that the number of donors has an inverse relationship with, and is a proxy for, the degree of monitoring exerted by donors, at least for the T&C and education sectors.[14]

3.4 Conclusion

This paper set out to explore two issues: (i) the extent of aid fungibility in Sub-Saharan Africa; and (ii) reasons why aid was fungible or not. In terms of the first question, we find that the broad pattern of aid fungibility observed in cross-country and country-specific studies is reflected in our analysis of African countries. Specifically, we find relatively little evidence that aid leads to greater tax relief in Africa; every dollar of aid leads to an increase in government spending of 90 cents.

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[13] As noted at the bottom of Table 3.4, Botswana is evidently an outlier for the education regression. The analysis in the text focuses on regression (5.7), without Botswana in the sample.

[14] Using a similar procedure, we tested for the possibility that the level of fungibility may change over time. We did not find any such evidence for the six sectors.

We reiterate that the implications of this result are by no means clear-cut. If the marginal cost of taxation is exceptionally high—and there is some evidence that this is so in African countries (see Devarajan, et al., 1998)—then using aid for tax relief may well be the best use of foreign resources. The effect of aid on the composition of public spending between current and capital expenditures is also broadly consistent with international evidence. Aid in Africa leads to an increase in current and capital spending in equal amounts. Again, we note that, even if all aid was intended to finance capital expenditures, the reallocation to current spending may not necessarily be harmful. One of Africa's problems is the chronic underspending on operations and maintenance. Interestingly, we find that an almost equal amount of aid goes towards repaying the principal on past loans. On the surface, this appears to be a striking result. Very few donors would have explicitly given aid in order to repay loans. But on further reflection, this is not so surprising. The inability to meet debt-service payments threatened many African countries with a complete cut-off from foreign capital. The use of aid resources to relax this constraint could have been quite rational. Moreover, the fungibility of loans intended for particular sectors in Africa roughly mirrors a pattern found with a broader sample of countries, with some exceptions. Aid to energy and transport and communication sectors lead to some increase in public spending in those sectors, but it is by no means one-for-one. By contrast, in the worldwide sample, aid to transport and communications was almost fully nonfungible.[15] Finally, aid to the education sector—which had no discernible effect on education spending in the global

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[15] Though nonfungibility of aid to a sector as a whole does not preclude aid fungibility within the sector.

sample—has an almost one-for-one effect on education sector spending in Africa. In any event, even in these partially fungible sectors, governments spend more out of aid resources than they do out of their own resources at the margin. Aid to Africa is partially fungible: governments do not spend all sectoral aid in that sector, nor do they treat such aid as merely budgetary support.

Our answers to the second question shed light on the findings about partial fungibility. We find that as the number of donors to a country increases, aid is more likely to be fungible. If we accept the notion that the number of donors represents a proxy for monitoring costs, then it is not surprising that most aid is partially fungible. Recipients are trading off the benefits of full fungibility with the costs. When these costs are low, such as when there are a large number of donors in a country, we observe greater fungibility.

The implications of these results are threefold. First, the development community seems to have swung from a denial of the existence of fungibility (with some notable exceptions) to the other extreme of accepting that all aid is fungible. The facts seem to indicate, though, that aid is partially fungible. On the one hand, this strengthens the conclusion that donors should be concerned with the quality of the overall public expenditure program of the recipient country. It also confirms the importance of donor coordination. On the other hand, our results seem to indicate that aid to particular sectors does have an influence on the composition of public spending, so that sectoral aid programs and projects, have a role to play in development assistance. Second, our preliminary findings about the influence of the number of donors on fungibility suggest that further work on the costs of fungibility to the recipient may be a fruitful area of research. Third, countries that are highly aid dependent and where aid is fungible, would be hurt most if the level of aid is reduced. This is because in the case of aid being fungible, its reduction would be equivalent to a decrease in the country's own revenue. Another issue, hitherto unstudied, is fungibility across donors: in a country, does increased aid from one donor increase or decrease aid from other donors? These issues are probably best addressed in individual country studies. But, for policy purposes, it is also useful—not to say essential—to pull these studies together into a cross-country analysis, as we have attempted here.

Table 3.1: Summary Statistics
(constant per capita 1995US$, except ratios which are in percent)

Variable	*Sample mean*	*Standard deviation*	*Minimum [country mean]*	*Maximum [country mean]*
1. Government expenditure				
Total expenditure	249	233	39 (Burkina Faso)	691 (Botswana)
Capital expenditure	58	58	5 (Burkina Faso)	252 (Botswana)
Current expenditure	185	188	32 (Burkina Faso)	525 (Botswana)
Repayments on concessionary loans	5	11	0.50 (Zaire)	12 (Swaziland)
Share of total expenditure in GDP	27.8	11.8	11.2 (Burkina Faso)	52.7 (Lesotho)
2. Foreign aid				
Total aid	62	46	2 (Nigeria)	151 (Botswana)
Concessionary loans	21	19	1 (Nigeria)	40 (Swaziland)
Grants	40	36	2 (Nigeria)	119 (Botswana)
Share of total aid in GDP	10.0	8.0	0.2 (Nigeria)	20.8 (Gambia)
3. Gross domestic product	837	627	178 (Ethiopia)	1,951 (Mauritius)

Notes: 1. The above numbers are for our sample of 280 observations, from 18 Sub-Saharan African countries. (See Data Appendix for more details.)
2. Foreign aid above refers to Official Development Assistance as reported by OECD.

Table 3.2: Least Squares Regressions: Government Expenditure on Foreign Aid					
Equation	*(2.1)*	*(2.2)*	*(2.3)*	*(2.4)*	*(2.5)*
Dependent variable	***Total expenditure***	***Domestic resources***[2]	***Capital expenditure***[3]	***Current expenditure***[3]	***Principal repayments***[3]
Constant	2.59 (0.84)	2.59 (0.84)	0.93 (0.69)	1.93 (1.37)	-0.25 (-0.39)
GDP_{t-1}	0.11 (4.89)	0.11 (4.89)	0.03 (3.21)	0.08 (7.81)	0.001 (0.25)
Foreign aid[4]	0.89 (5.89)	-0.11 (-0.72)	0.28 (4.30)	0.30 (4.31)	0.31 (10.07)
Residuals from regression (2-2)			0.28 (10.03)	0.72 (24.75)	0.007 (0.56)
Overall R-squared	0.22	0.14	0.34	0.74	0.29
Model[5]	Fixed	Fixed	Random	Random	Random

Notes: 1. Before regressing, all variables were converted to constant 1995 US$ per capita. Regressions were done in first differences based on a sample of 280 observations, from 18 countries (see Data Appendix for more details). Parentheses indicate *t*-statistics.

2. The variable "Domestic Resources" is defined as all expenditure financed from domestic resources, i.e., total expenditure minus foreign aid.

3. Total expenditure are divided into three components: capital, current, and principal repayments. The latter include only repayments on foreign concessionary loans.

4. Foreign aid is defined as Official Development Assistance (the definition used by the Organisation for Economic Co-operation and Development).

5. Model indicates whether the country dummies in the regression represent a fixed effects or a random effects model. The Hausman test statistic was used to select the appropriate model.

Table 3.3: Least Squares Regressions: Government Expenditure on Concessionary Loans and Grants

Equation	*(3.1)*	*(3.2)*	*(3.3)*	*(3.4)*	*(3.5)*
Dependent Variable	*Total expenditure*	*Domestic resources*[2]	*Capital expenditure*[3]	*Current expenditure*[3]	*Principal repayments*[3]
Constant	2.59 (0.84)	2.59 (0.84)	0.95 (0.70)	2.01 (1.44)	-0.36 (-0.63)
GDP_{t-1}	0.11 (4.88)	0.11 (4.89)	0.03 (3.21)	0.08 (7.95)	0.001 (0.20)
Concessionary loans[4]	0.89 (3.81)	-0.11 (-0.44)	0.32 (3.20)	0.51 (4.89)	0.06 (1.30)
Grants[4]	0.89 (4.42)	-0.11 (-0.52)	0.25 (2.87)	0.14 (1.54)	0.51 (13.67)
Residuals from regression (3-2)			0.28 (10.02)	0.72 (25.07)	0.01 (0.61)
Overall R-squared	0.22	0.14	0.34	0.74	0.43
Model	Fixed	Fixed	Random	Random	Random

Notes: See Table 2.2 for notes 1,2,3, and 5.
4. Official Development Assistance is the aid variable. It is subdivided into its two components: grants and concessionary loans.

Table 3.4: Panel Data Regressions: Sectoral Expenditure and Concessionary Loans

Equation	*(4.1)*	*(4.2)*	*(4.3)*	*(4.4)*	*(4.5)*	*(4.6)*	*(4.7)*	*(4.8)*	*(4.9)*
Dependent variable	*Total*	*Agriculture*	*Energy*	*Industry*	*T&C.*	*Education*[2]	*Education without Botswana*[2]	*Health*	*Other*[3]
Constant	2.59 (0.84)	-1.21 (-0.92)	-0.04 (-0.15)	-0.23 (-0.68)	-0.11 (-0.13)	0.26 (0.17)	3.00** (2.08)	-0.62 (-1.20)	2.41** (2.30)
GDP_{t-1}	0.11** (4.89)	0.01 (1.33)	0.002 (1.25)	0.004 (1.61)	0.01* (1.82)	0.02** (5.20)	0.01** (3.78)	0.004** (3.20)	0.06* (8.27)
Foreign aid	0.89** (5.87)								
Concessionary Loans to sector		-0.04 (-0.45)	0.13* (1.72)	0.11 (1.57)	0.36** (2.62)	-0.80** (-2.93)	0.98** (2.10)	0.26 (0.66)	0.65** (6.50)
Concessionary Loans to all other sectors		0.11** (2.63)	0.004 (0.24)	0.002 (0.07)	-0.03 (-0.50)	-0.05 (-1.60)	-0.06* (-1.77)	0.002 (0.15)	0.13 (1.26)
Total grants (to all sectors)		0.10** (2.78)	-0.03 (-1.64)	0.01 (0.58)	0.09* (1.67)	0.08** (2.50)	0.07* (1.89)	0.03** (2.80)	0.12* (1.80)
Agriculture as share of GDP_{t-1}		0.05 (1.14)							
Primary school enrolment $rate_{t-1}$						0.03 (1.17)	-0.007 (-0.28)		
Secondary school Enrolment $rate_{t-1}$						-0.06 (-1.25)	-0.11** (-2.42)		
Infant mortality $rate_{t-1}$								0.008* (1.72)	
Residuals from domestic resources regression		0.07** (6.66)	0.01** (2.50)	0.02** (2.87)	0.13** (7.44)	0.14** (13.19)	0.12** (10.75)	0.04** (10.46)	0.57** (26.90)
R-squared	0.22	0.20	0.06	0.06	0.23	0.49	0.40	0.36	0.78
Model	Fixed	Random	Random	Random	Random	Random	Random	Random	Random

Notes: 1. The large negative coefficient of "concessionary loans to sector" in the education regression is reversed when Botswana is dropped. Botswana is hence an outlier; the analysis in the text focuses on regression (4.7), without Botswana in the sample.

2. Other expenditure is defined as total expenditure less spending on the six sectors.

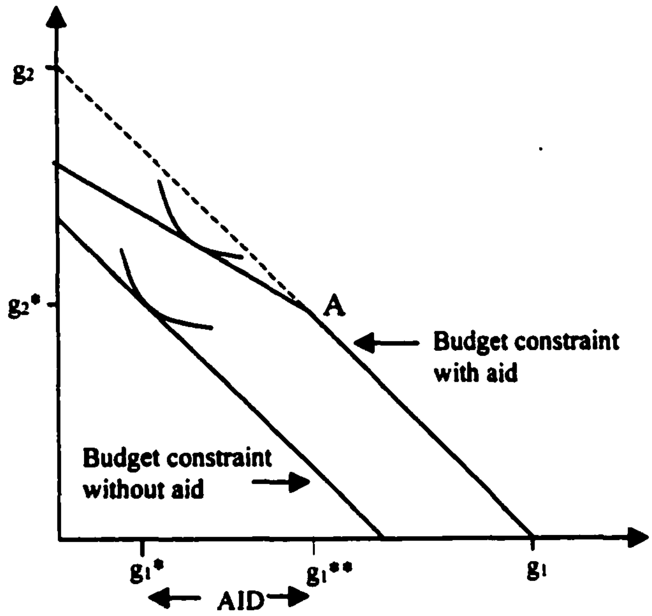
3. ** indicates a coefficient statistically different from zero at the 5 percent significance level, while * indicates 10 percent significance.

Table 3.5: Estimates for $h_{1,s}$, or the Impact of the Number of Donors On The Level of Fungibility

Equation	*(5.2)*	*(5.3)*	*(5.4)*	*(5.5)*	*(5.6)*	*(5.7)*	*(5.8)*	*(5.9)*
Dependent variable	*Agriculture*	*Energy*	*Industry*	*T&C*	*Education*	*Education without Botswana*	*Health*	*Other*
Number of donors x concessionary loans to sector (estimated coefficient or $\hat{h}_{1,s}$)	-0.07 (-1.21)	-0.02 (-0.69)	0.01 (0.44)	-0.12** (-2.39)	-0.17 (-0.90)	-0.38* (-1.67)	-0.36 (-1.34)	-0.10** (-2.24)

Note: The information for the table came from estimating equation (3.5) in the text, for each sector. Due to the large number of regressors, only $\hat{h}_{1,s}$, or the coefficient of "number of donors x concessionary loans to sector", is reported for each sector regression. For notes 2 to 4 see Table 3.4.

Figure 3.1



Note: The bold lines and indifference curves illustrate the case where $0 < \theta < (\beta - \alpha) / \beta$ (see main text). The dotted line shows the budget constraint if $\theta = 0$. Point A is the chosen point if $\theta \geq (\beta - \alpha) / \beta$.

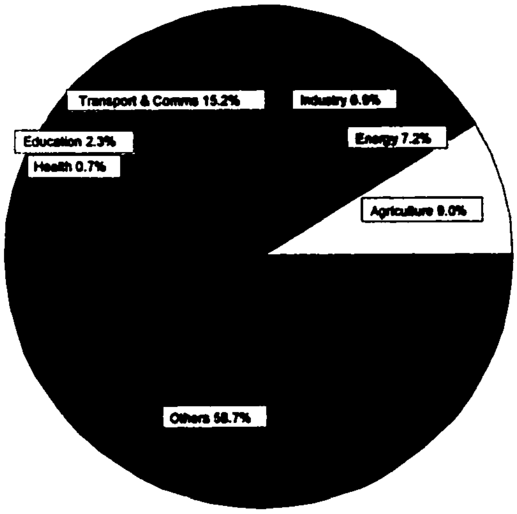


Figure 3.2: Breakdown of Concessionary Loans by Sector

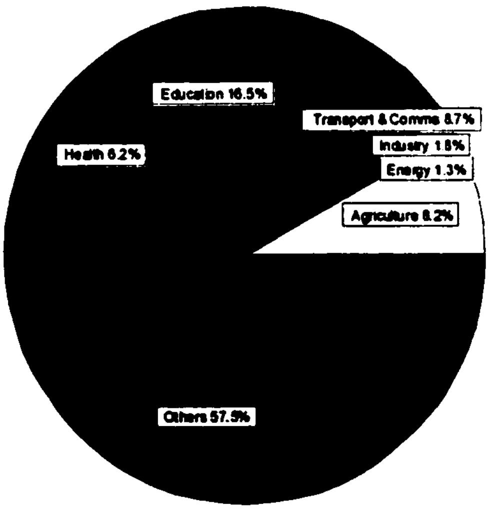


Figure 3.3: Breakdown of Government Expenditure by Sector

Data Appendix 3

1. Sample: Size and selection

The sample used in the empirical analysis comprises 280 observations from 18 Sub-Saharan African countries, from the years 1971 to 1995. The 18 countries are: Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, The Gambia, Kenya, Liberia, Lesotho, Madagascar, Malawi, Mauritius, Nigeria, Sudan, Swaziland, Zaire, Zambia, and Zimbabwe.

Sample size and selection were based entirely on data availability. We started by collecting all available data on the relevant variables for Sub-Saharan African countries, for the years 1971–95 (see sources listed below; 1971 is the first year and 1995 is the last year, for which sector-specific loan data is available). A country was included in the sample if it had complete information on all variables (aggregate as well as sector-specific) for at least 10 years of the chosen time period.

All aid and government expenditure/revenue variables, as well as gross domestic product, were converted to 1995 US$. Conversion from local currency units to US$ was done using World Bank conversion factors (which in most cases are the same as the official exchange rates reported in the *International Financial Statistics* of the International Monetary Fund).

2. Data sources

- Data on foreign aid are from *Geographical Distribution of Financial Flows to Aid Recipients* (OECD 1998) and from World Bank's database
- Data on principal repayments on concessionary loan and interest payments on foreign debt are from OECD (1998).
- Data on government expenditure, excepting concessionary loan repayments, are from *Government Finance Statistics* (International Monetary Fund, various years).
- Data on gross domestic product, agricultural output as a share of GDP, and exchange rates are from the *World Development Indicators* (World Bank); World Bank conversion factors were used for exchange rates.

Data on infant mortality rates and gross enrollment rates in primary and secondary schools are from United Nations Social Indicators.

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