A Model of Public Fiscal Behavior in Developing Countries: Aid, Investment, and Taxation

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In most less developed countries (*LDC*s), the public sector's role in the planning and implementation of development projects has been considerable. The rising level of public expenditure has been fueled by capital inflows from public and private sources abroad, and by the mobilization of domestic resources through taxation and local borrowing. Recently, the effectiveness of the government's development efforts have been cast in doubt. Critics argue that foreign capital inflows have resulted in increased public or private consumption rather than increased investment, and have contributed less to growth than was anticipated.[1] Others suggest that the higher tax burden has been squandered on nonproductive forms of public consumption (see Stanley Please (1967, 1972) and L. Krishnamurty).

In this paper, I shall examine these issues by developing a cross-section time-series econometric model of the public sector of eleven African countries (Nigeria, Ghana, Zambia, Kenya, Uganda, Tanzania, Malawi, Liberia, Ethiopia, Tunisia, and Morocco). Nine of these are English-speaking or "Anglophone," and seven were former British colonies; thus one would expect strong structural similarities in their budgetary processes. With the exception of Zambia, the economies of these countries are fairly similar in their structure and level of development. Tunisia and Morocco are unusual among "Francophone" countries in the degree that their fiscal system is independent of that of France,[2] and have been included to test for behavioral differences from the other sample countries. The time period is only postindependence.[3]

The econometric model will focus on the interactions among several categories of public expenditure and of domestic and foreign revenue. The model will further distinguish between alternative *types* of aid (grants vs. loans), and alternative *sources* (bilateral vs. multilateral, private vs. public). The results suggest that aid not only increases investment, but simultaneously facilitates a reduction in the level of domestic taxes and borrowing. However, the magnitude of these effects and the precise response of public consumption to aid

* University of Michigan. I am grateful for the helpful comments and criticism of E. Berg, H. Brazer, Jane Chalmers, Saul Hymans, Jan Kmenta, Richard Porter, the managing editor, and an anonymous referee. The Center for Research on Economic Development at the University of Michigan provided secretarial and financial assistance.

[1] Much of this literature has been surveyed recently, see Thomas Weisskopf (1972a,b), Gustav Papanek (1973), Keith Griffin, and John Enos and Mohammed Rahman.

[2] In other French African countries, an important share of local expenditure is financed completely out of the French government's budget.

[3] For certain countries, periods of political or military turmoil are also excluded. The time period used includes: Nigeria (1961–66), Zambia (1961–69), Uganda (1962–69), Malawi (1963–69), Liberia (1964–70), Kenya (1962–71), Ethiopia (1964–70), Tanzania (1963–71), Ghana (1964–70), Morocco (1960–70), Tunisia (1960–71). The sources of data are listed in my 1973 paper. Copies of the data series and discussion of the precise series used for each country can be obtained from the author upon request.

varies according to the type of aid. Grants have a stronger pro-consumption bias, whereas loans are more pro-investment. The model also confirms that only a small proportion of marginal tax increases is allocated to investment, with the bulk used for public consumption.

In Section I a theoretical model of public sector behavior is developed, and the data and econometric procedures used are summarized (with a fuller discussion of the econometric issues in the Appendix). In Section II the results are examined, and Section III summarizes their policy and behavioral implications.

I

One approach to an understanding of the fiscal behavior of the public sector is to assume that it reflects the actions of a set of public decision makers (i.e., a Council of Ministers, etc.).[4] We shall assume that they maximize their utility, taking into account (i) alternative uses of public resources such as expenditures for economic growth, for provision of current social and economic services, and for the maintenance of political order and stability; (ii) the distribution of total output between the private and public sector; (iii) alternative modes of domestic financing such as borrowing and taxation; and (iv) alternative types of external assistance, such as grants and loans.

In any period t, assume that the utility function of the decision makers is

$$(1) \quad U = F[I_g, (Y - T), G_c, G_s, B; A_1, A_2]$$

where I_g = public investment expenditure for development purposes
$(Y-T)$ = disposable income in the private sector (which equals gross domestic product Y less tax revenue T)
G_c = "civil" consumption in the public sector
G_s = "socioeconomic" consumption in the public sector
B = the flow of public borrowing from *domestic* sources
A_1 = total foreign grants to the public sector from all sources
A_2 = total foreign loans to the public sector from all sources

Each variable relates to time period t unless otherwise stated. All variables are in real terms.

The delineation of three expenditure categories, I_g, G_c, and G_s, reflects a functional distinction found in the budgets of many African *LDC*s. The capital budget I_g is the public sector's contribution toward the realization of economic growth targets.[5]

Socioeconomic consumption expenditures G_s include all current noncapital expenditures for socioeconomic ends, including expenditures for the staffing of schools, hospitals, and health centers, for the maintenance of roads and communication networks, for the staffing of agricultural extension or agricultural research projects, etc.[6] Theoretically, one might expect that both G_s and I_g have some impact on the rate of economic growth, but in the eyes of public decision makers, G_s is usually not regarded as investment, but as a form of

[4] In this respect, the model is derivative of models used to explain the fiscal behavior of state and local governments in the United States; see Edward Gramlich and L. Krishnamurty.

[5] I_g includes gross capital formation in the public sector (i.e., buildings and construction, transport equipment, draft animals, etc.) and net loans to other sectors of the economy, with the *exception* of capital formation already included in civil consumption as defined in the text.

[6] G_s is defined to include total government consumption as defined in the United Nations' budgetary statistics, less *current* civil consumption expenditure. Thus it includes current expenditure in such public sectors as education, health, transport, and agriculture. It also includes transfers to local government units since a large proportion of such transfers is used to subsidize this type of expenditure.

consumption without developmental impact.[7]

Civil consumption G_c includes all other public expenditures, much of this relating to the fundamental need of the state to maintain its political existence. It includes expenditures, capital and current, for government administration, for the servicing of public debt, for diplomatic representation, and for preservation of internal and external security through the police, courts, and armed forces. A smaller fraction is for subsidies and transfers to households and other nongovernmental units.[8] In distinguishing G_c from I_g and G_s, we hypothesize that decisions on G_c are both based on a different set of decision rules and have a stronger claim on public resources.

On the revenue side, increases in the tax burden T become increasingly difficult for the public decision maker to espouse, both because of the increased administrative difficulty of collection, and because of the economic cost and political resistance engendered in countries at low income levels. Of primary importance is the assumption that the choice of tax rate is a policy instrument available to public decision makers, so that T is endogenous.[9]

Borrowing from the local capital market constitutes an alternative means of resource mobilization, although it also yields disutility to the public decision maker. The net increase in the public sector's *long-term domestic* debt B is traditionally seen as fiscally irresponsible if it occurs in more than limited amounts, and unless it is used to finance public sector investment.[10] The latter restriction will be introduced below in our constraint equations.

Finally, capital inflows to the public sector from abroad, whether public or private, bilateral or multilateral, grants or loans, are assumed to be exogenous to the public sector. Although it is possible that these governments would reject aid encumbered by onerous political or economic implications, we shall assume that this is uncommon. We shall also assume that the governments are not in a position to increase significantly the level of capital inflows beyond that actually offered. In the estimations, we shall distinguish between (i) total grants and total loans received from *all* sources (public and private); (ii) net grants and net loans received from public sources; and (iii) bilateral and multilateral aid.[11]

It will be assumed that the utility function in (1) takes the form

$$(2) \quad U = \alpha_0 + \alpha_1(I_g - I_g^*) - \frac{\alpha_2}{2}(I_g - I_g^*)^2$$

[7] This can be easily discerned by a perusal of the annual budget speeches of the Ministers of Finance in our sample of African countries. See the author (1973).

[8] Although expenditures for the redistribution of income admittedly arise from a different kind of political motivation, these are not yet a major expenditure in the sample of African countries under analysis. It was felt that in a budgetary decision-making framework, the criteria applied to income redistribution would be most similar to that applied to other G_c expenditure.

[9] Total tax revenue includes direct and indirect property tax revenue (income taxes, customs and excise duties, export taxes, mineral royalties, etc.), and revenue from sales of government social services, license fees, interest, dividends and profits of the government, and miscellaneous revenues.

[10] The net increase in domestic debt was used instead of the stock of outstanding public debt obligations for conceptual and practical reasons. Besides the difficulty of obtaining data on the outstanding stock of debt, the budget messages in most countries indicate a conservative fear of excessive borrowing in any period, which, perhaps irrationally, appears unrelated to the level of existing debt.

[11] The variables in (ii) above measure *official* grants and loans, respectively, received from donor nations and multilateral aid agencies, and are derived from the Organization of Economic Cooperation and Development's (*OECD*) statistics. Grants include both "grant-like" flows (net) and net official grants, reparations, and indemnification payments. Loans are net of amortization and interest. The aid measure in (iii) is a breakdown of the same aid by *source*, i.e., bilateral and multilateral. Finally, each country compiles data on total grants and loans received from all foreign sources, *public* and *private* (this includes official aid as well as supplier's credits), and this is the aid measure in (i).

$$- \alpha_3(T - T^*) - \frac{\alpha_4}{2}(T - T^*)^2$$

$$+ \alpha_5(G_c - G_c^*) - \frac{\alpha_6}{2}(G_c - G_c^*)^2$$

$$+ \alpha_7(G_s - G_s^*) - \frac{\alpha_8}{2}(G_s - G_s^*)^2$$

$$- \alpha_9(B - B^*) - \frac{\alpha_{10}}{2}(B - B^*)^2$$

where $\alpha_i \geq 0$ for all i, and where a starred variable indicates a *target* level for each variable. The functional form chosen ensures diminishing marginal utility for each of the variables I_g, G_c, G_s, B, and T as they rise above a level determined jointly by their target level and by the specific set of α parameters for each variable. It also reflects a compromise between the need for heuristic accuracy and the need for an easily estimable functional form with desirable utility function properties. The absence of any interdependence between the policy variables is its primary deficiency.

The target variables in equation (2) are assumed to be determined by the following relationships:

$$(3) \quad I_g^* = \alpha_{11} Y_{t-1} + \alpha_{12} I_p$$

$$(4) \quad T^* = \alpha_{13} Y_t + \alpha_{14} M_{t-1}$$

$$(5) \quad G_c^* = \alpha_{15} G_{c,t-1}$$

$$(6) \quad G_s^* = \alpha_{16} E + \alpha_{17} Y_t + \alpha_{18}(Y_t - Y_{t-1})$$

$$(7) \quad B^* = 0$$

where M = the value of total real imports
E = primary school enrollments (in units of 10,000 students)
I_p = real private investment expenditure

The target level of investment I_g^* is set in the context of a long-term economic development plan and is influenced by the desired rate of economic growth, the perceived role of the public sector in achieving that growth, the absorption capacity of the public sector, and the relative productivity of public sector investment. Due to the absence of comparable annual investment targets in the country development plans, I_g^* was related to instruments with which it would be highly correlated. In a Harrod-Domar framework, one can posit that for a given target growth rate, I_g^* will be positively related to the level of output in the previous period Y_{t-1}, and inversely related to total private sector investment.[12] However, there may also be positive linkages between I_p and I_g if such investments are technologically complementary.[13]

The civil consumption target G_c^* is assumed to be linearly related to its value in the previous period, reflecting the importance attached to a fundamental continuity of these activities. Several instruments were used to determine G_s^*. Since educational expenditure is a substantial fraction of G_s, primary school enrollments were used to measure the level of this activity. This expenditure is also likely to be held to a fairly constant share of total output Y_t. An accelerator mechanism may also boost this expenditure, and hence $(Y_t - Y_{t-1})$ was also tested as an instrument.[14]

The tax target T^* is determined by the anticipated level of total income and by the value of tax handles such as imports or exports. Since the government sector's ex-

[12] An accelerator model would suggest that the change in total output $(Y_t - Y_{t-1})$ becomes an instrument.

[13] It was also hypothesized that the level of foreign exchange reserves would determine the practicality of a given level of investment, but this variable proved statistically insignificant.

[14] Since technical assistance aid is principally used to finance the staffing of operational positions within the governments of our sample, it could be considered a substitute for the government's own financing of these positions (although it may entail financial obligations, such as counterpart expenditures). The hypothesized inverse relationship between G_s^* and technical assistance was not borne out, with a completely insignificant effect on G_s. However, this may be due to the poor quality and limited amount of data available on technical assistance.

penditure program may substantially affect the level and composition of imports in a given period, imports in the previous period were used as one of the instruments for T^*. Finally, it was assumed that *ex ante*, the borrowing target is equal to zero. This would not, of course, preclude a positive level of borrowing.

There are both economic and institutional constraints on the set of feasible public sector decisions. The least restrictive assumption is that all revenue inflows are pooled and allocated among all expenditure categories. Specifically,

$$T + B + A_1 + A_2 = I + G_s + G_c \tag{8}$$

This is institutionally unrealistic. Most African *LDC*s not only reject borrowing for current expenditure, but are encouraged by donors to realize public sector savings through a surplus on the recurrent budget, viz., $(T-G_s-G_c)\geq 0$. This would suggest as an alternative constraint set that

$$I_g = B + (1-\rho_1)T + (A_1 + A_2) \tag{9}$$

$$G_s + G_c = \rho_1 T \tag{10}$$

where $0\leq\rho_1\leq 1$. The level of $(1-\rho_1)$ reflects the government's belief as to the maximum it can realistically "save" from the recurrent budget, and this enters as a constraint on its decisions. It is not an additional policy variable. Constraint set (9) and (10) also imply that aid cannot be used directly for public consumption. Assuming no relaxation of borrowing effort, aid flows would wholly finance investment.

In the radical literature,[15] it is contended that there is greater substitutability and that aid flows can also, *ex post*, be allocated to consumption. This may be expressed either by relating ρ_1 inversely to the level of A_1 and A_2 in a given period, or by including only $100(1-\rho_2)$ percent of A_1 and $100(1-\rho_3)$ percent of A_2 in (9) and the residuals in (10).[16] This suggests the following constraint set:

$$I_g = B + (1-\rho_1)T + (1-\rho_2)A_1 + (1-\rho_3)A_2 \tag{11}$$

$$G_s + G_c = \rho_1 T + \rho_2 A_1 + \rho_3 A_2 \tag{12}$$

Maximization of U with respect to current policy variables I_g, G_s, G_c, T, and B, given levels of A_1 and A_2 and subject to constraint set (11) and (12), yields the following first-order conditions:

$$\frac{\delta U}{\delta I_g} = \alpha_1 - \alpha_2(I_g - I_g^*) + \lambda_1 = 0 \tag{13}$$

$$\frac{\delta U}{\delta G_c} = \alpha_5 - \alpha_6(G_c - G_c^*) + \lambda_2 = 0 \tag{14}$$

$$\frac{\delta U}{\delta G_s} = \alpha_7 - \alpha_8(G_s - G_s^*) + \lambda_2 = 0 \tag{15}$$

$$\frac{\delta U}{\delta T} = -\alpha_3 - \alpha_4(T - T^*) - \lambda_1(1-\rho_1) - \lambda_2\rho_1 = 0 \tag{16}$$

$$\frac{\delta U}{\delta B} = -\alpha_9 - \alpha_{10}(B - B^*) - \lambda_1 = 0 \tag{17}$$

$$\frac{\delta U}{\delta \lambda_1} = I_g - B - (1-\rho_1)T - (1-\rho_2)A_1 - (1-\rho_3)A_2 = 0 \quad \text{and} \tag{18}$$

$$\frac{\delta U}{\delta \lambda_2} = G_s + G_c - \rho_1 T - \rho_2 A_1 - \rho_3 A_2 = 0, \tag{19}$$

where λ_1 and λ_2 are the Lagrangian multipliers associated with constraints (11) and (12). Equation set (13) through (19) can be solved to obtain structural equations for the estimation of the parameters of the

[15] See Griffin and Enos, and Weisskopf (1972a,b).

[16] The only constraint on ρ_2 and ρ_3 would be that total investment exceed the level of capital inflow and required counterpart expenditure. Obviously, an aid recipient cannot invest less than its total aid flow and counterpart commitments without facing a serious credibility problem when seeking additional aid. For our sample countries, this proves to be a nonbinding constraint.

utility function and the budgetary constraint relationships:

$$(20)\quad \begin{pmatrix} G_s \\ G_c \end{pmatrix} = \begin{pmatrix} \iota \\ -\iota \end{pmatrix}\beta_0 + \begin{pmatrix} -G_c^* \\ G_c^* \end{pmatrix}(1-\beta_1) + \begin{pmatrix} G_s^* \\ -G_s^* \end{pmatrix}\beta_1 + \left\{\begin{pmatrix} T \\ 0 \end{pmatrix} + \begin{pmatrix} -T \\ T \end{pmatrix}\beta_1\right\}\rho_1 + \left\{\begin{pmatrix} A_1 \\ 0 \end{pmatrix} + \begin{pmatrix} -A_1 \\ A_1 \end{pmatrix}\beta_1\right\}\rho_2 + \left\{\begin{pmatrix} -A_2 \\ 0 \end{pmatrix} + \begin{pmatrix} -A_2 \\ A_2 \end{pmatrix}\beta_1\right\}\rho_3 + \begin{pmatrix} \epsilon_1 \\ \epsilon_2 \end{pmatrix}$$

$$(21)\quad T = \frac{\beta_2}{\beta_3} + \frac{\rho_1\alpha_6}{\beta_3}(G_c^* - G_c) + \frac{\alpha_4}{\beta_3}T^* + \frac{\alpha_{10}}{\beta_3}\{[1-\rho_1][I_g - (1-\rho_2)A_1 - (1-\rho_3)A_2]\} + \epsilon_3$$

$$(22)\quad I_g = \frac{(\alpha_1 - \alpha_9)}{(\alpha_2 + \alpha_{10})} + \frac{\alpha_2}{(\alpha_2 + \alpha_{10})}I_g^* + \frac{\alpha_{10}}{(\alpha_2 + \alpha_{10})}\{(1-\rho_1)T + (1-\rho_2)A_1 + (1-\rho_3)A_2\} + \epsilon_4$$

where

$$\beta_1 = \alpha_8/(\alpha_8 + \alpha_6),\ \beta_0 = (\alpha_7 - \alpha_5)/(\alpha_8 + \alpha_6)$$
$$\beta_2 = \{\alpha_5 - \alpha_3 + \alpha_9(1-\rho_1)\}$$
$$\beta_3 = \{\alpha_4 + \alpha_{10}(1-\rho_1)^2\}$$

Also $[\iota]$ is a (n x 1) vector of ones and $[0]$ is a (n x 1) vector of zeros. The assumed properties of the error term ϵ_i are described in detail in the Appendix. Equations (3) to (6) indicate the instruments used to estimate I_g^*, T^*, G_c^*, and G_s^*.

Equation (20) reflects the symmetrical relationship that exists between the coefficients of the structural equations for the estimation of G_s and G_c. It was estimated first, in order to obtain estimates of the critical parameters, β_1, ρ_1, ρ_2, ρ_3, and α_{15}. Since (20) is non-linear in these parameters, and since we know that $0 \leq \beta_1 \leq 1$, equation (20) was estimated by iterating over values of β_1 between 0 and 1. The value of β_1 chosen is that yielding the *lowest* sum of squared errors in the estimations. The coefficients of the latter three terms in (20) yield estimates of ρ_1, ρ_2, ρ_3; α_{15} is obtained from the coefficient of the G_c^* term which equals $(1-\beta_1)\alpha_{15}$. On this point see equation (5). These parameters may be used to calculate the transformed independent variables in equations (21) and (22); the coefficients of these transformed variables will then yield estimates of other critical parameters of the system, viz., α_6/β_3, α_{10}/β_3, and $[\alpha_{10}/(\alpha_2+\alpha_{10})]$.

Three econometric problems arose in the estimation of this equation system. First, although we assumed that the structural coefficients are the same across countries, there may be differences in the country specific intercepts. Without careful attention to this issue, recent Monte Carlo studies by Marc Nerlove and others indicate that the uncorrected variation of the error term in a pooled cross-section time-series may cause both bias and inefficiency in an ordinary least squares (*OLS*) estimation of the structural coefficients. Using a method suggested by Nerlove and P. A. V. B. Swamy, a generalized least squares (*GLS*) estimation procedure is used to correct for this.[17] Second, if the uncorrected values of the variables are used, there appears to be heteroskedasticity with a higher variance in the estimated residuals for the larger countries in terms of population or income. By transforming the variables to a per capita basis, this problem is ameliorated. Third, since our model is a simultaneous equation system, this suggests the need for a simultaneous equation estimation procedure to obtain consistent estimators for the structural co-

[17] See Nerlove and Pietro Balestra (1966), T. D. Wallace and Ashig Hussain, and G. S. Maddala.

efficients. Since our equation system is overidentified, two-stage least squares (*2SLS*) is used for each equation. These econometric issues are dealt with more fully in the Appendix.

In the estimations, all the data have been deflated to constant 1966 prices, using each country's own *GDP* deflator.[18] To obtain readily interpretable coefficients, all variables have been converted to dollars using the current year exchange rate. Thus variables initially estimated in local currencies are sensitive to any exchange rate fluctuations. This would distort the nature of the observed statistical relationships if it caused variations in variables which were actually unaffected by a devaluation.[19] However, with the exception of Ghana, there were no significant changes in exchange rates during the period, and there were only four devaluations with respect to the dollar among all sample countries.

Finally, the distinction between the fiscal and calendar year results in varying fiscal periods across sample countries.[20] The convention used was to match all variables calculated on a calendar basis (*GDP*, imports, etc.) to the fiscal year beginning in that calendar year. This complicates the interpretation of regression coefficients since for some countries, the public expenditures are themselves calculated on a calendar basis. The justification for this procedure is pragmatic. Obtaining a moving average of calendar year data would have sacrificed at least one degree of freedom for each country, and the conceptual benefits are uncertain.

[18] An alternative deflation of the aid data by an export price deflator for the donor countries was attempted, but this led to only negligible differences in the statistical results.

[19] The appropriateness of this conversion depends on (i) the proportion of government purchases of foreign goods and services, and the source of these goods; (ii) whether aid flows are pegged to some target level of real purchasing power or to an absolute level of local or foreign currency; (iii) the frequency and severity of devaluations with respect to each country's primary trading partner; (iv) the degree of bias caused by use of a *GDP* deflator rather than an expenditure specific deflator; and (v) the degree of currency overvaluation and the policy instruments used to ration foreign currency.

[20] All *OECD* aid data are on a *calendar* year basis, whereas aid data derived from individual country statistics are for the fiscal accounting period used by the country.

II. Econometric Results

The estimation of (20)–(22) yields the structural parameters of the utility function (2) and the constraint equations (11) and (12). Reduced form estimates of the impact of foreign capital inflow on the public sector can then be derived. The results indicate the existence of structural differences in the model parameters of the Francophone and Anglophone countries. They also reveal that inclusion of Zambia fundamentally distorts the values of the parameters. In this section, we shall examine these results more closely. The estimated equations are presented in Tables 1 and 2.

A. *Constraint Equation Parameters*

Estimation of equation (20) yields estimates of ρ_1, ρ_2, and ρ_3 for each of the alternative measures of foreign capital inflow (Table 3). Several points can be made. First, our estimate of ρ_1, the proportion of tax revenues that remain within the recurrent budget, is smaller in the Anglophone country sample than in the pooled sample, the latter including the two Francophone countries. In the pooled sample, no more than 17 percent of recurrent tax revenues flow to the investment budget, as contrasted with 22 to 34 percent for the Anglophone countries.

In both samples, there are marked differences between the share of total (public and private) grants (ρ_2) and loans (ρ_3) allocated to the recurrent budget. Whereas total grants are partially allocated to the consumption budget (with ρ_2 falling to between 0.27 and 0.38), the negative values

TABLE 1—CONSUMPTION EXPENDITURE EQUATION; DEPENDENT VARIABLE = $\begin{bmatrix} G_s \\ G_c \end{bmatrix}$

Samples[f] & Aid Variable	Optimal[a] β_1	Constant = $\frac{\alpha_7-\alpha_5}{\alpha_8+\alpha_6}$	$G_{c,t-1}$ coeff. = $\left(\frac{}{\alpha_{15}(1-\beta_1)}\right)$	Primary School Enrollment (in 10,000)	Y_t	(Y_t-Y_{t-1})	Tax Term[b] (coeff. $=\rho_1$)	A_1 Term[c] (coeff. $=\rho_2$)	A_2 Term[d] (coeff. $=\rho_3$)	R^2 (N)	ν[e] or estimation technique
Pooled Samples											
Total Grants (A_1) & Loans (A_2)	.2	−2.68 (−4.12)	0.50 (3.88)	0.14 (1.01)	0.03 (2.22)		0.83 (18.04)	0.38 (0.89)	−0.39 (1.88)	0.93 (112)	[Dummy $\nu=.509$]
Official Grants (A_1) & Loans (A_2)	.3	−3.04 (−3.6)	0.50 (3.56)	0.24 (1.43)	0.03 (2.84)		0.91 (12.24)	−0.15 (−0.40)	0.04 (0.10)	0.89 (106)	[Dummy $\nu=.35$]
Anglophone Sample											
Total Grants (A_1) & Loans (A_2)	.5	−2.0 (−5.4)	0.48 (4.70)	−0.14 (−1.21)	0.06 (6.59)	−0.05 (−2.77)	0.73 (21.2)	0.27 (1.27)	−0.40 (−1.64)	0.92 (88)	[Dummy $\nu=.509$]
Official Grants (A_1) & Loans (A_2)	.5	−1.69 (−3.65)	0.42 (4.3)	−0.02 (−0.2)	0.05 (4.9)		0.78 (17.35)	0.65 (2.35)	−0.39 (−1.74)	0.92 (80)	[Dummy $\nu=.35$]
Bilateral (A_1) Multilateral (A_2)	.4	−2.4 (−5.53)	0.40 (4.15)	0.09 (0.69)	0.04 (3.56)		0.69 (12.5)	−0.04 (−0.32)	−0.06 (−0.11)	0.88 (92)	[Dummy $\nu=.46$]

Note: The t-statistics are in parentheses.

[a] β_1 is that $0 \leq \beta_1 \leq 1$ (in increments of .1) yielding minimum sum of squared errors.

[b] Where variable = $\left\{\begin{bmatrix} T \\ 0 \end{bmatrix} + \begin{bmatrix} -T \\ T \end{bmatrix}\beta_1\right\}$

[c] Where variable = $\left\{\begin{bmatrix} A_1 \\ 0 \end{bmatrix} + \begin{bmatrix} -A_1 \\ A_1 \end{bmatrix}\beta_1\right\}$

[d] Where variable = $\left\{\begin{bmatrix} A_2 \\ 0 \end{bmatrix} + \begin{bmatrix} -A_2 \\ A_2 \end{bmatrix}\beta_1\right\}$

[e] See Appendix for definition of ν.

[f] Samples exclude Zambia.

of ρ_3 indicate that a dollar of total loans actually pulls *nonloan* resources from the recurrent budget. Little difference emerges between the impact of official and private loans on the recurrent and capital budgets. In the Anglophone sample, *both* official and total loans draw 139 percent of their value to the investment budget ($\rho_3 = -.39$).

However, a higher fraction of official grants remain within the recurrent budget (64 vs. 27 percent). The addition of the two Francophone countries drops ρ_2 below zero (in case 2, $\rho_2 = -.15$). Finally, since bilateral and multilateral aid flows have insignificant values for ρ_2 and ρ_3, respectively, the grant and loan components within each must have offsetting influences.

When we included Zambia in the sample, the results were considerably different with more than 100 percent of total grants allocated to the consumption budget, and 172 percent of loans to the investment budget ($\rho_3 = -.72$). Since ρ_2 and ρ_3 are not significantly different from zero for official grants and loans in the samples which include Zambia, it is clear that *private* capital flows account for the strongly divergent effects of the total capital flow measures. The distorting effect of Zambia was also clear from the other equations and parameter estimates. This suggested that the structural dissimilarities in Zambia's industrial structure vis-à-vis the other sample countries has led to a marked difference in its fiscal position and in the character of its fiscal behavior.[21] Although I have not included the cum-Zambian results in the tables, I shall point out the pattern of divergence suggested by the results.

B. *Utility Function Parameters*

Estimation of (20) also yields estimates of the relative values of α_6 and α_8, the quadratic terms in the utility function associated with G_c and G_s, respectively. The lower the value of (α_8/α_6), the greater the disutility arising from sharper deviations from the expenditure target for G_c relative

[21] For example, with the exception of 1970, Zambia experienced a net outflow of multilateral assistance throughout the decade, yielding a strong negative multiplicative dummy in the estimation of (20).

TABLE 2

Sample Used and Aid Variable	Constant	Y_t	*var* 1[a] $\left(\text{coeff.} = \frac{\alpha_6}{\beta_3}\right)$	*var* 2[b] $\left(\text{coeff.} = \frac{\alpha_{10}}{\beta_3}\right)$	Imports_{t-1}	R^2 (N)	ν or estimation technique
Revenue Equations[c]							
Pooled Sample							
Total Grants (A_1)	−3.39	0.24	0.70	1.10	−0.13	0.86	0.51
& Loans (A_2)	(−3.41)	(13.24)	(3.34)	(1.61)	(−2.71)	(56)	
Official Grants (A_1)	−1.74	0.19	0.59	5.21	−0.04	0.88	0.45
& Loans (A_2)	(−2.00)	(11.72)	(3.22)	(3.46)	(−0.89)	(53)	
Anglophone							
Total Grants (A_1)	−4.42	0.26	1.33	1.87	−0.16	0.87	0.51
& Loans (A_2)	(−3.87)	(8.48)	(4.15)	(3.34)	(−2.68)	(44)	
Official Grants (A_1)	−4.83	0.26	1.09	2.44	−0.11	0.89	0.45
& Loans (A_2)	(−4.58)	(9.23)	(3.80)	(3.69)	(−2.20)	(40)	
Bilateral (A_1)	−4.80	0.29	1.58	1.56	−0.10	0.85	0.58
& Multilateral (A_2)	(−4.32)	(9.49)	(3.31)	(3.22)	(−1.61)	(46)	

	Constant	Independent *var* 3[d] $\left(\text{coeff.} = \frac{\alpha_{10}}{\alpha_{10}+\alpha_2}\right)$	Y_{t-1}	R^2 (N)	ν or estimation technique
Investment Equations[c]					
Pooled Sample					
Total Grants (A_1)	−0.69	0.55	0.03	0.52	0.57
& Loans (A_2)	(−0.78)	(5.08)	(1.99)	(61)	
Official Grants (A_1)	−1.64	0.56	0.05	0.63	0.65
& Loans (A_2)	(−2.15)	(4.83)	(3.72)	(54)	
Anglophone					
Total Grants (A_1)	−0.33	0.48	0.02	0.38	0.57
& Loans (A_2)	(−0.41)	(3.77)	(1.74)	(49)	
Official Grants (A_1)	−0.95	0.31	0.03	0.54	0.65
& Loans (A_2)	(−1.31)	(3.62)	(2.62)	(41)	
Bilateral (A_1)	−0.29	0.38	0.02	0.43	0.57
& Multilateral (A_2)	(−0.42)	(4.63)	(1.96)	(52)	

[a] *var* $1 = (\rho_1\alpha_{15}G_{c,t-1} - \rho_1 G_c)$
[b] *var* $2 = (1-\rho_1)[I_g - (1-\rho_2)A_1 - (1-\rho_3)A_2]$
[c] Where values of α_{15}, ρ_1, ρ_2, ρ_3 are derived from coefficients in corresponding equations in Table 1.
[d] *var* $3 = (1-\rho_1)T + (1-\rho_2)A_1 + (1-\rho_3)A_2$

to that for G_s. In general (α_8/α_6) is equal to 1 for the Anglophone countries and is less than 1 for the pooled sample. Hence our hypothesis that G_c expenditures have higher priority but lower variability relative to G_s is borne out *only* for the Francophone countries. In the Anglophone countries, the rate of diminishing marginal utility is the same for both expenditures. The only difference is that with $\alpha_5 > \alpha_7$ (from the negative constant term of these equations), higher utility will be obtained from overachievement of G_c relative to G_s, in terms of their respective targets.[22]

The estimation of equation (21) (see Table 2) yields estimates of the relative values of α_4, α_6, and α_{10}, where α_4 and α_{10}

[22] This assumes that both α_5 and α_7 are also non-negative. This condition cannot be explicitly verified from the results.

TABLE 3—PARAMETERS ASSOCIATED WITH THE UTILITY FUNCTION AND CONSTRAINT EQUATIONS[c,d]

Sample (with aid variable used)	Tax Parameter ρ_1	Aid Parameters ρ_2	Aid Parameters ρ_3	Some Utility Parameters $\frac{\alpha_2}{\alpha_{10}}$	$\frac{\alpha_3}{\alpha_6}$	$\frac{\alpha_4}{\alpha_{10}}$	$\frac{\alpha_6}{\alpha_{10}}$	$\frac{\alpha_4}{\alpha_2}$	$\frac{\alpha_8}{\alpha_2}$	Partial Tax Coefficients $\frac{\partial B}{\partial T}$	$\frac{\partial G_s}{\partial T}$	$\frac{\partial G_c}{\partial T}$	$\frac{\partial I}{\partial T}$
Pooled Sample[a]													
Total Grants (ρ_2) and Loans (ρ_3)	.83	.38	−.39	.82	.25	.88	.63	1.08	0.19	−0.08	0.67	0.17	0.09
Official Grants (ρ_2) and Loans (ρ_3)	.91	−.15	.04	.79	.43	.18	.11	.24	0.06	−0.04	0.64	0.27	0.05
Anglophone Sample[b]													
Total Grants (ρ_2) and Loans (ρ_3)	.72	.27	−.39	1.13	1.0	.46	.71	.40	0.63	−0.15	0.36	0.36	0.13
Official Grants (ρ_2) and Loans (ρ_3)	.78	.64	−.39	2.23	1.0	.36	.45	.16	0.20	−0.15	0.39	0.39	0.07
Bilateral (ρ_2) and multilateral (ρ_3)	.66	.02	.07	1.63	1.0	.52	1.00	.32	0.62	−0.21	0.33	0.33	0.13

[a] Excludes Zambia, but includes Nigeria, Uganda, Malawi, Liberia, Kenya, Tanzania, Ghana, Morocco, Tunisia, Ethiopia.
[b] As in (a) but also excludes Morocco and Tunisia.
[c] $U=\alpha_0+\alpha_1(I_g-I_g^*)-\alpha_2/2(I_g-I_g^*)^2-\alpha_3(T-T^*)-\alpha_4/2(T-T^*)^2+\alpha_5(G_c-G_c^*)-\alpha_6/2(G_c-G_c^*)^2+\alpha_7(G_s-G_s^*)-\alpha_8/2(G_s-G_s^*)^2$
$-\alpha_9(B-B^*)-\alpha_{10}/2(B-B^*)^2$
[d] $I_g=B+(1-\rho_1)T+(1-\rho_2)A_1+(1-\rho_3)A_2$; $G_s+G_c=\rho_1 T+\rho_2 A_1+\rho_3 A_2$

are the quadratic terms associated with tax revenues and borrowing, respectively (see Table 1).[23] For example, since α_6 and α_8 are each less than α_{10}, the results imply that additional borrowing incurs a sharper increase in disutility than the marginal gain in utility from additional units of G_c or G_s. Conversely in the Anglophone cases the additional utility from G_s or G_c falls off more sharply relative to the increase in disutility from taxation (α_6/α_4, $\alpha_8/\alpha_4 \geq 1$).

Since (α_4/α_{10}) is less than 1 in all cases, the marginal disutility of additional taxation increases at a rate less than that associated with increased borrowing. It is interesting to note the impact of including Zambia on these parameters. The ratio (α_4/α_{10}) falls substantially to under .10, indicating that copper-rich Zambia is far more averse to borrowing and amenable to increased taxation than the other African countries. Lacking the tax revenue base provided by abundant mineral resources, the cost associated with increased taxation to the latter countries is, not surprisingly, greater.

Finally, from the coefficients of equation (22) (see Table 2), one can derive an estimate of the ratio of α_2 to α_{10}. For the Francophone countries, (α_2/α_{10}) is less than 1, indicating greater disutility to increased borrowing relative to the diminished marginal utility associated with increased investment. The converse appears to hold for the Anglophone countries.

Given a consistent set of parameter estimates for the $[\rho]$ set and the quadratic terms of (1), one can also obtain the partial derivatives of taxation on borrowing and expenditure. These indicate the impact of an exogenous change in tax revenues on public sector fiscal behavior. In Table 3, it is clear that the bulk of any tax increase is allocated to consumption expenditures, with no more than 13 percent going to investment and 10 to 21 percent going to reductions in domestic borrowing. In the Anglophone sample, the two types of consumption are neutrally affected, with a stronger impact on investment and borrowing. The addition of the French countries weakens the borrowing and investment impact, with a larger share of resources going to consumption, particularly G_s.

These results also verify the fiscal interdependence between the recurrent and capital budgets. If there were complete separability of these budgets, $\hat{\rho}_1$ would equal 1 and tax revenues would have no impact on the investment equation and

[23] The coefficients of equation (21) yield estimates of α_6/β_3 and α_{10}/β_3, where $\beta_3=\alpha_4+\alpha_{10}(1-\rho_1)^2$. This allows estimation of (α_6/α_{10}), (α_6/α_4), and (α_4/α_{10}).

vice versa; both possibilities can be clearly rejected.[24] The opposite extreme of complete fungibility between all revenue sources and expenditures appears equally invalid. Tax revenues and borrowing are not fully substitutable.

C. *Target Parameters*

In addition to the utility and constraint equation parameters, we can obtain estimates of the target coefficients specified in (3) through (7). In the consumption equation (20), the coefficients of $G_{c,t-1}$, primary school enrollment, income, and change in income variables can be used to derive α_{15} through α_{18}, respectively.[25] The lagged $G_{c,t-1}$ term is clearly significant, and yields values of α_{15} equalling .62–.70 in the pooled sample and .83–.96 in the Anglophone sample.[26] Assuming positive values of α_5, these are reasonable values, since utility maximization would yield an optimal value of G_c above $\alpha_{15}G_{c,t-1}$. Income is equally significant with values of α_{17} between .10 and .15, which is close to the average share of G_s in total income. Primary enrollment is positively correlated with socioeconomic consumption, but is not significant at a 10 percent level. Finally, in most cases, the change in income variable is insignificant, and has little impact on any of the other coefficients in the consumption equation. Where significant, it enters with a paradoxically negative sign.[27]

In the revenue equation, income and lagged imports are used to estimate T^*. The income coefficient α_{13} is approximately .20–.30, and is clearly significant. Lagged imports have a surprisingly negative coefficient, which can perhaps be explained by the collinearity of Y_t and Y_{t-1}. Alternatively, high imports in the previous period may relax the need for import tariff revenue reliance in the present. Finally, the investment equations were estimated with and without private investment, since the shortage of data on private investment significantly reduces the sample size.[28] The private investment instrument was clearly insignificant for the Anglophone sample, but quite significant with a positive sign when Tunisia and Morocco are added (with α_{12} in the latter case equalling .24–.26). The other instrument, Y_{t-1}, was significant in all cases with α_{11} equalling 0.02–0.05.

D. *Reduced Form Estimates*

The first-order conditions (13)–(19) can be solved to obtain reduced form equations. Table 4 presents the reduced form estimates of the impact of aid on each fiscal variable. For example, grants (A_1) lead to an increase in total spending by 30 to 60 percent of the grant proceeds. The distribution of this income across fiscal variables markedly differs depending on the type of grant flow and country sample. In the Anglophone sample, *official* grants disproportionately increase consumption, with 9 percent of the grant allocated to investment relative to 40 percent for consumption. The Francophone countries differ substantially with a stronger impact on

[24] From the above estimates, $\partial I/\partial T$ ranges from .05−.13 for the non-Zambian samples; $\partial T/\partial I$ ranges from .2 to .5.

[25] For α_{16} through α_{18}, the estimated coefficients need to be divided by β_1; for α_{15}, they must be divided by $(1-\beta_1)$.

[26] From (20), it should be noted that a positive value of α_{15} implies a *positive* correlation with G_c and a *negative* correlation with G_s. Conversely, positive values of α_{16} through α_{18} suggest the reverse.

[27] It was argued that the $(Y_t - Y_{t-1})$ variable would positively affect socioeconomic consumption in the same way as an accelerator might positively stimulate investment. However, from our estimates on aid and investment, it may be that any such positive effect on investment is partly financed by a *reduction* in socioeconomic consumption.

[28] The following countries had data on private foreign investment: Nigeria, Zambia, Malawi, Kenya, Tanzania, Tunisia, Morocco.

TABLE 4—REDUCED FORM ESTIMATES

Sample (with aid variable used)	$\frac{dT}{dA_1}$	$\frac{dB}{dA_1}$	$\frac{dR}{dA_1}$[a]	$\frac{dI_g}{dA_1}$	$\frac{dG_s}{dA_1}$	$\frac{dG_c}{dA_1}$	$\frac{dT}{dA_2}$	$\frac{dB}{dA_2}$	$\frac{dR}{dA_2}$[b]	$\frac{dI_g}{dA_2}$	$\frac{dG_s}{dA_2}$	$\frac{dG_c}{dA_2}$
Pooled Sample[c]												
Total Grants (A_1) & Loans (A_2)	−.09	−.27	.64	.33	.25	.06	−.07	−.62	.31	.76	−.36	−.09
Official Grants (A_1) & Loans (A_2)	−.19	−.50	.31	.64	−.23	−.10	−.18	−.42	.40	.53	−.09	−.04
Anglophone Sample[c]												
Total Grants (A_1) & Loans (A_2)	−.26	−.35	.39	.31	.04	.04	−.16	−.71	.13	.63	−.25	−.25
Official Grants (A_1) & Loans (A_2)	−.31	−.20	.49	.09	.20	.20	−.27	−.92	−.19	.41	−.30	−.30
Bilateral (A_1) & Multilateral Aid (A_2)	−.26	−.55	.18	.34	−.08	−.08	−.27	−.52	.21	.32	−.05	−.05

[a] $\frac{dR}{dA_1} = 1 + \frac{dT}{dA_1} + \frac{dB}{dA_1} = \frac{dI_g}{dA_1} + \frac{dG_s}{dA_1} + \frac{dG_c}{dA_1}$

[b] $\frac{dR}{dA_2} = 1 + \frac{dT}{dA_2} + \frac{dB}{dA_2} = \frac{dI_g}{dA_2} + \frac{dG_s}{dA_2} + \frac{dG_c}{dA_2}$

[c] Excluding Zambia.

investment. Addition of private grants as reflected in the *total* grant measure had opposite effects in the two samples. In the Anglophone case, it shifts the expenditure increase toward investment; with the Francophone countries included, private grants pull expenditure toward consumption. Thus, both the source of grant and the prevailing budgetary behavior (French system vs. British system) are important determinants of how aid affects the public sector.

As would be expected, the receipt of grants leads to a reduction in taxes and domestic borrowing. The reduction in taxes appears primarily a phenomenon associated with the Anglophone countries. Inclusion of Tunisia and Morocco consistently lowers (dT/dA_1). The decrease in domestic borrowing is less than that of taxes only in the case of official grants received by the Anglophone countries. Inclusion of the two Francophone countries and of private grants strongly leads to a sharper reduction in borrowing than in taxation. Finally, when we include Zambia, the lower ratio of α_4 to α_{10} strongly reverses this pattern, with dT/dA_1 considerably larger than dB/dA_1 (dT/dA_1 equalling −.30 to −.50 relative to dB/dA_1 close to zero). In other words, when we dropped Zambia, the rise in (α_4/α_{10}) implies a greater unwillingness to either lower or raise taxes relative to the target tax burden. The greater disutility of borrowing is mirrored by the stronger negative effect associated with the receipt of external grants.

Foreign loans contribute to both an increase in total expenditure and a restructuring of the mode of domestic financing and pattern of expenditure. Considerable substitutability exists between domestic and foreign borrowing, dB/dA_2 varying between .42 and .92, with the highest value among the Anglophone countries. In both samples, the impact of loans on taxes is negative but considerably smaller than the impact on borrowing. The result is to increment total spending by less than 40 percent of the total value of the loan assistance.

The loan impact on expenditure is more striking. Loans increase investment with the strongest effect arising from the inclusion of private loans. In both samples, investment rises by 63 to 76 percent of total loans, as contrasted with 41 to 53 percent of official loans. Conversely, both types of consumption expenditure are *adversely* affected by loans. In the Anglophone sample,

total consumption falls by 50 to 60 percent of the loan inflow. The Francophone countries reduce their consumption to a lesser degree (and thus reduce taxes and borrowing less as well). The inclusion of Zambia only accentuates these broad trends. The investment impact is larger, as is the corresponding consumption reduction, and there is a sharper decline in domestic tax revenues.

The differential impact of loans and grants is not surprising. Grants have a more stimulative impact on consumption, and a weaker impact on investment. Tax reductions are more likely with an inflow of grants; borrowing reductions more likely in response to a loan inflow. More surprising, *grants* have a more stimulative impact on total spending, which may reflect the unwillingness of African countries to expand public spending through a sharp increase in their debt obligations.

Finally, the reduced form estimates of bilateral and multilateral aid for the Anglophone sample reveal only negligible differences in their respective impact on the public sector. Both cause a small reduction in taxes and a larger reduction in borrowing. Both lead to increases in investment with a small negative impact on consumption.

III. Conclusions

The results obtained from the estimation of the model are instructive as to the structure of the fiscal decision-making process in the public sector of Africa, and they shed light on some recent controversies on aid, taxation, and the public sector. In this section I briefly discuss some policy and behavioral implications of the model.

1) The most reassuring aspect of the results is the confirmation of the most basic model assumptions concerning the sign and magnitude of the utility function and constraint equation parameters. They reveal the strong but not fully substitutable interdependence of the recurrent and capital budgets. Not surprisingly they confirm that public decision makers clearly differentiate in their preferences between types of expenditure and their mode of financing.

In solving for the structural coefficients, the signs are consistent with some basic behavioral assumptions. Increases in tax revenue positively influence the expenditure categories and reduce total borrowing, and vice versa. If the results had shown consistently perverse signs for these relationships, the basic model structure would have been highly suspect. This does not mean that there are no differences in fiscal preference; Zambia and the two French-speaking countries, Tunisia and Morocco, appear to react to fiscal pressures in a different way than the other Anglophone countries.

2) The partial derivatives of taxes on the other expenditure and revenue variables verify Please's contention that an increase in the tax burden is unlikely to be fully used for investment. Far more is likely to be allocated to G_s and G_c. A reversal of the Please Effect would require greater pressure on African governments to change their public sector preference map.

3) The impact of the various aid measures is fully consistent with the assumption of utility maximization, and in particular, with the assumption in (1) that I_g, $(Y-T)$, G_c, and G_s are superior goods, and B an inferior good. The precise effect of aid is clearly determined by the shape of the preference map, and the degree to which the recurrent and capital budgets are interdependent.

4) The attempt to focus on the public sector aspect of the "aid-savings" controversy reveals the complexity of the response mechanism to aid. Foreign loans do *not* fully increment total expenditure, but reduce both borrowing and taxation, which is consistent with the radical critique.

However, aid causes a strong shift away from public consumption and toward investment. Moreover, the reduction in public fiscal effort is primarily focused on reduced borrowing rather than reduced taxation. This is more likely to stimulate the availability of capital for private investment than would the reverse situation. Consequently, if all public domestic borrowing were matched by an equal expansion in private borrowing for investment, the effect of foreign loans on total domestic investment would be considerably higher. However, it may be equally myopic to view this negative effect on consumption as wholly beneficial. If the increase in investment comes at the expense of the maintenance and operating funds for ongoing projects, a loss in the overall marginal productivity of capital may result.

Although grant flows also positively affect investment, there is a much stronger bias toward an increase in public consumption, and indirectly, through tax reduction, of private consumption. The problem in evaluating this grant effect is that even aid proponents will agree that some proportion of aid, and particularly grants, is intended at the outset to be used for government consumption. To support the radical argument, one would have to know the size and sign of the deviation from the unknown proportion. On the other hand, the radical critique is supported by the tax reduction effect.

5) The oft-repeated assertion that a shift from bilateral to multilateral aid will induce a greater increase in investment does not appear to be borne out, at least for the Anglophone countries. Only negligible differences emerge in the pattern of expenditure and revenue changes induced by either type of aid. This does not suggest that a multilateralization of aid will not have a beneficial impact on investment and growth. Rather, it indicates that there are probably considerable differences in the type of aid given by alternative multilateral (or bilateral) agencies.

6) The study suggests that further research on the fiscal activities of the public sector in *LDC*s may be fruitful. Our utility function is relatively simple, being both additive and highly aggregative. A more detailed breakdown of the revenue sources and expenditure uses of the public sector, with a more detailed specification of the determinants of each, would be desirable. By further disaggregation, one could better comprehend the decision processes of the public sector, and the way they are influenced by foreign capital inflow.

Appendix

Heteroskedasticity: The structural equations in (20)–(22) were initially estimated using the original values of the variables (deflated and converted to 1966 *U.S.* dollars). In the second stage of the *2SLS* estimations, the estimated variances of the country-specific residuals appeared to be positively correlated with the size of the country in terms of output and population. The problem is corrected by reestimating the equations with the variables expressed on a per capita basis. This clearly lowers the relative dispersion in the variance of the error term for the observations of each country.

Autocorrelation: Testing for autocorrelation is not possible with the usual Durban-Watson statistic, since the data is a pooling of cross-section and time-series data. Theoretically, an estimation of the autocorrelation parameter[29] δ_i for the error term of each of the N countries ($i=1, \ldots, N$) might be appropriate, yielding N parameters to be used in a generalized least square (*GLS*) estimation of the model. For each set of observations, we estimated δ_i and the multiple correlation coefficient of the autocorrelation function for a one-period lag. The correlation coefficient is quite low for most countries ($r<.3$), implying there is probably

[29] The δ_i is normally referred to as ρ_i in the econometrics literature.

insufficient autocorrelation to justify a further *GLS* correction of the data. Conceivably our correction for heteroskedasticity reduces the severity of the autocorrelation problem. Since the population series for any country is based on extrapolations of past trends in the birth and mortality rates, the observed growth in population embodies a constant time trend. By dividing by population, one is essentially removing part of any time trend from the data itself.

The actual equations estimated are modified in certain cases to remove variables which seemed to induce considerable multicollinearity. Although this undoubtedly introduces specification bias in the coefficients of the included variables, this was judged to be preferable to the indeterminacy which multicollinearity could introduce in the coefficients.

The Pooling of Cross-Section Time-Series Data: The pooling of a cross-section time-series data set necessitates assumptions concerning the stochastic process generating the error term for each equation and as to the similarity of fiscal behavior across countries. We assume the existence of such behavioral similarity, viz., that the structural coefficients of each equation are the same for all countries. Although this is reasonable for the Anglophone countries, the assumption is stretched with the inclusion of Morocco and Tunisia and thus we examine the validity of pooling the entire sample by also estimating separate equations for the Anglophone countries (i.e., excluding Tunisia and Morocco).

If we use an error components approach, the error term for each equation in (20) through (22) is broken down as follows:

$$\epsilon_{it} = u_i + v_{it} \quad \text{for } i = 1, \ldots, N; \quad t = 1, \ldots, T$$

where N is the number of countries and T the number of years. We shall also assume that u_i and v_{it} have means of zero, are independent for all i and t, and where

$$E(u_i u_{i'}) = \begin{cases} \sigma_u^2 & \text{for } i = i' \\ 0 & \text{for } i \neq i' \end{cases}$$

$$E(v_{it} v'_{it}) = \begin{cases} \sigma_v^2 & \text{for } i = i' \ \ t = t' \\ 0 & \text{otherwise,} \end{cases}$$

$$E(\epsilon\epsilon') = \sigma^2 \begin{bmatrix} A & 0, \ldots, 0 \\ 0 & A \quad\quad 0 \\ 0 & 0, \ldots, A \end{bmatrix}$$

$$A = \begin{bmatrix} 1 & \nu \ldots \nu \\ \nu & 1 \ldots \nu \\ \nu & \nu \ldots 1 \end{bmatrix}$$

where $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\nu = \sigma_u^2/\sigma^2$.[30]

A priori one would expect this decomposition of the error ϵ_{it} to be reasonable. Specifically, despite behavioral similarity (viz., equal slopes), there may be differences in each country's intercepts u_i (reflecting different levels of development). However, the choice of estimation procedure will depend on whether u_i is assumed to be random (as above). If one expects that the country-specific intercepts are *unchanged* as new points are added to each country's data set, one could assume u_i to be nonrandom and estimable along with the other parameters using a dummy variable procedure. On the other hand, one might expect that u_i is random, and in this case, the Monte Carlo studies of Nerlove, Swamy, and others indicate that using dummy variables may be inefficient in terms of the relative mean square error of the estimators $\hat{\beta}$ (the remaining structural coefficients) and the degree of small-sample bias.[31]

One method suggested to determine the appropriate estimation procedure is to estimate $\hat{\nu}$, according to methods developed by Nerlove and Swamy. Swamy's method (see chapters 2 and 3) requires a specific transformation of the *error sum of squares* obtained in two regressions: (i) on the "group

[30] In the econometrics literature, this is referred to as $\rho = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$, but in order to avoid confusion with our model parameter ρ, we shall use ν.

[31] It should be noted that these Monte Carlo studies focused on this problem in a single equation context. It is not clear whether application to a simultaneous equation problem will change the conclusions significantly. See Maddala.

mean" data, and (ii) on the "deviations from the group mean" data. For a given equation ((20), (21), etc.), the corresponding error sum of squares is obtained from this pair of regressions run on the second stage of the *2SLS* estimation.

The Nerlove procedure obtains $\hat{\nu}$ by estimating the variance σ_u^2 of the dummy term coefficients as a proportion of σ^2. The latter equals σ_{ui}^2 *plus* the remaining variance σ_{vi}^2 in the dummy variable equation. Since the Swamy and Nerlove estimates of $\hat{\nu}$ prove considerably different in several cases, $\hat{\nu}$ was calculated as the average of the alternative estimates. Given alternative values for $\hat{\nu}$, the number of time periods, and the number of countries, the Monte Carlo studies of Nerlove and Swamy provide small-sample measures of the relative efficiency of *OLS*, *OLS* with dummy variables, and the *GLS* procedure using $\hat{\nu}$.

In general, if $\hat{\nu}$ is close to 1, the use of *OLS* with dummy variables is the best estimation procedure; if $\hat{\nu}$ is close to zero, *OLS* without dummies dominates. I calculated $\hat{\nu}$ values for each equation in (20) through (22), and transformed the variables in the second stage of the *2SLS* estimation procedure according to the procedure indicated as most efficient in the Swamy-Nerlove studies.[32] These transformed variables were then used as inputs to the estimations of equation system (20)–(22). In other words, the variables in each half of the vector in (20) and the whole vector in (21) and (22) were initially transformed according to the Nerlove-Swamy procedure.

[32] The values of ν for each estimation are specified in Tables 1 and 2. If ν was close to 1, dummy variables were used for that component of the variable.

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