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International Tax Comparisons Reconsidered

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Abstract

Traditional tax effort studies yield reliable results only under the assumption that taxes raised by a government depend on the taxable capacity variables and bear no relationship to the variables affecting the total amount of revenue needed to balance the budget. The paper shows that recent empirical data of a cross-section of a large number of developing countries contradicts this assumption. It is, therefore, concluded that the econometric equation underlying traditional tax effort studies suffers from serious misspecification errors and the normative conclusions derived from it are questionable.

The author proposes an alternative equation of "revenue effort and adequacy" (as distinguished from "tax effort"), based on government budget constraint in present value terms and the tax smoothing principle. According to his specification, the total (tax and nontax) revenue raised by a country during a given period of time depends upon a number of factors, representing both the taxable capacity of its population and the expected time path of government's future net cash outflows. This specification, when tested with the cross-section data of 61 developing countries for 1974-79, is shown to yield a good econometric fit; all coefficients have the expected sign; and most of them are statistically significant. The econometric results of the proposed specification are also found to be stable with respect to the various subsamples of developing countries. Finally, the "revenue effort" rankings of developing countries derived from the proposed equation are shown to exhibit very little correlation with the "tax effort" rankings, computed from the traditional tax effort equations.

The proposed specification, however, has a simultaneous equation bias and is sensitive to the period chosen. The coefficients change markedly when the revenue effort equation is applied to the data for 1981-82, a period after the oil, interest rate, and terms of trade shocks of 1979, and the direction of change does not always conform to prior expectations. The author, therefore, concludes that further research is needed before the proposed specification is used for international comparisons and suggests the direction future research should take.

I. Introduction

Suppose that the ratio of tax revenue to some measure of national income (hereafter the tax ratio) in a given country is significantly different from the average tax ratio of other countries. Can one infer from this difference any positive or normative suggestions about tax policy in the country in question?

An answer to this question was attempted in a number of papers published in the IMF Staff Papers in the 1970s. ^{1/} The main contribution of these papers was that international differences in the tax ratio of developing countries could be explained to a large extent by differences in the availability of "tax handles" (cf., Musgrave (1969), Hinrichs (1966)). Specifically, the papers quantified the "taxable capacity" of a country by running a cross-sectional regression of the tax ratio against a number of "proxy" variables for the stage of development and for the tax bases available to the country. The suggestion was then made that the predicted values for the tax ratio obtained from these regressions could be interpreted as a measure of the taxable capacity of each country, and that the estimated residuals would give a measure of the country's "tax effort," defined as the intensity with which the country was using its taxable capacity. It was also suggested that international comparisons of these estimated residuals (or of some algebraic transformations of them) could be used as an input in policy evaluation and policy advice. A country with a negative estimated residual could be seen as making a low tax effort; that is, it was using its taxable capacity with below average intensity, while a country with a high taxable capacity was seen as making a high tax effort. It was argued that this information, coupled with other indicators of the country's macroeconomic performance, could be useful in considering whether or not a change in the tax rates or some other tax reform is desirable to meet the problem of budget deficit in a given country (cf., Bird 1976)).

A specific assumption implicitly or explicitly made in all the above-mentioned studies is that the tax revenue equation being estimated is the first equation of a recursive simultaneous equation model; that is, the fiscal authorities first collect whatever tax revenue is available and, given their total tax revenue, they then decide on the amount of government expenditures and of nontax revenue, and possibly on other sources of finance (borrowing and money creation). As illustrated in Bolnick (1978), if this assumption is violated, the econometric results contained in the tax effort studies would suffer from serious misspecification errors or identification problems, or both. Consequently, the interpretation of the tax effort rankings would also be seriously affected. A country with a low tax effort index could simply have public expenditures below the sample average; or it could have a low stock of public debt outstanding on which it has to pay interest; or it could be raising

^{1/} Lotz and Morss (1967), Bahl (1971 and 1972), Chelliah, Baas, and Kelly (1975), and Tait, Gratz, and Eichengreen (1979). Also see Tait and Eichengreen (1978).

revenues from other nontax sources. Naturally, each of these cases would have different implications for tax policy, and none of them would contain the suggestion that tax rates should be raised to meet the budget deficit, even if the sample average could be assigned some normative value.

In this paper the assumption of recursivity is tested and shown to be strongly rejected by the recent data. The author then illustrates how the information contained in the readily available data can be exploited by making a more reasonable fiscal assumption (tax smoothing hypothesis) and an alternative econometric specification (based on government budget constraint in present value terms). The econometric results, and their economic interpretation, turn out to be substantially different from those suggested in the original tax effort studies.

To start with, Section II uses the 1974-79 data and updates the equations estimated in the published IMF papers for earlier periods. Section III, then, shows that the hypothesis of a recursive model is rejected by the recent data and suggests an alternative econometric specification. Section IV interprets the results based on the new specification and compares them with earlier results. Section V performs some sensitivity analysis of the new results, with respect to different subsamples of countries and different time periods. Section VI contains the conclusions of the study and gives suggestions for future research.

II. The Original Regressions Updated

The data used in this Section are averages of annual data over the 1974-79 period and cover 61 developing countries. The period chosen is between the two oil shocks and the sample of countries is determined by data availability and coincides approximately with the sample used by Tait, Gratz, and Eichengreen (1979), the latest published staff paper on the subject.

The data used here differ from those used in earlier studies in the following respects:

1. Much of the data are drawn from the IMF's Government Finance Statistics Yearbook (GFS) and International Financial Statistics (IFS) rather than from national sources. (Some data are also drawn from World Bank sources.) These data are based on standardized concepts; this should improve their comparability.

2. All variables used in the regressions (except per capita income and per capita exports) are scaled to gross domestic product (GDP) at factor cost, rather than to gross national product (GNP) at market prices to compute the tax ratio and GDP at market prices to scale all other variables, as was done in the previous studies. Because GDP and GNP at market prices include indirect taxes, they artificially reduce the values of all variables. Specifically they reduce the tax

ratio for those countries whose tax revenue is mainly in the form of indirect taxes. Thus, using factor cost with GNP or GDP seems preferable to using market prices. 1/ GDP, rather than GNP, has been chosen for this study to compute the tax ratio for two reasons: (a) it treats all variables uniformly in the regression; 2/ and (b) it is a better measure of the country's overall taxable capacity (in the sense of "ability to collect" taxes); GNP, on the other hand, is a better measure of the "sacrifice" undertaken by the country (i.e., of its "willingness to pay").

3. Tax revenue here is inclusive of social security contributions; the same as in GFS. Not all countries show separate data for social security contributions, and it is difficult to verify, without checking the national sources, whether or not all countries include social security contributions in their tax revenue figures; errors may consequently occur in variables.

4. Again for reasons of data availability, only central government data are considered, whereas the other studies had included local government data when they accounted for more than 10 percent of tax revenue. This too may cause serious errors in the data on variables.

The previous IMF studies estimated the following five equations: 3/

$$\frac{T}{YN} = f\left(YP, \frac{X + M}{Y}\right) \quad (1)$$

$$\frac{T}{YN} = f\left(YP - XP, \frac{N}{Y}, \frac{X'}{Y}\right) \quad (2)$$

$$\frac{T}{YN} = f\left(YP - XP, \frac{X}{Y}\right) \quad (3)$$

$$\frac{T}{YN} = f\left(\frac{N}{Y}, \frac{A}{Y}, \frac{X}{Y}\right) \quad (4)$$

$$\frac{T}{YN} = f\left(\frac{N}{Y}, \frac{A}{Y}\right) \quad (5)$$

1/ This point is elaborated at length in Newlyn (1983).

2/ One can think of the true model being estimated as: $T = f(Y, X)$, where Y is some measure of national income, X is a vector of other explanatory variables. To correct for heteroscedasticity, the model being estimated is $\frac{T}{Y} = f\left(\frac{X}{Y}\right)$, under the assumption that $f(\cdot)$ is linear.

3/ The economic justification behind these equations is discussed at length in the published IMF papers mentioned at the beginning and will not be reproduced here.

where T = tax revenue;
 YN = GNP;
 Y = GDP;
 M = imports;
 X = exports;
 YP = per capita income;
 XP = per capita exports;
 N = output of mining sector;
 A = output of agricultural sector; and
 X' = exports excluding mineral exports.

Table 1 below reports the regression results of these five equations. Line A reproduces the econometric results of Chelliah, Baas, and Kelly (1975), using a sample of 47 countries and for the period 1969-71. Lines B and C reproduce the econometric results of Tait, Gratz, and Eichengreen (1979), using a sample of 47 and 63 countries, respectively, and for the period 1972-76. Line D reports the regression results obtained by this author, based on the sample of 61 countries and for the period 1974-79--T hereafter. Line C provides the best terms of comparison for the new results, because the sample of countries is more similar than for the remaining two regressions lines A and B (the difference amounts to 16 countries).

Except for equation 5, which has a very low \overline{R}^2 , and equation 4, where the share of mining sector over GDP has the wrong sign, that is, a minus, the new regressions provide results which, on the basis of statistical criteria, are as good as the previous ones. The coefficients, however, are generally very different from those estimated in the previous studies. ^{1/} (As can be seen from Table 1, instability of the coefficients across time and across equations emerges also from a comparison of previous results alone.)

The existence of large collinearity between the variables A/Y, N/Y, X/Y, and the conjecture that the tax revenue obtained from the traded goods sector comes mainly from imports rather than exports, induced the author to try an alternative specification. This is reported as equation 6 in Table 1. The results of equation 6 are better when compared with equations 2 through 4; the mining sector output has the correct sign--a

^{1/} A word of caution is needed in comparing equation 2D with equations 2A-2C. Since data for nonmineral exports were not available, X' was calculated simply as the difference between total exports and total output of the mining sector, thereby assuming that in all countries the output of the mining sector was entirely exported.

Table 1. Developing Countries Samples: Taxable Capacity Equations 1/

Equation 1

A. 1969-71 (47 countries)	$T/YN = 11.65 + 0.002 YP + 0.06(X + M)/Y$ (7.77) (0.50) (2.36) $\overline{R}^2 = 0.110$	CBK <u>2/</u>
B. 1972-76 (47 countries)	$T/YN = 9.9683 + 0.0003 YP + 0.1108(X + M)/Y$ (6.02) (0.18) (3.91) $\overline{R}^2 = 0.267$ F(2,44) = 9.378	TGE <u>3/</u>
C. 1972-76 (63 countries)	$T/YN = 6.5775 + 0.003 YP + 0.1457(X + M)/Y$ (3.75) (1.20) (5.28) $\overline{R}^2 = 0.343$ F(2,60) = 17.200	TGE
D. 1974-79 (61 countries)	$T/Y = 9.6705 + 0.0017 YP + 0.0961(X + M)/Y$ (8.94) (2.40) (5.90) $\overline{R}^2 = 0.448$ F(2,58) = 25.37	T <u>4/</u>

Equation 2

A. 1969-71 (47 countries)	$T/YN = 11.47 + 0.001 (YP - XP) + 0.44 N/Y + 0.05 X'/Y$ (7.84) (0.38) (5.45) (1.17) $\overline{R}^2 = 0.376$	CBK
B. 1972-76 (47 countries)	$T/YN = 9.9949 - 0.0008 (YP - XP) + 0.4068 N/Y + 0.1938 X'/Y$ (6.15) (-0.34) (5.41) (3.12) $\overline{R}^2 = 0.413$ F(3,43) = 11.80	TGE
C. 1972-76 (63 countries)	$T/YN = 7.1134 + 0.0024 (YP - XP) + 0.5700 N/Y + 0.2218 X'/Y$ (4.82) (0.94) (9.31) (4.17) $\overline{R}^2 = 0.581$ F(3,59) = 29.69	TGE
D. 1974-79 (61 countries)	$T/Y = 10.3949 + 0.0023 (YP - XP) + 0.0731 N/Y + 0.2137 X'/Y$ (9.51) (2.77) (1.36) (5.19) $\overline{R}^2 = 0.388$	T

Equation 3

A. 1969-71 (47 countries)	$T/YN = 10.36 + 0.005 (YP - XP) + 0.15 X/Y$ (6.31) (1.32) (3.35) $\overline{R}^2 = 0.178$	CBK
B. 1972-76 (47 countries)	$T/YN = 8.4022 + 0.0005 (YP - XP) + 0.3037 X/Y$ (5.54) (0.22) (6.49) $\overline{R}^2 = 0.470$ F(2,44) = 21.37	TGE
C. 1972-76 (63 countries)	$T/YN = 7.3663 + 0.003 (YP - XP) + 0.3025 X/Y$ (4.41) (0.94) (6.19) $\overline{R}^2 = 0.375$ F(2,60) = 19.58	TGE
D. 1974-79 (61 countries)	$T/Y = 11.456 + 0.0016 (YP - XP) + 0.163 X/Y$ (10.42) (2.07) (4.66) $\overline{R}^2 = 0.348$ F(2,58) = 17.04	T

Table 1 (concluded). Developing Countries Samples: Taxable Capacity Equations 1/

Equation 4

A. 1969-71 (47 countries)	T/YN = 14.46 + 0.32 N/Y - 0.07 A/Y + 0.04 X/Y (8.12) (3.85) (2.04) (1.10)	CHK
	\overline{R}^2 = 0.445	
B. 1972-76 (47 countries)	T/YN = 8.0840 + 0.2119 N/Y + 0.0158 A/Y + 0.2452 X/Y (4.08) (2.82) (0.36) (4.91)	TGE
	\overline{R}^2 = 0.542 F(3,43) = 19.16	
C. 1972-76 (63 countries)	T/YN = 9.1859 + 0.3550 N/Y - 0.0240 A/Y + 0.1903 X/Y (4.88) (5.51) (-0.61) (4.30)	TGE
	\overline{R}^2 = 0.593 F(3,59) = 31.12	
D. 1974-79 (61 countries)	T/Y = 15.769 - 0.1285 N/Y - 0.1245 A/Y + 0.2007 X/Y (10.22) (-2.13) (3.47) (5.02)	T
	\overline{R}^2 = 0.426 F(3,57) = 15.84	

Equation 5

A. 1969-71 (47 countries)	T/YN = 15.66 + 0.35 N/Y - 0.08 A/Y (11.07) (4.44) (2.37)	CHK
	\overline{R}^2 = 0.442	
B. 1972-76 (47 countries)	T/YN = 14.3579 + 0.3555 N/Y - 0.0302 A/Y (7.67) (4.15) (-0.57)	TGE
	\overline{R}^2 = 0.302 F(2,44) = 10.94	
C. 1972-76 (63 countries)	T/YN = 14.2423 + 0.4521 N/Y - 0.0571 A/Y (8.54) (6.59) (-1.30)	TGE
	\overline{R}^2 = 0.475 F(2,60) = 29.01	
D. 1974-79 (61 countries)	T/Y = 19.8697 + 0.0412 N/Y - 0.1423 A/Y (13.64) (0.69) (-3.36)	T
	\overline{R}^2 = 0.186 F(2,58) = 7.869	

Equation 6

D. 1974-79 (61 countries)	T/Y = 9.7898 + 0.0371 N/Y + 0.0019 YP + 0.1534 M/Y (8.80) (0.71) (2.35) (5.51)	T
	\overline{R}^2 = 0.419 F(3,57) = 15.42	

1/ The numbers in parentheses below the estimated coefficients are t-statistics.

2/ Chelliah, Baas, and Kelly (1975).

3/ Tait, Gratz, and Eichengreen (1979).

4/ Tabellini (1985).

plus sign--even though it is still insignificant. This equation, therefore, will be used in the remainder of this paper, including the tests carried out in Sections III-V.

Table 2 reports the actual tax ratios (column 2) and their predicted values from equation 2D (column 3) and from equation 6D (column 6). Equation 6D was chosen for comparison because it gives good results according to statistical criteria; equation 2D was chosen so that the new results could be compared with those of Tait, Gratz, and Eichengreen, which are reproduced in column 5 of Table 2. Two conclusions can be drawn from Table 2. First, the correlation coefficient between the two tax effort indices (given in columns 3 and 6) is 0.883 and the Spearman rank correlation coefficient between the two corresponding rankings (given in columns 4 and 7) is 0.887, which is fairly high given the low \bar{R}^2 of the two regressions. Second, the correlation coefficients between the actual tax ratio and the two tax effort indices are 0.735 for index 1, and 0.74 for index 2.

The second conclusion is important because it indicates that countries with high tax ratios tend to have high tax effort indices. This result is somewhat disturbing from an econometric point of view, for it suggests that the regressions may suffer from heteroscedasticity or from a misspecification error. This point is further discussed in Section III.

III. Are the Taxable Capacity Equations Correctly Specified?

As anticipated in Section I, equations 1 through 6 are all based on the assumption that the tax revenues collected by the fiscal authorities are determined independently of the size of public expenditures and of other sources of revenue and finance. In other words, it is assumed that the behavior of the fiscal authorities in developing countries can be described by a recursive system of simultaneous equations, the first equation being the tax revenue equation as specified in any of equations 1 through 6.

If this assumption is correct, the other variables entering the government budget constraint should have coefficients not significantly different from zero when added to the tax revenue equation. Scaling all other variables to GDP and writing the government budget constraint in present value terms, one obtains equation 7 (cf., King and Plosser (1984), Buiter (1983), Barro (1979))

Equation 7

$$\sum_{i=0}^{\infty} \hat{T}_{t+i} \delta^i = \hat{D}_t + \sum_{i=0}^{\infty} \delta^i (\hat{G}_{t+i} - \hat{NT}_{t+i} - \hat{Z}_{t+i})$$

Table 2. Selected Developing Countries: Tax Effort Indices and Rankings ^{1/}

Country (1)	Actual Tax Ratios (2)	Tax Effort Index 1 ^{2/} (3)	Rankings of Tax Effort Index 1 (4)		Tax Effort Index TGE ^{3/} (5)		Rankings of Tax Effort Index 2 (7)	
Guyana	31.238	135.815	8		129	1.447	2	
Trinidad and Tobago	30.645	110.308	23		--	1.181	14	
Greece	26.339	138.919	5		--	1.384	5	
Malta	25.067	107.808	24		--	0.934	31	
Swaziland	23.897	106.759	25		104	1.116	21	
Barbados	23.860	122.820	15		--	1.082	22	
Tunisia	23.511	149.954	1		114	1.370	6	
Zambia	23.439	135.815	7		122	1.425	4	
Venezuela	23.062	116.067	19		92	1.180	15	
Liberia	21.773	97.143	30		62	1.038	25	
Chile	21.298	139.461	4		106	1.457	1	
Mauritius	20.394	92.548	33		--	0.996	26	
Malaysia	20.381	93.790	31		118	1.144	19	
Panama	20.216	128.265	11		69	1.074	23	
Nigeria	20.114	148.518	2		--	1.338	7	
Morocco	19.807	141.205	3		126	1.304	9	
Botswana	19.239	97.524	29		--	0.910	34	
Zaire	19.147	138.733	6		121	1.435	3	
Jordan	18.885	129.655	9		93	0.840	44	
South Africa	18.523	104.779	26		--	1.154	18	
Sri Lanka	18.478	122.595	16		96	1.306	8	
Senegal	18.257	110.547	22		97	1.128	20	
Kenya	17.991	112.144	21		135	1.170	16	
Brazil	17.638	120.565	17		160	1.300	10	
Turkey	17.556	128.674	10		153	1.292	11	
Tanzania	17.268	123.253	13		153	1.186	13	
Somalia	17.122	126.036	12		--	1.155	17	
Fiji	17.020	93.037	32		--	0.906	36	
Indonesia	16.560	122.981	14		75	1.264	12	
Costa Rica	16.439	87.696	38		86	0.928	32	
Sierra Leone	15.402	112.736	20		86	0.992	28	
Oman	15.212	69.197	57		--	0.668	59	
Papua New Guinea	15.112	83.407	43		--	0.877	39	
Korea	15.089	84.104	40		91	0.902	37	
Cyprus	14.800	75.599	51		--	0.691	57	
Peru	14.450	103.601	27		95	1.048	24	
Cameroon	13.951	90.019	34		134	0.992	29	
Gambia, The	13.676	76.744	50		96	0.731	54	
Dominican Republic	13.646	86.105	39		95	0.907	35	
El Salvador	13.321	72.914	53		77	0.835	45	
Yemen Arab Republic	13.192	119.628	18		87	0.719	55	
Sudan	13.102	100.370	28		172	0.993	27	
Malawi	12.905	84.083	41		81	0.849	43	
Honduras	12.635	71.781	55		69	0.777	52	
Thailand	12.430	82.788	44		106	0.864	41	
Nicaragua	12.218	66.688	58		69	0.763	53	
Mexico	11.984	83.959	42		69	0.869	40	
Philippines	11.805	81.359	46		78	0.828	47	
Argentina	11.802	71.105	56		--	0.806	50	
Ghana	11.442	77.859	49		104	0.861	42	
Syrian Arab Republic	11.437	80.176	47		56	0.678	58	
Pakistan	11.430	89.519	36		110	0.879	38	
Ethiopia	11.381	89.648	35		97	0.959	30	
Colombia	10.700	73.755	52		97	0.827	48	
Rwanda	10.473	82.687	45		91	0.810	49	
Paraguay	10.454	72.687	54		73	0.781	51	
India	10.359	87.854	37		156	0.927	33	
Bolivia	9.285	65.636	59		74	0.644	60	
Burma	9.170	78.383	48		84	0.832	46	
Iran, Islamic								
Republic of	8.711	50.622	61		--	0.505	61	
Uganda	7.836	59.514	60		--	0.695	56	
Sample mean	16.468							

Correlation coefficient between

(a) Actual Tax Ratio and Tax Effort Index 1 = 0.735

(b) Actual Tax Ratio and Tax Effort Index 2 = 0.740

(c) Tax Effort Index 1 and Tax Effort Index 2 = 0.883

Spearman rank correlation coefficient between

Rankings of Tax Effort Index 1 and Tax Effort Index 2 = 0.8875

^{1/} As was mentioned in the text, the data used in this paper relate to central government only. Actual tax ratios and tax effort indices for each country given in the table, therefore, carry little or no normative significance. The same is true of the relative tax effort rankings between the countries, which are significantly affected by the degree of centralization. All calculations presented in this table must, therefore, be viewed as illustrative for purposes of testing the methodology and no more.

^{2/} Equation 2D applied to 1974-79 data.

^{3/} Equation 2C (Tait, Gratz, and Eichengreen) applied to 1972-76 data.

^{4/} Equation 6D applied to 1974-79 data.

where the symbol (^) over a variable indicates that it is scaled to nominal GDP; and where $\delta = 1+g/1+R$ (R being the real interest rate and g, the rate of growth of real GDP); D_t = stock of public debt outstanding in period t; NT = nontax revenue; Z_t = other sources of revenue or finance, such as grants or revenue from money creation; and G_t = public expenditures net of interest payments.

Equation 7 is derived from forward iteration of the one-period government budget constraint, under the assumption that $\delta < 1$ (i.e., that, on average, real income grows at a rate lower than the real rate of interest). It can be interpreted as imposing intertemporal consistency between the stock of public debt outstanding at the beginning of the period, on which interest has to be paid, and the time path of the cash outflows and cash inflows of the government.

The hypothesis implicit in the tax effort studies is that, for all developing countries, the time path of tax revenues is determined by the fiscal authorities independently of all the variables entering the right-hand side of equation 7. That is, given the "tax handles" that each country has available, the time path of its tax revenues is uniquely determined. On the basis of this expected time path, and of the stock of public debt outstanding, the time paths of the remaining variables, \hat{G} , \hat{NT} , \hat{Z} , are residually chosen so as to satisfy equation 7.

An alternative hypothesis is suggested by the "Tax Smoothing Principle," successfully tested by Barro (1979) and (1981) using U.S. data. He conjectured and could not reject the hypothesis that collection costs and "excess burden" of taxation are minimized by keeping the tax rates constant through time. ^{1/} Under this hypothesis, and if the true model is not recursive, tax rates are chosen so as to balance the budget expressed in present value terms (i.e., taking into account the existing debt obligations and the expected future net cash outflows); in other words, tax rates are changed only subsequent to permanent shocks either to the future time path of the tax bases or to the future time path of public expenditures net of other (nontax) sources of revenue.

By using simple averages of all variables over the 1974-79 period as an approximation for the present value of their expected future time path, ^{2/} this hypothesis can be easily tested against the alternative hypothesis that the true model is recursive. Table 3 reports the results of a regression (equation 8) where this test is carried out. In estimating equation 8, the following variables were added to the right-hand side of equation 6. ^{3/}

^{1/} On this, see also Buiter (1983).

^{2/} This implies the following two assumptions: (a) in the long run, all variables grow at the same rates across countries (though not necessarily with the same rate for all variables; (b) the five-year average computed for each variable cancels out all temporary deviations from trend.

^{3/} The source for the data on the first three variables is GFS and on the last variable, IFS and the World Bank.

GR/Y = grants over GDP;

NT/Y = nontax revenue over GDP;

G/Y = public expenditure net of interest payments over GDP;
and

$\frac{D(74)}{Y(74)}$ = total public debt outstanding in 1974 (central government) over GDP in 1974.

If the model is recursive, the coefficients of these four variables should not be significantly different from zero. On the other hand, if the fiscal authorities set their tax rates simultaneously with the other fiscal instruments and according to the tax-smoothing principle, one should expect G/Y and $D(74)/Y(74)$ to have positive and significant coefficients and GR/Y and NT/Y to have negative and significant coefficients (cf., equation 7 above).

Table 3. Tests of Recursivity Assumption and Tax-Smoothing Hypothesis 1/

Equation 8

1974-79	$T/Y = 2.1650 + 0.0989 N/Y + 0.0019 YP + 0.0877 M/Y$			
(61 countries)	(2.29)	(2.81)	(3.68)	(4.62)
	$- 0.8767 GR/Y - 0.7558 NT/Y + 0.5346 G/Y$			
	(-7.89)	(-10.47)	(8.94)	
	$+ 0.0191 D(74)/Y(74)$			
	(0.68)			
	$\bar{R}^2 = 0.84$		$F(7,53) = 46.39$	

1/ The F ratio relative to the hypothesis that the coefficients of GR/Y, NT/Y, G/Y, and $D(74)/Y(74)$ are all zero is $F(4,53) = 38.87$. Figures in parentheses are t-statistics.

The hypothesis that the true model is recursive is strongly rejected by the data: in equation 8, all variables have the expected sign, and all of them except $D(74)/Y(74)$ are highly significant; the R^2 improves dramatically relative to the equations in Table 1; and the hypothesis that all four coefficients are zero is rejected by an F test at the 99 percent confidence level.

When revenue from money creation is added to equation 8 as a further explanatory variable, 1/ its estimated coefficient is not significantly different from zero and little else is changed. When the numerator of $D(74)/Y(74)$ in equation 8 is replaced by larger stock variables (such as the outstanding debt of the public sector or total external debt of the country), the coefficient of that variable increases, but it still remains insignificant. When the equation is estimated without imposing the restriction that current and capital public expenditures enter with the same coefficients, all the other estimated coefficients remain approximately as in Table 3; however, as one would predict, the coefficient on current public expenditures is larger than the coefficient on capital expenditures (0.5727 and 0.4674, respectively), and the restriction is rejected at the 95 percent confidence level. Since the classification of the data between current and capital expenditures is highly unreliable, the constraint that the two coefficients are equal will be maintained in the analysis that follows. Finally, when the "proxies" for the tax bases and the stage of development (N/Y , M/Y , YP) are substituted with some of the other variables used in equations 1 through 6, the coefficients of G/Y , GR/Y , and NT/Y retain the expected sign and remain highly significant, even though the R^2 deteriorates somewhat.

In comparing the coefficients of equation 8 with those of equation 6D, notice that only the coefficient of YP remains unchanged. In particular, notice that the coefficient of N/Y now becomes significant. This is hardly surprising: the sample contains five oil exporting countries, which raise substantial nontax revenue from their mining sector. Indeed, the simple correlation coefficient between N/Y and NT/Y is 0.6869. If equation 6D is misspecified, and NT/Y belongs to the true model, the coefficient of N/Y in that equation is biased downward.

1/ Defined as $g(M/Y)$, where g is the rate of growth of nominal GDP, and M is the stock of monetary base. For a derivation of this definition of money seigniorage from an optimizing model of central bank behavior, see Auernheimer (1974).

Because of the inclusion of the oil exporting countries in the sample, the distinction between tax and nontax revenue is somewhat artificial. Moreover, NT/Y is likely to be correlated with the residuals of equation 8, because of a simultaneous equation bias problem. Finally, NT/Y is likely to be measured with substantial error.

These three considerations suggest that a better specification would be to add NT/Y to T/Y on the left-hand side of equation 8 and estimate a regression with total revenue (TOTR) as the endogenous variable. The results of this regression, equation 9, are reported in Table 4. As in equation 8, public debt outstanding at the beginning of the period is insignificant. For the rest, the estimated coefficients retain the expected sign and \bar{R}^2 improves further. A regression of the estimated residuals of this equation against G/Y reveals no heteroscedasticity problem with respect to this variable.

Table 4. Total Revenue Equation: 61 Developing Countries 1/

Equation 9

1974-79	$TOTR/Y = 0.8597 + 0.1411 N/Y + 0.0021 YP$			
(61 countries)	(0.91)	(3.92)	(3.75)	
	$+ 0.0756 M/Y - 0.9505 GR/Y + 0.6379 G/Y$			
	(3.71)	(-7.98)	(11.37)	
	$+ 0.0068 D(74)/Y(74)$			
	(0.22)			
	$\bar{R}^2 = 0.928$		$F(6,54) = 129.2$	

Standard error of estimate = 2.303; where TOTR = Total Revenue.

1/ Figures in parentheses are t-statistics.

Equation 9 can be interpreted as a structural form equation of a larger simultaneous equation model: it says that the total revenue collected in a country depends on the tax bases available to that country (proxied by the variables M/Y and N/Y), on its stage of development (proxied by its per capita income, YP), on the size of its public expenditures net of interest payments (G/Y), on the grants that it receives (GR/Y), and on the stock of debt which it will have to service (D/Y).

There is likely to be a simultaneous equation bias owing to a positive correlation of G/Y with the residuals of equation 9. The impact of this bias on the estimated coefficients can be assessed by (a) regressing G/Y on the remaining explanatory variables, and (b) estimating the asymptotic bias of various coefficients. The latter can be easily assessed as follows. Let σ_{GU} be the covariance between G/Y and the true residuals in equation 9. Also, let $V(G)$ be the estimated variance of the regression of G/Y on the remaining explanatory variables and

let $\hat{\lambda}_i$ be the estimated i^{th} coefficient in such regression. Appendix I shows that, for a large sample (i) the asymptotic bias in the estimated coefficient of G/Y in equation 9 can be approximated by $\sigma_{GU}/V(G)$; and (ii) the asymptotic bias in the estimated coefficient of the i^{th} explanatory variable in equation 9 can be approximated by $-\hat{\lambda}_i \cdot \sigma_{GU}/V(G)$.

Table 5 regresses G/Y on the remaining explanatory variables (equation 10), which allows the estimation of $V(G)$ and $\hat{\lambda}_i$ for the sample of 61 countries, and the computation of the bias in all coefficients of equation 9 as a function of ρ_{GU} (the correlation coefficient between G/Y and the true residuals of equation 9). The basis of this computation is shown in Appendix II.

The results show that the coefficient of G/Y in equation 9 is biased upward, and that all other coefficients are biased downward. Even for small values of ρ_{GU} , the bias is estimated to be very large for all coefficients. To give an idea of the magnitudes involved, Table 6 in Section IV reports the total revenue indices from equation 9 under the assumption that $\rho_{GU} = 0$ (no bias) and under an alternative assumption of $\rho_{GU} = 0.25$.

Table 5. Tests of Simultaneous Equation Bias

Equation 10

1974-79 $G/Y = 9.5221 + 0.3380 N/Y + 0.0041 YP + 0.1489 M/Y$
 (61 countries) (5.10) (4.60) (3.34) (3.34)

$+ 0.1655 D(74)/Y(74) + 1.2554 GR/Y$
 (2.40) (5.44)

$\overline{R}^2 = 0.728$

$F(5,55) = 33.11$

Residual sum of squares = 1683

Estimated variance = 30.6

Sample standard deviation of $G/Y = 10.607$

Estimates of asymptotic bias of various coefficients in equation 9

<u>Explanatory variable</u>	<u>Estimate of asymptotic bias 1/</u>
G/Y	0.7984 ρ_{GU}
Intercept	-7.6022 ρ_{GU}
N/Y	-0.2699 ρ_{GU}
YP	-0.0032 ρ_{GU}
M/Y	-0.1189 ρ_{GU}
GR/Y	-1.0023 ρ_{GU}
$D(74)/Y(74)$	-1.3215 ρ_{GU}

1/ ρ_{GU} is the correlation coefficient between G/Y and the true residuals of equation 9.

IV. Tax Effort Rankings Reinterpreted

If, as argued in Section III, the taxable capacity equations estimated in the earlier IMF papers are statistically misspecified, because of the omission of the variables appearing in equations 8 and 9 (Tables 3 and 4), the tax effort rankings derived from those equations could be distorted in at least two ways: (a) the estimated coefficients in equations 1 through 6 are biased; hence, the weights assigned to the proxy variables for the country tax bases and for stage of development are likely to be wrong and so are the predicted tax ratios; and (b) the size and the sign of the residual for each country reflects the size and the sign of the deviation of the omitted variables from their sample average. Thus, a country with low estimated tax effort indices 1 or 2 in Table 2 could have public current and capital expenditures below the average; or it could have a particularly low stock of public debt outstanding; or it could be receiving substantial aid from abroad; or could simply be raising a large revenue in the form of royalties, or users fees, or from other nontax sources.

The interpretation of the predicted values and of the estimated residuals of the regression equations 8 and 9 (reported in Tables 3 and 4), on the other hand, is less ambiguous. These regressions do not attempt to estimate the taxable capacity of each country. They are based on the plausible conjecture that different countries could be using their taxable capacity with different intensities, and that these differences are systematically related to differences in the total amount of revenues needed to service the existing stock of public debt or to pay for the flow of public expenditures. Thus, a country with, say, a negative residual estimated from equations 8 or 9 (Tables 3 or 4) is using its taxable capacity with a lower degree of intensity than other countries with a similar combination of debt service, public expenditures, grants, and nontax revenue, and vice versa, for a country with a positive estimated residual. This information could be valuable when assessing a country's creditworthiness or aidworthiness, but only provided that the sample average has some normative significance. As illustrated in Tabellini (1985), in a similar framework and for the subsample of 48 non-oil exporting developing countries for which rankings are computed in Section V, this requirement may be very restrictive. It will nonetheless be assumed in the remainder of this paper.

Table 6 reports the actual ratio of total revenue to GDP, in descending order for all the countries in the sample. Dividing this ratio by the predicted values of equation 9 (in Table 4), one can construct an index of "total revenue effort," or better, of "total revenue effort and adequacy," analogous to the one reported for tax revenue only in Table 2, above. Columns 3 and 5 of Table 6 report this index, under the hypothesis that $\rho_{GU} = 0$ (i.e., no simultaneous equation bias) and under the hypothesis that $\rho_{GU} = 0.25$, respectively (see the concluding paragraph of Section III).

Table 6. Selected Developing Countries: Total Revenue Indices and Rankings ^{1/}

Country (1)	Total Revenue Over GDP (2)	Total Revenue Index 1 ^{2/} (3)	Ranking for Total Revenue Index 1 (4)	Total Revenue Index 2 ^{3/} (5)	Rankings for Total Revenue Index 2 (6)
Oman	51.980	100.447	30	125.854	29
Malta	44.841	111.091	9	143.155	9
Iran, Islamic Republic of	38.922	103.721	26	133.443	15
Trinidad and Tobago	38.076	105.284	22	156.680	1
Guyana	35.430	108.186	17	136.451	13
Syrian Arab Republic	31.443	109.081	12	113.948	44
Venezuela	30.250	93.542	43	128.353	23
Greece	29.450	106.987	18	141.247	10
Tunisia	28.708	108.694	14	131.043	17
Botswana	28.559	110.105	10	125.264	30
Chile	27.777	124.463	2	146.171	7
Zambia	26.720	90.951	47	108.338	48
Barbados	26.251	95.841	39	128.696	19
Swaziland	26.072	102.402	29	132.742	16
Jordan	24.775	90.969	46	67.612	61
Morocco	24.547	90.510	49	105.422	52
Nigeria	23.957	97.980	36	128.382	22
Panama	23.919	93.880	44	115.952	42
Liberia	22.805	86.637	53	111.939	47
Malaysia	22.596	94.088	43	121.063	35
Mauritius	22.337	85.046	56	106.755	51
South Africa	20.999	90.140	51	118.878	37
Somalia	20.990	111.490	8	128.582	21
Kenya	20.546	106.897	19	123.841	34
Sri Lanka	20.031	104.981	23	114.420	43
Fiji	19.943	95.475	40	124.424	33
Tanzania	19.888	96.594	38	102.367	56
Cyprus	19.869	84.084	59	103.342	53
Zaire	19.704	84.807	57	89.737	60
Turkey	19.609	105.748	21	127.849	24
Senegal	19.532	117.351	5	149.886	3
Brazil	19.470	121.259	3	150.497	2
Costa Rica	18.005	90.205	50	118.685	38
Papua New Guinea	17.969	116.593	6	94.439	58
Indonesia	17.869	99.416	33	127.195	26
Gambia, The	17.818	90.671	48	108.270	49
Sierra Leone	17.185	98.385	35	125.197	31
Korea	16.607	97.965	37	129.765	18
Yemen Arab Republic	16.174	118.280	4	107.487	50
Malawi	16.039	94.414	42	102.664	55
Peru	15.935	108.994	13	144.044	8
Dominican Republic	15.689	103.556	27	136.688	12
Sudan	15.452	100.101	32	116.359	41
Cameroon	14.735	106.108	20	128.651	20
Argentina	14.653	84.202	58	112.307	46
Honduras	14.016	95.194	41	127.301	25
Pakistan	13.821	86.197	54	97.979	57
El Salvador	13.816	108.435	16	149.051	5
Ethiopia	13.589	108.545	15	113.780	45
Thailand	13.578	100.323	31	126.136	28
Philippines	13.337	104.642	24	133.907	14
Nicaragua	13.326	80.318	60	103.265	54
Ghana	12.891	78.308	61	92.974	59
Burma	12.748	127.954	1	140.178	11
Mexico	12.688	87.813	52	117.736	39
India	12.445	104.343	25	116.979	40
Paraguay	11.580	110.005	11	146.860	6
Colombia	11.423	114.926	7	149.629	4
Rwanda	11.236	102.961	28	127.138	27
Bolivia	11.195	85.651	55	124.912	32
Uganda	8.329	99.221	34	120.955	36

Sample mean 20.72

Correlation coefficient between

- (a) Actual Total Revenue over GDP and Total Revenue Index 1 = 0.124
- (b) Actual Total Revenue over GDP and Total Revenue Index 2 = 0.166
- (c) Total Revenue Index 1 and Total Revenue Index 2 = 0.622

Spearman rank correlation coefficient between

Rankings of Total Revenue Index 1 and Total Revenue Index 2 = 0.638

^{1/} As was mentioned in the text, the data used in this paper relate to central government only. Actual revenue ratios and revenue effort indices for each country given in the table, therefore, carry little or no normative significance. The same is true of the relative revenue effort rankings between the countries, which are significantly affected by the degree of centralization. All calculations presented in this table must, therefore, be viewed as illustrative for purposes of testing the methodology and no more.

- ^{2/} Equation 9 applied to 1974-79; $\sigma_{GU} = 0$.
- ^{3/} Equation 9 applied to 1974-79; $\sigma_{GU} = 0.25$.

Notice that, unlike in the case of the tax effort index, there is practically no correlation between the actual ratio of total revenue to GDP and the total revenue index. This has at least two implications. First, the ratio of total revenue to GDP is by itself a poor indicator of the country's fiscal performance, in the sense that it differentiates neither between countries with different taxable capacity nor between countries with different "needs" for government revenue. When these differences are controlled for, as they are in the total revenue index, the position of most countries relative to the average turns out to be much different.

Second, the regressions on which the total revenue index is based are less likely to suffer from misspecification error or heteroscedasticity than the regressions used in the tax effort studies. As shown in Section III, the positive correlation between the actual tax ratio and the tax effort index that emerges from the tax effort equations (Table 2) indicates that the estimated residuals of these equations exhibit a systematic pattern. When the variables listed on p. 10 are added as explanatory variables (see equation 8 in Table 3), the systematic pattern of the estimated residuals seems to vanish.

The correction for the simultaneous equation bias affects the total revenue index in two ways: by raising the index for most countries (as revealed by the fact that the mean and the median of the sample increase by more than 20 percent); and by changing the rankings: the correlation coefficient between the two indices is 0.622, the Spearman rank correlation coefficient for the corresponding rankings is 0.638. Thus, the index and the rankings in Table 6 are shown to be very sensitive to the correction for the simultaneous equation bias. In the absence of strong prior hypothesis on the size of the ρ_{GU} coefficient--and it is hard to see where this hypothesis could come from, no reliable international comparisons can be made by using the predicted values of equation 9 (Table 4) either. In the light of the results reported in Table 5, it is likely that the alternative procedure of estimating equation 9 by means of instrumental variables estimators would also run into similar sensitivity problems (unless the choice of the instruments can be derived from a sharp prior hypothesis).

Finally, the rankings obtained from the two total revenue indices, given in Table 6, are almost unrelated with the rankings obtained from the tax effort indices, reported in Table 2. With no adjustment for simultaneous equation bias, the correlation coefficient between the total revenue index and the tax effort index obtained from equation 6 is 0.14; with the adjustment for the simultaneous equation bias (for $\rho_{GU} = 0.25$), the correlation coefficient is 0.15. For the other tax effort index (obtained from equation 2D), the coefficient is 0.16 if no correction for the bias is made and is negative when the correction for the bias is introduced. Thus, there is almost no relation between the rankings obtained from the tax effort indices (given in Table 2) and the total revenue indices (given in Table 6).

If the arguments raised in this Section, and in Section III, against the methodology used in the earlier tax effort studies are valid, the usefulness of those studies for international comparisons, if any, will indeed be limited.

V. Further Sensitivity Analysis and Comparisons With the 1980-82 Period

The regressions carried out in the previous Sections are based on a sample containing very heterogeneous countries. In this Section several country groupings are tried, according to geographic location and to the structure of their economies. Also, the 1974-79 period is compared with the 1980-82 period, in order to check the influence of the oil, interest rate, and terms of trade shocks of 1979 on the regression coefficients and on the rankings. The prior conjecture is that the coefficients should increase in absolute value for all variables (except possibly for imports) as a consequence of the three shocks. A theoretical framework from which this conjecture can be derived is illustrated in Tabellini (1985).

The basic sample considered throughout this Section consists of 48 non-oil exporting developing countries. The sample is obtained by excluding from the previous sample all oil exporting countries and other non-oil exporting countries for which data were unavailable for the post-1979 period.

Table 7 reports the estimate of the regression for 48 non-oil exporting countries for the period 1974-79 with no dummies. Equation 11 in Table 7 is the same as in Table 4, except that public debt of the central government has now been replaced by the total external debt of the country, ^{1/} and that the sample is smaller. The R^2 deteriorates slightly relative to Table 4, but all coefficients, except the intercept and the coefficient of external debt, remain stable and significant. Notice that the sample average for total revenue is 19.53, more than 1 percentage point below the average of the larger sample of 61 countries.

^{1/} This substitution improves the t-statistic of the public debt variable and leaves all other coefficients roughly unaffected. A priori, one would expect fiscal policy to react to total external debt of the country to the extent that private external debt is publicly guaranteed. This is the case for most developing countries.

Table 7. Total Revenue Equation: 48 Non-Oil Exporting
Developing Countries, 1974-79 Data ^{1/}

Equation 11

$$\begin{aligned}
 &1974-79 \quad \text{TOTR/Y} = 1.0115 + 0.1469 \text{ N/Y} + 0.0023 \text{ YP} + 0.0795 \text{ M/Y} \\
 &(48 \text{ countries}) \quad (0.84) \quad (2.52) \quad (3.09) \quad (3.04) \\
 &\quad \quad \quad + 0.0113 \text{ ED/Y} - 0.9037 \text{ GR/Y} + 0.6081 \text{ G/Y} \\
 &\quad \quad \quad (0.40) \quad (-6.73) \quad (9.59) \\
 &\quad \quad \quad \overline{R^2} = 0.88 \quad \quad \quad F(6,41) = 59.96
 \end{aligned}$$

^{1/} The figures shown in parentheses are t-statistics. ED/Y = external debt of the country over GDP, both variables being 1974 data. TOTR/Y sample average is 19.53

Three dummy variables were added to the intercept of the regression equation 11 in Table 7 and the regression re-estimated. They represent three groups of countries: (i) countries whose oil and lubricant imports were more than 20 percent of total imports in 1980; (ii) newly industrialized countries, defined as countries with per capita income above \$1,700 in 1981 and with output of the manufacturing sector larger than 20 percent of GDP in 1981; and (iii) countries which experienced a drop of 20 percent or more in their terms of trade between 1979 and 1982. ^{1/} Only the dummy variable for the first group of countries was found to be significant at the 95 percent confidence level and had a positive coefficient: the total revenue ratio for these countries was significantly higher than for other countries, even controlling for all the other variables included in the regression. When a second set of dummy variables, grouping countries by their geographical location, was added to the regression equation 11 in Table 7, they all turned out to be insignificant, and an F test that all their coefficients differed from zero was rejected at the 95 percent confidence level: unlike in previous studies (for instance, Bahl (1972)), geographic location was found to play no role, at least with respect to the intercept of the regression.

Equation 11 is then re-estimated for the period 1980-82 (with data for most countries available only up to 1981). Table 8 reports the results of the regression, equation 12, with no dummy variables. Notice that the sample mean has increased by 1 percentage point when compared with the 1974-79 period. The overall fit of the regression deteriorates, possibly reflecting the stronger influence of cyclical fluctuations in this shorter time period. Moreover, the variable M/Y becomes barely

^{1/} The data source for the country groupings is World Bank (1984).

Table 8. Total Revenue Equation: 48 Non-Oil Exporting
Developing Countries, 1980-82 Data 1/

Equation 12

$$\begin{aligned}
 \text{1980-82} \quad \text{TOTR/Y} &= 1.7555 + 0.2232 \text{ N/Y} + 0.0013 \text{ YP} + 0.0620 \text{ M/Y} \\
 \text{(48 countries)} \quad &\quad (1.07) \quad (3.10) \quad (2.41) \quad (1.93) \\
 &+ 0.0130 \text{ ED/Y} - 0.8368 \text{ GR/Y} + 0.5788 \text{ G/Y} \\
 &\quad (0.38) \quad (-4.63) \quad (6.52) \\
 \bar{R}^2 &= 0.82 \qquad F(6,41) = 35.68
 \end{aligned}$$

1/ t-statistics are shown in parentheses. TOTR/Y sample average is 20.54.

insignificant (with $t = 1.93$). All coefficients exhibit some instability, particularly those corresponding to the intercept and to N/Y (both moving upward). Contrary to expectations, however, some of the estimated coefficients drop relative to the earlier subperiod. This issue is investigated in more detail in Tabellini (1985).

When the dummy variables for the country groupings mentioned above are added to equation 12, the results are as those for the previous period: only the dummy variable for countries with oil imports larger than 20 percent of total imports turns out to be significant; the coefficient for this dummy is positive and larger than in the previous period, as expected (the countries belonging to this group are those most adversely hit by the 1979 oil shock). The dummy variables for geographic location are not significantly different from zero in isolation or as a group.

When two dummy variables for the countries which underwent debt restructuring between 1979 and 1984 are added to the intercept and to the coefficient of the debt variables in equation 12, for the 1980-82 period, the second dummy is almost significant at the 95 percent confidence interval (its t -statistic is -1.93) with a negative sign, and the coefficient on debt increases and becomes significant. The same qualitative results also emerge for the 1974-79 period, but the coefficients of neither the dummies nor the debt are significant. This result implies that for a group of countries the time path of tax revenue has been set independently of the size of the stock of debt outstanding at the beginning of the period (as predicted from the international budget constraint, this group of countries was unable to

service its debt according to schedule); for the remaining countries in the sample the coefficient on the debt variable in the second subperiod is positive and significant, as expected.

Table 9 reports the actual ratios of total revenue to GDP and the total revenue index and rankings for the two periods 1974-79 and 1980-82. No correction for the simultaneous equation bias is done. Both the rankings and the actual ratios have changed for many countries between the two periods. The correlation coefficient between the total revenue indices for the two periods is only 0.35. The Spearman rank correlation coefficient is 0.45. However, in the light of the results of the previous section, the rankings ought to be interpreted with great caution.

VI. Conclusions and Suggestions for Future Research

Traditional tax effort studies yield correct results only under the hypothesis that the taxes raised by developing countries do not depend on the total amount of revenue needed to balance the budget. Empirical evidence contradicts this hypothesis. An alternative hypothesis is suggested by the government budget constraint in present value terms, together with the "tax smoothing principle" proposed by Barro (1979 and 1981) and Buiter (1983), according to which the total amount of (tax and nontax) revenue raised by a country during a given period of time depends both on its taxable capacity and on the expected time path of its future net cash outflows.

When total revenue is regressed against a number of variables proxying for the taxable capacity of the country, plus other variables entering the government budget constraint in present value terms, the fit is very good, all coefficients have the expected sign and most of them are significant. However, the equation is very sensitive to a simultaneous equation bias problem. In principle, the problem could be overcome by means of an appropriate choice of instrumental variables. In practice, such a choice is unlikely to be easy. ^{1/} On the other hand, the econometric results seem to be very stable with respect to the sample of countries chosen. As expected, the estimated coefficients change when the model is re-estimated for the period subsequent to the 1979 shocks; however, the direction of the change does not always conform to prior expectations.

^{1/} However, see Tait and Heller (1982).

Table 9. Forty-Eight Developing Countries: Total Revenue Indices and Rankings, 1974-79 and 1980-82 ^{1/}

Country (1)	Actual Total Revenue over GDP 1974-79 (2)	Total Revenue Index ^{2/} 1974-79 (3)	Rankings for Total Revenue 1974-79 (4)	Actual Total Revenue over GDP 1980-82 (5)	Total Revenue Index ^{3/} 1980-82 (6)	Rankings for Total Revenue Index 1980-82 (7)
Malta	44.841	0.891	42	34.334	0.928	36
Trinidad and Tobago	38.076	0.956	30	42.867	0.948	33
Syrian Arab Republic	31.443	0.904	41	24.428	0.998	26
Tunisia	28.708	0.911	39	31.838	0.893	38
Botswana	28.559	0.909	40	35.878	0.967	30
Chile	27.777	0.815	47	30.753	0.808	45
Zambia	26.720	1.086	13	26.118	1.178	7
Barbados	26.251	1.041	19	27.358	1.116	12
Swaziland	26.072	0.970	26	28.016	0.846	43
Jordan	24.775	1.096	12	22.720	0.980	29
Morocco	24.547	1.083	14	25.426	1.033	23
Panama	23.919	1.062	15	26.835	0.881	40
Liberia	22.805	1.156	8	23.641	1.188	5
Malaysia	22.596	1.048	17	27.584	1.076	17
Mauritius	22.337	1.157	7	21.924	1.104	14
Kenya	20.546	0.922	37	24.015	0.861	42
Sri Lanka	20.031	0.936	34	19.072	1.182	6
Fiji	19.943	1.045	18	23.037	0.943	35
Tanzania	19.888	1.018	21	19.781	0.619	48
Cyprus	19.869	1.196	3	21.674	1.135	11
Zaire	19.704	1.167	6	21.387	0.905	37
Turkey	19.609	0.936	33	20.760	0.867	41
Senegal	19.532	0.848	45	22.065	0.945	34
Brazil	19.470	0.824	46	21.767	0.816	44
Costa Rica	18.005	1.114	11	17.796	1.093	15
Papua New Guinea	17.969	0.869	43	21.429	1.080	16
Sierra Leone	17.185	1.013	22	16.749	1.270	4
Korea	16.607	1.034	20	19.224	0.997	28
Yemen Arab Republic	16.174	0.859	44	23.363	1.151	8
Malawi	16.039	1.052	16	18.253	0.997	27
Peru	15.935	0.923	36	18.677	0.887	39
Dominican Republic	15.689	0.966	27	13.932	1.074	18
Sudan	15.452	0.988	24	11.591	0.999	25
Cameroon	14.735	0.940	32	23.918	0.781	46
Argentina	14.653	1.193	5	17.143	1.144	9
Pakistan	13.821	1.151	10	16.166	0.953	31
El Salvador	13.816	0.931	35	12.229	1.110	13
Thailand	13.578	0.986	25	14.058	1.050	21
Philippines	13.337	0.956	29	12.229	1.066	19
Nicaragua	13.326	1.256	2	21.536	1.009	24
Ghana	12.891	1.265	1	6.646	1.757	3
Burma	12.748	0.773	48	16.510	0.691	47
Mexico	12.688	1.152	9	15.502	1.140	10
India	12.445	0.941	31	12.663	1.045	22
Paraguay	11.580	0.921	38	10.650	1.058	20
Rwanda	11.236	0.961	28	12.781	0.950	32
Bolivia	11.195	1.195	4	7.351	1.785	2
Uganda	8.329	1.000	23	2.143	2.567	1

Sample mean 19.53

Correlation coefficient between

Total Revenue Index, 1974-79 and Total Revenue Index, 1980-82 = 0.35.

Spearman rank correlation coefficient between

Rankings of Total Revenue Index, 1974-79 and Total Revenue Index, 1980-82 = 0.45.

^{1/} As was mentioned in the text, the data used in this paper relate to central government only. Actual revenue ratios and revenue effort indices for each country given in the table, therefore, carry little or no normative significance. The same is true of the relative revenue effort rankings between the countries, which are significantly affected by the degree of centralization. All calculations presented in this table must, therefore, be viewed as illustrative for purposes of testing the methodology and no more.

^{2/} The index is based on the regression equation 11, Table 7.

^{3/} The index is based on the regression equation 12, Table 8.

The rankings of "total revenue effort and adequacy," computed from these econometric regressions, exhibit very little correlation with the "tax effort" rankings, computed from the traditional tax effort equations. Moreover, the rankings differ substantially between the two periods being estimated. If the arguments raised in this paper are correct, they cast doubt on the usefulness of the tax effort indices.

This paper could be extended and improved in a number of directions. One has been mentioned already--in order to overcome the simultaneous equation bias problem, discussed at length in Section III, an instrumental variables estimation of public expenditures could be attempted. A second improvement would consist of doing some sensitivity analysis for errors in variables, as suggested, for instance, in Klepper and Leamer (1984). Similarly, a sensitivity analysis for outliers or relevant groups of observations could also be fruitfully undertaken according to the techniques illustrated in, for instance, Belsley, Kuh, and Welch (1980). This may be particularly important in the light of the crucial role of the estimated residuals in the construction of the country rankings. Finally, other country groupings could be attempted, for instance, to check whether the fiscal behavior of countries undergoing an adjustment program is substantially different from the behavior of countries not undergoing an adjustment program.

Approximation of Simultaneous Equation Bias

Let the true model be

$$y_t = x_t\beta + z_t\gamma + u_t \quad (1)$$

where y , z , γ , and u are scalars, and where x_t and β are vectors.

Suppose that $\text{Cov}(z_t, u_t) > 0$, $\text{Cov}(x_t, u_t) = 0$. The problem is to evaluate the inconsistency on the ordinary least squares estimators of β and γ . Define $\delta = (\beta/\gamma)$, and $\hat{\delta}_{OLS}$ its ordinary least squares estimator.

We have

$$\text{plim } \hat{\delta}_{OLS} = \delta + \text{plim} \begin{bmatrix} x'x \ 1/T & x'z \ 1/T \\ z'x \ 1/T & z'z \ 1/T \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ \sigma_{zu} \end{bmatrix} \quad (2)$$

where the assumptions

$$\text{plim } 1/T(x'u) = 0, \text{plim } 1/T(z'u) = \sigma_{zu} > 0$$

have been used.

From the partitioned inverse rule we then obtain

$$\begin{aligned} \text{plim } \hat{\beta}_{OLS} &= \beta + a\sigma_{zu} \\ \text{plim } \hat{\gamma}_{OLS} &= \gamma + b\sigma_{zu} \end{aligned} \quad (3)$$

where $a = -\text{plim } (x'x)^{-1} x'z(z'M_x z)^{-1}$

$$b = \text{plim } (1/T z'M_x z)^{-1}$$

$$M_x = [I_x - x(x'x)^{-1} x'],$$

I_x being the identity matrix.

For a large sample, a and b can be obtained by running the following regressions

$$z = \lambda x + v \quad (4)$$

b is simply the inverse of the estimated variance of the regression; and a is obtained from

$$a = -\hat{\lambda}_{OLS} \cdot b$$

where $\hat{\lambda}_{OLS}$ is the OLS estimator of λ in (4).

Estimation of Biases in Coefficients

$\text{Cov}(G/y, u) = \sigma_{GU}$ can be written as $\sigma_{GU} = \rho_{GU} \cdot \sigma_U \cdot \sigma_G$, where σ_G is the standard deviation of G/Y and σ_U is the standard deviation of the true residuals of equation 9. Since the sample is fairly large (61 countries), we can approximate σ_G with the sample standard deviation.

Thus, $\sigma_G = 10.607$. Moreover, σ_U can be approximated by the standard error of estimate of equation 9: $\hat{\sigma}_U = 2.303$. This second estimate, however, is itself affected by the simultaneous equation bias and is thus an unreliable estimate of σ_U . Neglecting this problem, we have $\sigma_{GU} \approx 24.43 \rho_{GU}$.

From the results of Appendix I, the asymptotic bias for the estimated coefficients in equation 9 can be approximated as follows: (i) for the coefficient of G/Y in equation 9, by dividing $24.43 \rho_{GU}$ by the estimated variance of the regression equation 10, reported in Table 5; and (ii) for the remaining coefficients, by multiplying the negative of $24.43 \rho_{GU}$ by the ratio between the estimated coefficients in Table 5 and the estimated variance for that same regression.

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