NBER WORKING PAPER SERIES

FISCAL POLICY
AND ECONOMIC GROWTH

Eric M. Engen

Jonathan Skinner

Working Paper No. 4223

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 1992

We are grateful to Brad DeLong, Don Fullerton, Bill Gale, Gerhard Glomm, William R. Johnson, Michael Palumbo, James Poterba, Rati Ram, David Weil, and seminar participants at Princeton University, the University of Virginia, UCLA, the International Monetary Fund, and NBER for valuable suggestions, and to Robert Barro for making his investment data available to us. Phillip Cook provided helpful research assistance. This paper is part of NBER's research programs in Public Economics and Growth. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #4223
December 1992

FISCAL POLICY AND ECONOMIC GROWTH

ABSTRACT

One view of government fiscal policy is that it stifles dynamic economic growth through the distortionary effects of taxation and inefficient government spending. Another view is that government plays a central role in economic development by providing public goods and infrastructure. This paper develops a generalized model of fiscal policy and output growth that allows for (i) a positive or negative effect of government spending on private productivity, (ii) increasing or decreasing returns to scale, (iii) a transition path away from the equilibrium growth path, and (iv) intratemporal tax distortions. Using data from 107 countries during the period 1970-85, and correcting for the potentially serious problem of endogeneity in government policy, we find that a balanced-budget increase in government spending and taxation is predicted to reduce output growth rates.

Eric Engen
Department of Economics
U.C.L.A.
405 Hilgard Avenue
Los Angeles, CA 90024

Jonathan Skinner
N.B.E.R.
1050 Massachusetts Ave.
Cambridge, MA 02138

I. Introduction

There is considerable debate over the effects of government fiscal policy on economic growth, especially in developing countries. One view suggests that cutbacks in government spending are justified by the low productivity and inefficiency of government expenditures and the high welfare cost of taxation. An alternative view is that the government plays a central role in economic development by providing public goods, encouraging productive investment, and providing a socially optimal direction for economic growth.

Three general approaches have been followed to measure the impact of government fiscal policy on economic growth. The first is to simply introduce the average level of government spending or tax rates in cross-country regressions on growth rates. Landau (1983, 1986) found a negative correlation between government fiscal activity and output growth rates, as did studies by Kormendi and Meguire (1985), Grier and Tullock (1989), and others. But it is difficult to know how to interpret these reduced-form equations, especially in light of the standard neoclassical result that taxation and government spending should have no impact on the *growth rate* of national output -- in the long run, they affect only the *level* of output.

Recent "new growth" models of government spending and taxation imply that fiscal policies can have a permanent impact on equilibrium steady-state growth paths.[1] This second approach stresses either the productivity of government spending, or fundamental nonconcavities in the aggregate production function. For example, King and Rebelo (1990) suggest that the impact of distortionary taxation on output growth rates far exceeds that of traditional Harberger measures. Jones, Manuelli, and Rossi (1991) and Glomm and Ravikumar (1991) find large growth effects in models where government spending is a productive investment input.

Their theoretical approach relies on equilibrium conditions to derive empirically tractable estimating equations. However, empirical evidence suggests that fiscal policy is far from a steady state. Consider, for example, the share of government spending in GNP. In equilibrium, this ratio is constant over time. But in a sample of 107 countries between 1970-85, the standard deviation in the growth rate of the government share was 2.4 percentage points. Equilibrium models of growth, by definition, cannot account for such *changes* in government fiscal policy. A third approach is therefore to relax the equilibrium assumption and allow countries to be on a transition path in which the share of government spending and taxation may vary over the sample

---

[1] For a partial list of studies, see Barro (1990, 1991b), Jones and Manuelli (1990), King and Rebelo (1990), King and Robson (1989), Rebelo (1990), Jones, Manuelli, and Rossi (1991), and Glomm and Ravikumar (1991). See Plosser (1992) for a good overview of this approach.

period. This was the approach taken by Ram (1986), who found a strong and significant positive effect of government spending growth on output growth.

This paper attempts to integrate these three approaches by specifying a generalized model of production that allows for transition growth paths as well as production functions exhibiting increasing returns to scale. We focus on how government fiscal policies affect allocative efficiency conditioning on capital accumulation and labor supply.[2] In this general model, the growth rate and the level of government fiscal policy can affect output growth. We provide an empirical test of the model using cross-section data on 107 countries with a newly constructed series of overall tax rates. To account for heterogeneity across countries, regression coefficients are estimated that allow for correlated random coefficients and country-specific data quality. Finally, we treat the potentially serious problem of endogeneity between government fiscal policies and output growth rates by using the White (1982) two-stage instrumental variable (2SIV) procedure.

Empirical results using data on growth rates over the period 1970-85 suggest a significant and negative impact of government fiscal activity on output growth rates in both the short-term and the long-term. There is a pronounced negative

---

[2] Levine and Renelt (1992), for example, suggest that this approach shows more promise empirically than the alternative of measuring how fiscal policy affects the supply of labor or capital.

medium term (15 year) impact of tax increases on output growth; a 10 percentage point tax increase is predicted to reduce output growth by 3.2 percentage points per annum. The long-term effects are large as well; a 10 percent balanced budget increase in government spending and taxation is predicted to reduce output growth by 1.4 percentage points per annum, a number comparable in magnitude to results from the one-sector theoretical models in King and Robello (1990). Our results are in contrast to many of the "new growth" models, however, in finding that government spending, rather than tax rates, have the greatest long-term negative impact on private sector productivity. Finally, we show that endogeneity in fiscal behavior is a potentially important problem in cross-country regressions; the Ram (1986) finding that government spending spurs economic growth is not supported in the instrumental variables estimation approach.

II. Research on Fiscal Policy and Growth: Theory and Evidence

Whether governments are necessary agents for promoting economic growth or intrusive institutions which drain free market economies of their dynamic strength has been one of the more hotly debated issues of the past decade. A number of recent studies have attempted to shed light on this issue. We separate our review into studies of government spending, and then studies of taxation.

A. Government Spending and Output Growth

Landau (1983, 1986), Grier and Tullock (1989), and Barro (1991b) found a consistently negative impact of the share of government spending on output growth rates, lending support to the notion that smaller government sectors are associated with faster growth rates.[3] Grier and Tullock (1989) also estimated that a change in the share of GDP devoted to government spending reduced significantly the rate of output growth. One interpretation of this result is that government spending is bad for output growth. Another is that the negative coefficient is an artifact of a spurious correlation between output growth and changes in the share of government spending; an unusually high level of output growth tends to depress the rate of change in the government share.[4] One method for correcting this bias is to use instrumental

---

[3] Kormendi and Meguire (1985) found smaller effects of government spending on output growth. Landau (1986) also estimated how particular uses of government spending affected growth rates. In particular, spending on military and education was estimated to have little effect on output growth, while other categories exerted a generally negative effect. Also see Barro (1991a) for similar estimates.

[4] Letting Y denote output, G government spending, and Δ the first-difference operator, note that the change in the government share of GDP can be expressed as $\Delta(G/Y) = \Delta G/Y - (G/Y)\Delta Y/Y$. Hence one might anticipate a negative correlation between changes in the government share and output growth $\Delta Y/Y$ if Y were measured with error or subject to exogenous shifts.

variables for changes in the government share, a strategy we pursue below.

Levine and Renelt (1992) have shown that many of the estimated partial correlations between output growth and various explanatory factors can be quite fragile with respect to specification of the model. For example, they found that the share of government spending was negatively correlated with output growth rates, although the significance of the result depended on whether other variables, such as the growth in domestic credit, were also included.[5]

Aschauer (1989) stresses the importance of distinguishing between government consumption and government capital accumulation such as infrastructure. His empirical work suggests that the government capital stock has a positive impact on productivity growth; in related work, he finds a much smaller impact on output of government consumption (Aschauer, 1988). Barro (1990) formalized the Aschauer view by including government spending in the aggregate production function. In his model, the return to capital exhibits diminishing returns to scale holding government

[5] Their results underscore the importance of specifying an underlying model that identifies which factors are endogenous. For example, even if the share of government spending were exogenous and negatively correlated with output growth, including potentially endogenous variables such as the growth in domestic credit on the RHS of the equation could lead one to incorrectly identifying the government share variable as "fragile."

spending constant, but together they show constant returns to scale. Fiscal policy will therefore affect the equilibrium growth path owing to the absence of long-run diminishing returns.

An alternative specification of the output growth model is presented in Ram (1986), who develops a general model of government and private output along the lines of Feder (1982), and estimates that governments have a positive and highly significant impact of government spending on output growth rates.[6] It is interesting to note that the (first-differenced) Barro (1990) production function is just a special case of Ram's estimating equation. An obvious shortcoming with Ram's econometric estimates is endogeneity; countries that grow fast also tend to increase government spending (see Rao, 1989) although Ram (1989) failed to rejected the hypothesis of exogeneity using standard Hausman tests.

Dowrick (1992) extended the Ram model to allow for technological growth, and showed that at a theoretical level, both the level and the growth rate of government spending should affect output growth. He found strong evidence of endogeneity in the growth of government spending, but not in the level of government spending. There was little evidence

---

[6] Ram (1986) defines GDP as the sum of government and private "output." It is not clear what government output corresponds to in national income accounting, since by definition, the government's contribution to output is the payroll of government employees. We focus instead on the "external" effect of government spending on private output also discussed in Ram (1986).

that either the growth of government spending or the level of government spending had a significant impact on output growth rates. The nominal government share -- used as a proxy for the tax or financing requirements of the government -- exerted a larger and significant negative effect on output growth.

B. Taxation and Output Growth

In general, studies of taxation suggest that it has a negative impact on output growth. Koester and Kormendi (1988) showed using cross sectional regressions that the marginal tax rate -- conditional on fixed average tax rates -- has an independent, negative effect on output growth rates.[7] Skinner (1988) used data from African countries to conclude that income, corporate, and import taxation led to a greater reductions in output growth than average export and sales taxation. Dowrick (1992) also found a strong negative effect of personal income taxation, but no impact of corporate taxes, on output growth in a sample of OECD countries between 1960 and 1985.

Chamley (1981) and King and Rebelo (1990) have demonstrated that in a nonconcave growth model, tax policy can have a potentially large impact on long-term growth rates. For example, the King and Rebelo baseline simulations suggest

---

[7]Also see Kormendi and McGuire (1985) and Grier and Tullock (1989) for cross-country regressions which focus on how inflation and monetary policy affects output growth. However, inflation may be endogenous if it reflects government financial distress.

a ten-percentage point increase in the tax rate will reduce output growth rates by nearly two percentage points. The intuition in this model (and Barro's model) is that taxes create a wedge between the gross and net return on saving. Since individuals are assumed to live forever, they are very sensitive to the net return on saving. Without the usual stabilizing impact of traditional neoclassical production functions (the lower capital-labor ratio increases the gross interest rate, which partially offsets the initial decline in saving), the tax effects on investment and saving are strong and persistent.[8]

The focus of the model presented below is different. We define a generalized production function, and hence take an agnostic stance on the nature of increasing or decreasing returns to capital or labor. Taxes affect intratemporal production decisions rather than intertemporal choices as in Barro (1990) or King and Rebelo (1990). That is, we estimate how fiscal policy affects output growth conditioning on investment and labor supply. We also need not assume an equilibrium growth path, so that empirical estimates are not restricted to conform to the stringent conditions of equilibrium steady states.[9]

---

[8] King and Robson (1989) developed a more complicated model of output growth and tax policy in which the level of technical change is itself a function of new investment.

[9] Is the notion of a "transition" useful in modeling economic growth? There are two opposing views. David (1977) suggests that much of the 19th century in the US

There are two advantages to deriving a specific model of output growth rather than simply running reduced-form regressions. First, the model provides guidance on the proper specification of the model; government levels of spending and taxes are shown to enter as interactive terms rather than entering linearly in the regression equation. Second, the estimated coefficients can yield rough estimates of the behavioral parameters of the theoretical model, such as the sensitivity of factor supply to changes in tax distortions. The disadvantage of our model is that we cannot sharply distinguish among the competing models of growth, nor can we estimate how tax policy affects labor supply or investment decisions.

III. The Theoretical Model

Assume that the economy consists of a taxed and an untaxed (or more generally, a lightly-taxed) sector. In developing countries, the untaxed sector is often small-scale trade or services, or smallholder agricultural output, while the taxed sector comprises manufacturing or large scale exporting industries subject to import taxation (of intermediate inputs), corporate taxes, payroll taxes, and excise taxes on their

---

was characterized by a transition from a low to a high capital intensity economy. King and Rebelo (1989) downplay the importance of transitions, suggesting on theoretical grounds that transition paths in the orthodox neoclassical model are inadequate for explaining post-war empirical growth patterns.

outputs. The tax "wedge" in more developed countries corresponds to the taxation of corporate income, the taxation of salaried earnings, and inter-asset capital tax distortion. In the model below, taxation affects output primarily by distorting production decisions as factor inputs are attracted from the taxed to the untaxed sector. Since the net return to factor payments will tend towards equality between the two sectors, the gross, or social return in the untaxed sector will be less than that in the taxed sector. Hence, by encouraging the flow of inputs into the least productive sector (e.g., import substitution industries, lightly-taxed services, "underground" economies), the overall output of the economy -- given inputs of capital and labor -- will be reduced. To allow for production "linkages" between the two sectors, we write the sum of output from both sectors, Y, as a general function of private inputs and government services;

$$Y = H(K_n, L_n, K_x, L_x; g) \tag{1}$$

where L_i and K_i measure labor and capital in the taxed (x) and untaxed (n) sectors, and g is the share of government expenditures on goods and services to total output.[10] We assume that government services affect the productivity of individual factors proportionately;

[10] There is some ambiguity as to which sector the government -- defined in GDP statistics simply as the public payroll -- should be included. In the empirical section, we find that estimated coefficients are not affected by where one includes it.

$$Y = H(\psi_k K_n, \psi_l L_n, \psi_k K_x, \psi_l L_x). \quad (2)$$

where $\psi_i = \psi_i(g)$, for i = l (labor) or k (capital). That is, ψ_i affects (either positively or negatively) the efficiency "units" of capital and labor. Note that this assumption places no restrictions on the nature of H with respect to capital and labor; for example, H may exhibit increasing returns to scale. By providing goods and services, the government enables private factors to increase their productivity (this is the "spillover" effect discussed by Ram, 1986; also see Barro, 1991b). An example of spillover effects comes from the World Development Report (1988);

> According to the Nigerian Industrial Development Bank (NIDB), frequent power outages and fluctuations in voltage affect almost every industrial enterprise in the country. To avoid production losses as well as damage to machinery and equipment, firms invest in generators.... One large textile manufacturing enterprise estimates the depreciated capital value of its electricity supply investment as $400 per worker.... Typically, as much as 20 percent of the initial capital investment for new plants financed by the NIDB is spent on electric generators and boreholes (World Bank, 1988; p. 144)

That is, when the government of Nigeria did not provide the necessary electricity supply, private firms were forced to generate electricity on their own, and presumably at much higher cost. Conversely, government expenditures on these services reduces the costs of investment, and increases the "effective" units of capital ψK, and hence the rate of return on a given dollar of investment, by 20 percent. For this reason, equation (2) models government spending as a factor which affects the productivity (positively or negatively) of private factor inputs.

Taking the total differential of (2) with respect to changes in inputs and the share of government spending in total output yields

$$\dot{Y} = \psi_k^*(g)\left[H_{kn}\dot{K}_n + H_{kx}\dot{K}_x\right] + \psi_l^*(g)\left[H_{ln}\dot{L}_n + H_{lx}\dot{L}_x\right] + \theta^*(g)\dot{g} \quad (3a)$$

where

$$\psi_i^* = \psi_i\left[1+\left(\frac{\psi'_i}{\psi_i}\right)gh_i\right]^{-1} \quad (3b)$$

$$\theta^* = \psi'_k\left[H_{kx}K_x+H_{kn}K_n\right] + \psi'_l\left[h_{lx}L_x+H_{ln}L_n\right] \quad (3c)$$

and H_{ij} is the derivative of H with respect to the input i = k,l for sector j = n, x, ψ' is the first derivative of ψ, θ^* is the marginal productivity of increasing g, and h_i is the share of factor income received by capital (i=k) and labor (i=l).[11]

The model shows a divergence between the private marginal product ψH_{ij} and the social marginal product $\psi^* H_{ij}$. The intuition is that increased private production places a strain

[11]For example, $h_l = \psi_l[H_{lx}L_x + H_{ln}L_n]/Y$.

on government services (i.e., more wear on roads, more use of electricity); unless government spending keeps pace with private output, aggregate productivity will fall (Barro, 1990). Thus far, taxes have not entered the equation which explains output growth rates. As discussed above, taxes affect production by discouraging production in the highly-taxed sector and encouraging the flow of inputs to the lightly taxed sector. If individuals equate the net rates of return to capital, or to labor, then the gross return in the taxed sector will generally be higher than the gross (and net) return in the untaxed sector. To show this more formally, let the shares of capital and labor in the two sectors be a function of the distortionary tax rate, summarized by τ. That is, define:

$$L_x = \mu_l(\tau)L \qquad L_n = [1-\mu_l(\tau)]L \tag{4a}$$

$$K_x = \mu_k(\tau)K \qquad K_n = [1-\mu_k(\tau)]K \tag{4b}$$

where μ_l and μ_k are the share of labor and capital in the taxed sector, and L and K represent aggregate labor and capital. Taking the total differential with respect to inputs and the tax rate;

$$\dot{L}_x = \mu_l(\tau)\dot{L} + \mu_l'L\dot{\tau} \qquad \dot{L}_n = [1-\mu_l(\tau)])\dot{L} - \mu_l'L\dot{\tau} \tag{5a}$$

$$\dot{K}_x = \mu_k(\tau)\dot{K} + \mu_k'K\dot{\tau} \qquad \dot{K}_n = [1-\mu_k(\tau)]\dot{K} - \mu_k'K\dot{\tau} \tag{5b}$$

where $\dot{\tau}$ is the change in the tax rate over time and $\mu_i' = \partial\mu_i/\partial\tau$. If the allocation of factor supplies is sensitive to relative price differences in the two sectors, then $\mu_i' < 0$. Substituting (5a) and (5b) into (3a), and dividing through by Y to express the dependent variable as the rate of output growth, yields

$$\frac{\dot{Y}}{Y} = \alpha(g,\tau)\frac{\dot{K}}{Y} + \beta(g,\tau)\frac{\dot{L}}{L} + \theta(g)\dot{g} + \omega(g,\tau)\dot{\tau} \qquad (6)$$

where

$$\alpha(\tau,g) = \psi_k^*(g)[H_{kn} + \mu_k(\tau)(H_{kx}-H_{kn})]$$
$$ß(\tau,g) = \psi_l^*(g)[H_{ln} + \mu_l(\tau)(H_{lx}-H_{ln})](L/Y)$$
$$\theta(g) = [\psi_k'/\psi_k]h_k + [\psi_l'/\psi_l]h_l = \theta^*(g)/Y$$
$$\omega(\tau,g) = [\mu_k'\psi_k^*(g)(H_{kx}-H_{kn})K/Y + \mu_l'\psi_l^*(g)(H_{lx}-H_{ln})L/Y].$$

The coefficients α and ß are the marginal productivity of capital and the output elasticity of labor, θ can be interpreted as the weighted output elasticity of a change in government expenditure share (g), while ω is a measure of the distortionary impact of taxation on output growth; because μ_k' and μ_l' are assumed to be negative and the factor marginal product in the taxed sector should be greater than in the untaxed sector ($H_{ix} > H_{in}$, i=l,k), ω should be negative also. Government spending g affects each variable directly through ψ_i^*, while the tax rate τ affects the allocation of production in the taxed and untaxed sector.

For example, consider an initially untaxed equilibrium in which the net rate of return on investment $\bar{H}_k$ is the same in the x and n sectors. A tax τ introduces a divergence between the net returns in each sector, and suppose that over a period of time, net returns are equalized where $H_{kx}(1-\tau) = H_{kn}$. If μ_k is negatively related to the tax rate (as would be expected) then the overall marginal productivity of capital declines as factors flow to the less efficient (untaxed) sector.[12]

To this point, the analysis has focused on a single country. It is likely, however, that α, ß, θ, and ω will differ across countries for a variety of reasons. First, as noted in the model, capital productivity and labor elasticity measures α and β will be affected by τ and g. Second, the parameters often depend on factors that we cannot measure, such as $\mu_j(\tau)$, j = x,n, or on unobservables, all of which differ across countries. The coefficients α, ß, and ω are modeled as random coefficients linearly correlated with τ and g, while θ is assumed to be random but linearly correlated with g only;

$$\alpha_i = \bar{\alpha} + \lambda_1\tau_i + \delta_1 g_i + v_{1i} \tag{7a}$$

$$\beta_i = \bar{\beta} + \lambda_2\tau_i + \delta_2 g_i + v_{2i} \tag{7b}$$

$$\omega_i = \bar{\omega} + \lambda_3\tau_i + \delta_3 g_i + v_{3i} \tag{7c}$$

$$\theta_i = \bar{\theta} + \delta_4 g_i + v_{4i} \tag{7d}$$

where the coefficient subscripts, i, represent each country, and v_{ij}, j = 1,...,4, are the country-specific random effects. By combining (7a)-(7d) with equation (6), and using vector notation, output growth ($\dot{y} \equiv \dot{Y}/Y$) can be expressed as follows:

$$\dot{y} = X\Gamma' + e \tag{8}$$

---

[12] Suppose further that H_{kx} rises by $(1/2)\tau$ over $\bar{H}_k$, H_{kn} falls by $(1/2)\tau$, and that μ_k, the share of investment flowing to the taxed sector, is 1/2. When μ_k falls to 1/3 as a consequence of a tax wedge of 40 percent, the marginal productivity of capital, α, declines to $.93\bar{H}_k$ (i.e.; $[1.2(1/3)+.8(2/3)\bar{H}_k)$.

where, dropping country subscripts for simplicity,

$$X = \left[\frac{I}{Y} \;\; \frac{\dot{L}}{L} \;\; \dot{g} \;\; \dot{\tau} \;\; g\frac{I}{Y} \;\; \tau\frac{I}{Y} \;\; g\frac{\dot{L}}{L} \;\; \tau\frac{\dot{L}}{L} \;\; \tau\dot{\tau} \;\; g\dot{\tau} \;\; g\dot{g} \right] \tag{9a}$$

$$\Gamma = \left[\overline{\alpha} \;\; \overline{\beta} \;\; \overline{\theta} \;\; \overline{\omega} \;\; \delta_1 \;\; \lambda_1 \;\; \delta_1 \;\; \lambda_2 \;\; \delta_3 \;\; \lambda_3 \;\; \delta_4 \right] \tag{9b}$$

and

$$e = \frac{-\rho K}{Y} + \left[\frac{I-\rho K}{Y}\right]v_1 + \frac{\dot{L}}{L}v_2 + \dot{\tau}v_3 + \dot{g}v_4 + \varepsilon$$

Net investment, or net capital growth K_i is expressed as $I_i - \rho_i K_i$, where I_i measures gross investment and ρ_i the country-specific depreciation rate.[13] The variance-covariance matrix of the error terms $\{\rho \;\; v_1 \;\; v_2 \;\; v_3 \;\; v_4 \;\; \varepsilon\}$ may be correlated within a country, but are assumed uncorrelated across countries. Further issues in the estimation of this model are discussed in the next section.

IV. Econometric Issues

There are at least two potential problems with the estimation of this model. First, it is clear that the error term e_i is heteroscedastic. Second, the growth of the government

---

[13] We assume that private and government investment yield the same return owing to lack of reliable data on government investment.

spending share, $\dot{g}$, and the growth in the tax rate, $\dot{\tau}$, may be correlated with the error term e.[14] We address both of these problems by using the Two-Stage Instrumental Variables (2SIV) technique developed by White (1982). He has shown that this procedure is more efficient than 2SLS and provides a straightforward way of estimating the variance-covariance matrix to correct for heteroscedasticity.[15] We first estimate Γ_1 using a standard 2SLS procedure. Letting Z be the vector of instrumental variables and $\hat{u}_i$ the predicted residual for country i from this first stage equation, the second stage coefficients are $\hat{\Gamma}_2 = (X'P_vX)^{-1}X'P_vy$, where $P_v = Z(Z'\Omega^{-1}Z)^{-1}Z'$. Finally, the variance-covariance matrix of the estimate $\hat{\Gamma}_2$ is $n(X'\hat{Z}\Omega^{-1}Z'X)^{-1}$, where $\Omega = [\text{diag}\{\hat{u}_1^2, \hat{u}_2^2, \ldots, \hat{u}_n^2\}]/n$.

We focus now on the instruments, Z, which are correlated with the potentially endogenous variables ($\dot{g}$ and $\dot{\tau}$), but are deemed exogenous to output growth. A number of studies have modeled the (endogenous) choice of taxation and

---

[14]Landau (1986) has recognized the problem of endogeneity, and attempted to correct for it by using lagged values of government activity as an instrument for the current endogenous variable. However, predetermined (lagged) variables cannot be used as instruments if (as is likely) there is serial correlation in growth rate error terms.

[15]See Bowden and Turkington (1984), chapter 3 for a more detailed discussion of generalized instrumental variables estimation.

spending levels. Kelley (1976) explained government spending as a function of factors such as the dependency ratio (the percent of the population under age 15 or over age 64), the percentage of population urbanized, density, and per capita income. Bolnick (1978) analyzed tax patterns across countries in a simultaneous model structure; "demand" factors which would tend to increase government spending and taxation were similar to the variables used in Kelley, but Bolnick also included variables reflecting "supply" factors -- the ease of tax collection. These variables included literacy rates and the percent living in urban areas. A similar supply approach was used by Riezman and Slemrod (1987), who suggested that factors such as literacy rates, percent agriculture, percent urban, and other factors could explain countries' choices between trade taxes (with relatively easy collection costs) and other types of taxes. We use demographic variables (population size, percent urbanization, population density, population age ≤ 14, population age ≥ 65, and the literacy rate in 1970) and predetermined economic variables (government expenditure share in 1970, and average tax rate in 1970) as instruments for the endogenous fiscal policy variables, $\dot{g}$ and $\dot{r}$, in the output growth equation. We do not use lagged endogenous variables as instruments because of potentially serious biases in the presence of fixed effects or serially correlated error terms, nor do we use economic variables such as the size of the agricultural, foreign trade, and manufacturing sector (especially in first differences) as instruments since they may be simultaneously determined with output growth rates. Finally, a number of other factors, such as credit expansion, inflation, and political stability, are excluded from the regressions because of potential endogeneity.[16]

V. Data and Estimation

The econometric analysis used data during the period 1970-85 from a data set published by Summers and Heston (1988). Tax data is not available for many countries previous to 1970, so data for the 1960s in the Summers and Heston data set could not be used. Tax rates were compiled primarily from an unpublished IMF data source, but were supplemented from World Bank, OECD, and United Nations publications when overlapping data was consistent. Because of incomplete tax data, this paper includes cross-section results for 107 of the 115 countries reported in Summers and Heston. The 15-year time period is presumably long enough to net out the effects of short-term fluctuations of government spending and taxes on growth rates. Average tax rates are calculated as total tax revenue divided by GDP using tax revenue data from OECD National Accounts for the developed countries and IMF data for

---

[16] For example, Alesina, Ozler, Roubini, and Swagel (1991) found some evidence suggesting that low output growth increased the chance of political instability. They found evidence that political instability reduced growth rates even after correcting for the endogeneity.

developing countries. For a few countries tax rates were calculated using 1971 or 1972 beginning points and adjusted for the shorter time period due to the lack of earlier data. Although the model suggests that the appropriate tax rates are the effective marginal tax rates on capital and labor in different sectors of the economy, a single average tax rate is all that is available.

Output growth $\dot{y}$ is defined to be the average annual logarithmic change in GDP over the 1970-85 period. The variables I/Y, $\dot{L}/L$, $\dot{g}$, and $\dot{\tau}$ were constructed using the averages of the ratio of domestic investment to GDP, the growth rate in the work force between ages 15 and 64, the percentage point change in the ratio of government spending to output, and in the ratio of tax revenue to output, respectively. We include the average literacy rate and the average fraction of the eligible population (age 12 to 17) enrolled in secondary school as a rough measure of the external effects of education stressed by Lucas (1988), or the importance of human capital accumulation in Mankiw, Romer, and Weil (1991) and Barro (1991a).[17] A number of authors have also noted evidence favoring convergence (that is, a negative correlation between

---

[17] One might expect on theoretical grounds that the literacy rate coefficient would be negative holding constant secondary schooling. Schooling augments the stock of human capital. Deaths depreciate the stock of human capital. If the general population, or more specifically, those who die, are more literate than newly graduated students, there is a net loss in average literacy rates.

initial income and output growth rates) conditioning on investment and labor growth (Barro, 1991a; Mankiw, Romer, and Weil, 1992), so we also include the log of per capita income in 1970, LY, in many of the regressions. While these variables are not explicitly a part of our theoretical framework, they may be correlated with the error term in explaining output growth. As we show below, these additional factors make little difference in interpreting the coefficients on fiscal policy variables. All variables are summarized in Table 1 with their mean values and standard deviations.

We begin with three simple graphs showing how the share of government spending (Figure 1), the growth rate in government spending (i.e., $\Delta G/Y$) (Figure 2), and the average tax rate are correlated with output growth rates (Figure 3). Asterisks denote Latin American countries, squares denote African countries, and triangles denote all other countries. There is a weak negative correlation between the share of government spending and output growth except in African countries. The growth rate is positively correlated with output growth for all subsections of the world, which is consistent with the Ram (1986) result. Finally, there is a weak, possibly nonlinear, correlation between output growth and taxation, although for Latin America the negative correlation seems quite strong. We return to regional differences in Table 4 below.

The simplest benchmark equation using all 107 countries expresses output growth as a function of labor and capital growth, with the absolute value of t-statistics (reported in parentheses) in this and all other OLS regressions corrected for heteroscedasticity (White,1980);

$$\underset{}{\dot{y}} = \underset{(2.30)}{0.057} + \underset{(3.73)}{0.129(I/Y)} + \underset{(3.97)}{0.463(\dot{L}/L)} +$$

$$\underset{(0.79)}{0.010LIT} + \underset{(1.86)}{0.026SEC} - \underset{(2.94)}{0.011LYPOP}$$

The implied marginal productivity of capital is 12.9 percent, while the labor elasticity is estimated to be 0.463. The log of per capita income in 1970 (LY) is negative and significant, while secondary schooling (SEC) is weakly significant and positive but literacy (LIT) is not significant. These variables combined account for 26 percent of the variance in output growth.

Table 2 presents the regression results which include government spending and taxation variables, again for the entire cross-section sample of 107 countries. Column (1) reports coefficients for a standard OLS regression. The coefficient on tax growth is negative and significant, which is consistent with the theoretical model. The coefficient on $\dot{g}$, -0.109, is negative, which seems surprising in light of theoretical models implying that government spending (holding taxation constant) should increase output. However, there are at least two factors that would bias this coefficient. The first is, as noted above, a possible spurious negative correlation between $\dot{g}$ and $\dot{y}$ by the construction of $\dot{g}$. The second is that worsening deficits -- e.g., faster growth in government spending holding constant taxation -- would tend to signal (rather than cause) financial and economic distress.[18] For these reasons, we turn to the 2SIV approach that corrects for both types of bias, with coefficients presented in column 2 of Table 2.[19] We also include the (log) level of initial per capita income in 1970 in this and subsequent regressions. The coefficient on government spending growth is essentially zero, while the predicted impact of an increase in tax rates, $\dot{\tau}$, is large, -0.654, and highly significant.

The full model with the level and the growth rate of fiscal variables is presented in subsequent columns of Table 2; the OLS results are presented in column (3) while the 2SIV results are in column (4). We have suppressed the interactive terms $\tau\dot{\tau}$, $g\dot{\tau}$, and $g\dot{g}$ from equation (9a) because they were insignificant at the 95 percent level in a joint F-test and do not significantly alter the other estimated coefficients. Focusing on the 2SIV results, there is a negative but insignificant impact of

---

[18] Note that strictly speaking, the deficit is not $g - \tau$ since g includes only goods and services purchased and not transfer payments.

[19] In the first-stage regressions the adjusted R^2 is .17 for the growth in tax rates, and .70 for the growth rate of government expenditures. These results suggest that the sets of instruments used for these two endogenous variables are "good", in the sense that they are significantly correlated with the variable that they are instruments for (Nelson and Startz, 1990).

increasing the government share on output growth. Increasing the tax share is still predicted to reduce output growth; the coefficient implies that in the medium (15 year) term, raising the share of taxes to GDP by 10 percentage points will reduce output growth in the medium term by 3.2 percentage points.

It may be more useful for policy purposes to focus on the long-term effects of government spending and tax policy and ignore the medium term effects of changes in fiscal policy. As noted in Section III, we model fiscal policy as affecting factor productivity. Column (4) suggests that government spending and taxation both reduce the productivity of labor and capital, although the interacted taxation coefficients are not jointly significant at the 5 percent level. The coefficients imply that an increase of 10 percentage points in g and τ reduce the marginal productivity of capital by 2 percentage points, and the marginal elasticity of labor output by 0.26. Equivalently, the overall impact of a one-percentage point increase in g and τ, evaluated at mean values of the data, is to reduce output growth by 1.4 percentage points (with a standard error of 0.49 percentage points). The theoretical one-sector model by King and Rebelo (1990) predicts that a growth in taxation by 10 percentage points will reduce output growth by almost 2 percentage points (or more depending on the structure of the model). Hence our estimates are of similar magnitude to King and Rebelo's predictions, although for a different reason. King and Rebelo predict that the tax wedge will reduce saving, and hence reduce output growth rates as wealth accumulation suffers. By contrast, we condition on capital accumulation and find a strong negative impact of government spending on private productivity. How might this negative effect be explained, given that we are conditioning on tax rates? One possible explanation is that the government objective function includes arguments other than maximizing growth rates. Hence redistributional programs such as public works projects in depressed regions of the country yield positive gains to the government, but retard growth. Finally, Column (5) includes literacy rates and secondary schooling. Only secondary schooling is significant at the 10 percent level, and the coefficients on fiscal policy are essentially unchanged.[20]

Heston and Summers (1988) include a grade on data quality for each country that ranges from A to D. While there is no cardinal scale for data quality, we arbitrarily weight the data by the inverse of the square-root of the grade ($1/\sqrt{1}$ for a grade of A to $1/\sqrt{4}$ for a grade of D) to adjust for data quality. Different scales (i.e., from 1 to 1/4) did not make an appreciable difference for parameter estimates. Table 3 repeats

---

[20] The model focuses on the distortionary effects of taxation in private sector output, so it might be argued that a better measure of GDP would remove the government sector. Because the only contribution of the government to overall GDP is its payroll, we define "private" GDP net of the government payroll. Making this adjustment had little or no effect on the regression results.

the regression specifications from Table 2 only with the weighted data. In general, the coefficients are quite similar but the standard errors yield much tighter bounds.[21] The interacted tax terms, for example, are now jointly significant at the 90th percentile. The predicted impact of a 10 percent balanced-budget increase in government spending and taxes is to reduce output growth by 1.5 percentage points, with a standard error of 0.34 percentage points.

The estimated parameters can be used to cast some light on the magnitude of the behavioral parameters. We use coefficient estimates from Table 3, Column 4 to infer the sensitivity of factor inputs to tax distortions. Suppose that there is equality in the net return to capital, for example, so that $H_{kx}(1-\tau) = H_{kn}$. Then with some rearranging and assumptions about factor productivity, it can be shown that for a wide range of reasonable parameters, either (i) $\mu_k' \approx -1.8$, which implies that a 10 percentage point increase in the tax distortion will reduce investment in the taxed sector by 18 percent, or (ii) there are substantial unmeasured distortions, either in terms of tax rates or barriers to capital flows, between the taxed and untaxed sector of roughly 35 percentage points (holding

---

[21] The stability of coefficients between weighted and unweighted regressions can be viewed as the null of a specification test; see Godfrey, 1988, pp. 152-57.

$\mu_k' = -1.0$).[22] The estimated effects are even larger for labor force growth. In either case, the coefficient estimates imply that tax distortions have a substantial impact on the allocation of investment and labor supply.

One key assumption in cross-country regression models is that the 107 countries are sufficiently similar so that Sierra Leone, for example, can be pooled with Canada in a common regression. To relax this assumption, we consider separate regressions for different regions of the world, and for developed

---

[22] When the net factor returns in each sector are equalized, the expression for the marginal product of capital, from equation (6), may be written

$$\alpha(\tau,g) = \psi_k^*(g)[H_{kn} + \mu_k(\tau)\tau H_{kx}].$$

Assume that changes in H_{kx} and H_{kn} are second order; then one may write

$$\partial\alpha/\partial\tau \approx \psi_k^*(g)\{\mu_k'\tau H_{kx} + \mu_k H_{kx}\}$$

Because the second-term on the RHS is positive, the estimated $\hat{\lambda}_1 = \partial\alpha/\partial\tau$ (from equation 7a) is bounded from below by $\mu_k'[\psi_k^*(g)\tau H_{kx}]$. The expression in the brackets is the gross return in the taxed sector, which is higher than $\bar{\alpha}$, the average rate of return on capital. Assuming that the gross return in the taxed sector exceeds the average by at most 50 percent, then one may measure the responsiveness of factor supply by the ratio $\hat{\lambda}_1/[1.5\tau\bar{\alpha}]$, or, based on the coefficients in Table 3, Column 4, the ratio -0.086/(1.5x0.160x0.197) where τ is evaluated at its mean value in the sample and $\bar{\alpha} = 0.160$ is evaluated at mean values of τ and g. An even more extreme story holds for the effect of taxation on labor supply, yielding an estimated value for $\mu_l' = -9.4$.

and developing countries (as in Grier and Tullock, 1989). To ensure adequate degrees of freedom, we simply include g and τ rather than interacting them as in the text above. Table 4 presents results for these simplified regressions that are weighted by data quality and estimated using 2SIV. The impact of government spending is to reduce output growth in African, Latin American, and developing countries. The only exception is an essentially zero coefficient for the government share coefficient in developed countries. This may reflect the importance of transfer programs, which are not reflected in g (government consumption) but are typically reflected in τ. The negative impact of government spending, and in particular taxation, is particularly strong in Latin American countries. Finally, the effect of growth in the government spending share, and in tax rates, is consistently negative for all regions except Africa.

Our results are at odds with Ram (1986), who found that the growth in total government spending (i.e., $\Delta G/Y$ rather than $\Delta(G/Y)$) has a positive and significant impact on output growth rates. It is possible to derive an estimating equation much like Ram's by rewriting output as a function of G, total (or per capita) government spending rather than the government share g as in equation (1);

$$Y = H(K_n, L_n, K_x, L_x; G) \qquad (1')$$

Glomm and Ravikumar (1991) suggest that specifying the level of government spending G as in (1') makes sense if the government provides a pure public good, while specifying g makes sense if government spending provides an impure public good (or private good) subject to congestion. The production function in Barro (1990), for example, is a special case of (1′).

Regression results for the simplest form of the production implied output growth equation without taxes are shown in the first column of Table 5. The impact of government spending is estimated to be large and highly significant. The coefficient remains large in the OLS regressions for column (2) despite the introduction of the corresponding change in the tax rate $\dot{\tau}$. However, as pointed out by Rao (1989), government spending is likely to be endogenous with respect to output growth. Column (3) corrects for endogeneity using 2SIV; while the coefficient on government spending is still positive, it is no longer significant and less than one-third its previous value in column (1). Furthermore, the predicted effect of a ten percentage point balanced-budget increase in government spending and tax growth is to reduce the medium-term growth rate by 3.6 percentage points. This result holds as well for the more general model presented in Column (4). In short, the evidence presented in Table 5 strongly suggests the importance of correcting for endogeneity in estimating how fiscal policies affect output growth.

One final question is whether the instruments we have chosen are good in the sense that they are correlated with $\dot{g}$ or $\dot{\tau}$, but uncorrelated with the error term in the $\dot{y}$ equation. The unconditional correlation of output growth with the instruments rarely exceeds an absolute value of .15 except for population density (.37) and the tax rate in 1970 (-.18). More formally, we can test whether our assumption of exogeneity of instruments is warranted using the Hansen J-statistic. For all 2SIV regressions shown in Tables 2 through 5, there was no evidence of the exogeneity null being rejected at even the 50% level. In sum, there is no evidence of our instruments being tainted by independent correlation with output growth.

To this point, we have assumed that investment and labor supply are exogenous with respect to tax and spending policy. The "new" growth models suggest that tax policy affects output growth primarily through variations in investment levels (Rebelo and King, 1990; Barro, 1990). Is there any evidence across countries that tax rates are systematically related to investment levels? Two simple scatter diagrams of private investment as a fraction of output (from Barro, 1991b) and average tax rates τ during 1970-85 are shown in Figures 4a and 4b. Each country is weighted either by population (in the top graph) or by the square root of per capita output (the bottom graph), with the corresponding (weighted) predicted regression line included as well. There is a significant *positive* correlation between private investment and tax rates. The result may be explained by higher-income countries both investing more, and imposing higher tax rates. Also, this diagram is not a strong test of the theory, since average tax rates do not necessarily reflect effective marginal tax rates. For example, Summers, Gruber, and Vergara (1991) calculate that the overall tax burden in Sweden is very high, but the effective tax on corporate investment is quite low. Nevertheless, these figures provide little support for the view that taxes affect growth rates primarily by discouraging investment.

VI. Conclusion

The effect of government expenditures and taxation on GDP growth rates is central to many debates in both developing and developed countries. This paper has developed a theoretical model that integrates the effects of government spending, and the distortionary effects of taxation, in a model of output growth. Using a sample of 107 countries during the period 1970-85, we found strong and negative effects of both government spending and taxation on output growth. A balanced-budget increase in government spending and taxation of 10 percentage points was predicted to decrease long-term growth rates by 1.4 percentage points. The implied behavioral parameters from the model suggest that the allocation of factor inputs are sensitive to intrasectoral tax distortions.

The administrative structure of the tax system as well as the size of the tax base are also relevant in assessing the impact of taxation on output. For example, many African countries rely on a small tax base (and high tax rates) to collect a large fraction of their revenue. Such a country may report low average tax burdens despite the presence of substantial distortions. By contrast, a country with a large tax burden that is uniform across sectors would incur little intersectoral distortionary efficiency loss. Measuring a country's effective tax base may provide a better measure of the tax distortion than simply the ratio of tax revenue to GDP.

To this point, we have treated the ratio of tax rates to aggregate output as if it were "the" tax wedge. This is clearly a very rough approximation to the true tax distortions in the economy. Some attempts have been made to compare measures of tax distortion across countries, such as Dunn and Pellechio's (1990) research on effective marginal tax rates on business income across countries and Koester and Kormendi's (1988) measures of marginal tax rates. Plosser (1992) has constructed a graph showing a strikingly negative correlation between average per capita growth rates and average tax rates on income and profits in OECD countries (also see Dowrick, 1992). Finally, taxes on labor income are likely to have quite different effects on output growth than corporate, interest income, or trade taxes. Despite these caveats, the evidence from the empirical record appears to point towards an important role of fiscal policy in affecting output growth.

Bibliography

Alesina, Alberto, Sule Ozler, Rouriel Roubini, and Phillip Swagel, "Political Instability and Economic Growth," mimeo (October 1991).

Aschauer, David, "Public Consumption, Public Investment, and Output in the United States, 1949-1985," Federal Reserve Bank of Chicago Staff Memoranda (1988).

Aschauer, David, "Is Public Expenditure Productive?" Journal of Monetary Economics 23 (March 1989). pp. 177-200.

Barro, Robert J., "Government Spending in a Simple Model of Endogenous Growth," Journal of Political Economy 98 (October 1990, part 2): pp. S103-S125.

Barro, Robert J., "Economic Growth in a Cross-Section of Countries," Quarterly Journal of Economics 104 (May 1991a): 407-444.

Barro, Robert J., "A Cross-Country Study of Growth, Saving, and Government," in B. D. Bernheim and J. Shoven (eds.) National Saving and Economic Performance. Chicago: University of Chicago Press and NBER (1991b).

Bolnick, Bruce, "Demographic Effects on Tax Ratios in Developing Economies," Journal of Development Economics 5 (1978): pp. 283-306.

Bowden, Roger J., and Darrell A. Turkington, Instrumental Variables (Cambridge: Cambridge University Press, 1984).

Carr, Jack L., "Government Size and Economic Growth: A New Framework and Some Evidence From Cross-Section and Time-Series Data: Comment," American Economic Review 79 (March 1989): 267-71.

Chamley, Christophe, "The Welfare Cost of Capital Taxation in a Growing Economy," Journal of Political Economy 89(3): pp. 468-96.

David, Paul, "Invention and Accumulation in America's Economic Growth: A Nineteenth Century Parable," in Brunner and Meltzer (eds.) Industrial Organization, National Priorities, and Economic Development. Amsterdam: North Holland (1977).

Dowrick, Steve, "Estimating the Impact of Government Consumption on Growth: Growth Accounting and Optimizing Models," mimeo, Australian National University (October 1992).

Dunn, David, and Anthony Pellechio, "Analyzing Taxes on Business Income with the Marginal Effective Tax Rate Model," World Bank Discussion Paper No. 79 (April, 1990).

Feder, Gershon, "On Exports and Economic Growth," Journal of Development Economics 12 (1982): pp. 59-73.

Glomm, Gerhard, and B. Ravikumar, "Public Investment in Infrastructure in a Simple Endogenous Growth Model," mimeo, University of Virginia (1991).

Godfrey, L.G., Misspecification Tests in Econometrics. New York: Cambridge University Press (1988).

Grier, Kevin B., and Gordon Tullock, "An Empirical Analysis of Cross-National Economic Growth," Journal of Monetary Economics 24 (1989): pp. 259-276.

Jones, Larry E. and Rodolfo Manuelli, "A Convex Model of Equilibrium Growth: Theory and Policy Implications," Journal of Political Economy (October 1990):

Jones Larry E., Rodolfo Manuelli, and Rossi, "Optimal Taxation in Models of Endogenous Growth," mimeo (1991).

Kelley, Allen C., "Demographic Change and the Size of the Government Sector," Southern Economic Journal 43 (1976): pp. 1056-1066.

King, Mervyn, and Mark Robson, "Endogenous Growth and the Role of History," NBER Working Paper No. 3151 (October 1989).

King, Robert G., and Sergio Rebelo, "Transitional Dynamics and Economic Growth in the Neoclassical Model," NBER Working Paper No. 3185 (November 1989).

King, Robert G., and Sergio Rebelo, "Public Policy and Economic Growth: Developing Neoclassical Implications," Journal of Political Economy 98 (October 1990, part 2), pp. S126-S150.

Koester, Reinhard B., and Roger C. Kormendi, "Taxation, Aggregate Activity and Economic Growth: Cross Country Evidence on Some Supply- Side Hypotheses," Economic Inquiry (1988).

Kormendi, Roger C., and Philip G. MeGuire, "Macroeconomic Determinants of Growth: Cross-Country Evidence," Journal of Monetary Economics 16 (1985): pp. 141-163.

Landau, Daniel, "Government Expenditure and Economic Growth: A Cross-Country Study," Southern Economic Journal 49 (January 1983): pp. 783-92.

Landau, Daniel, "Government and Economic Growth in the Less Developed Countries: An Empirical Study for 1960-1980," Economic Development and Cultural Change (1986): pp. 35-75.

Levine, Ross, and David Renelt, "A Sensitivity Analysis of Cross-Country Growth Regressions," American Economic Review 82(4): pp. 942-63.

Lucas, Robert E., "On the Mechanics of Economic Development," Journal of Monetary Economics (July 1988).

Marsden, Keith, "Links Between Taxes and Economic Growth: Some Empirical Evidence," World Bank Staff Working Paper #605 (August 1983).

Mankiw, N. Gregory, David Romer, and David N. Weil, "A Contribution to the Empirics of Economic Growth," Quarterly Journal of Economics (forthcoming, 1991).

Nelson, Charles, and Richard Startz, "Some Further Results on the Exact Small-Sample Properties of the IV Estimator," Econometrica 58(4) (1990): 967-976.

OECD, Department of Economics and Statistics, National Accounts, 1960-1985, vol. II, Paris, 1986.

Plosser, Charles, "The Search for Growth," mimeo (August 1992).

Ram, Rati, "Government Size and Economic Growth: A New Framework and Some Evidence from Cross-Section and Time-Series Data," American Economic Review 76 (March 1986): pp. 191-203.

Ram, Rati, "Government Size and Economic Growth: A New Framework and Some Evidence from Cross-Section and Time-Series Data: Reply," American Economic Review 79 (March 1989): pp. 281-84.

Rao, V.V. Bhanoji, "Government Size and Economic Growth: A New Framework and Some Evidence From Cross-Section and Time-Series Data: Comment," American Economic Review 79 (March 1989): 272-80.

Rebelo, Sergio, "Long Run Policy Analysis and Long Run Growth," NBER Working Paper No. 3325 (April 1990).

Riezman, Raymond, and Joel Slemrod, "Tariffs and Collection Costs," Weltwirtschaftliches Archiv (1987): pp. 545-549.

Romer, Paul M., "Increasing Returns and Long-Run Growth," Journal of Political Economy 94 (October 1986): pp. 1003-1037.

Romer, Paul M., "Crazy Explanations for the Productivity Slowdown," NBER Macroeconomics Annual, 1987.

Skinner, Jonathan, "Taxation and Output Growth in Africa," Policy, Planning, and Research Working Paper 73, The World Bank (August 1988).

Summers, Lawrence, Jonathan Gruber, and Rodrigo Vergara, "Taxation and the Structure of Labor Markets: The Case of Corporatism," mimeo (May 1991).

Summers, Robert and Heston, Alan, "Improved International Comparisons of Real Product and its Composition: 1950-80," Review of Income and Wealth 30 (June 1984), pp. 207-262.

Summers, Robert and Heston, Alan, "A New Set of International Comparisons of Real Product and Price Levels Estimates for 130 Countries, 1950-85," Review of Income and Wealth 34 (March 1988), pp. 1-25.

United Nations, African Statistical Yearbook, 1970-1985.

________., Economic Survey of Latin America, 1970-1985.

________., Statistical Yearbook for Asia and the Pacific, 1970-1985.

________., Yearbook of National Account Statistics, 1970-1985.

White, Halbert, "A Heteroskedasticity-Consistent Covariance Matrix and a Direct Test for Heteroskedasticity," Econometrica 48 (1980): pp. 721-746.

White, Halbert, "Instrumental Variables Regression with Independent Variables," Econometrica 50 (March 1982): pp. 483-499.

World Bank, World Tables, 3rd ed., Baltimore: Johns Hopkins University Press, 1984.

________., World Development Report (1988).

Table 1: Variables and Summary Statistics

Variable	symbol	mean	std. dev.
real GDP growth rate	$\dot{Y}/Y$	0.033	0.021
investment/GDP	I/Y	0.191	0.077
labor force growth rate	$\dot{L}/L$	0.039	0.018
change in gov. exp. share	$\dot{g}$	0.008	0.024
change in gov. exp./GDP	ΔG/Y	0.007	0.006
change in tax rate	$\dot{\tau}$	0.019	0.018
gov. expend/GDP	g	0.186	0.070
average tax rate	τ	0.197	0.079
literacy rate (1970)	LIT	0.586	0.325
secondary schooling (%)	SEC	0.428	0.290
log(per capita GDP, 1970)	LY	7.341	1.030
population (millions)	POP	25.06	69.31
percent urban	URB	0.445	0.254
population density	DEN	166.6	571.5
percent pop., ≤14 yrs.	POP14	0.381	0.091
percent pop., ≥65 yrs.	POP65	0.056	0.039

Table 2: Unweighted Cross-Section Regression Estimates (N = 107)

Var.	[1] OLS	[2] 2SIV	[3] OLS	[4] 2SIV	[5] 2SIV
I/Y	0.120	0.151	0.170	0.198	0.159
	(5.10)	(4.74)	(3.76)	(5.21)	(3.54)
$\dot{L}/L$	0.434	0.227	0.965	0.811	1.069
	(5.52)	(1.70)	(3.53)	(3.48)	(3.00)
$\dot{g}$	-0.109	-0.044	-0.080	-0.063	-0.113
	(1.46)	(0.47)	(1.03)	(1.14)	(1.16)
$\dot{r}$	-0.308	-0.654	-0.239	-0.327	-0.176
	(3.45)	(3.64)	(3.04)	(2.13)	(1.61)
g(I/Y)			0.003	-0.121	-0.045
			(0.02)	(0.76)	(0.21)
$g(\dot{L}/L)$			-2.317	-1.835	-2.031
			(2.27)	(2.74)	(2.14)
$\pi(I/Y)$			-0.092	-0.086	-0.092
			(0.85)	(0.92)	(0.86)
$\pi(\dot{L}/L)$			-1.169	-0.845	-1.339
			(0.94)	(0.92)	(0.86)
LY		-0.005	-0.008	-0.009	-0.012
		(1.77)	(2.77)	(4.54)	(3.29)
LIT					0.004
					(0.44)
SEC					0.021
					(1.64)
C	0.000	0.049	0.050	0.056	0.065
	(0.02)	(1.92)	(2.20)	(3.31)	(2.30)
$\bar{R}^2$	0.30	0.24	0.41	0.39	0.42

Dependent Variable is the annual log change in real GDP. t-statistics reported in parentheses; standard errors of OLS regressions adjusted using White (1980).

Table 3: Weighted Cross-Section Regression Estimates (N = 107)

Var.	[1] OLS	[2] 2SIV	[3] OLS	[4] 2SIV	[5] 2SIV
I/Y	0.123	0.156	0.199	0.198	0.190
	(8.19)	(7.52)	(5.32)	(5.21)	(5.12)
$\dot{L}/L$	0.418	0.214	0.859	0.811	1.022
	(7.71)	(2.51)	(4.66)	(3.48)	(4.39)
$\dot{g}$	-0.085	-0.018	-0.051	-0.063	-0.080
	(1.93)	(0.32)	(1.09)	(1.14)	(1.41)
$\dot{\pi}$	-0.323	-0.632	-0.257	-0.327	-0.115
	(5.97)	(5.83)	(5.14)	(2.13)	(2.64)
g(I/Y)			-0.116	-0.121	-0.167
			(0.73)	(0.76)	(1.08)
$g(\dot{L}/L)$			-1.892	-1.835	-1.573
			(2.85)	(2.74)	(2.52)
$\pi(I/Y)$			-0.089	-0.086	-0.085
			(1.02)	(0.92)	(0.98)
$\pi(\dot{L}/L)$			-1.027	-0.845	-1.459
			(1.36)	(0.92)	(1.54)
LY		-0.006	-0.009	-0.006	-0.013
		(2.94)	(4.77)	(2.94)	(5.98)
LIT					0.008
					(1.26)
SEC					0.023
					(2.76)
C	0.000	0.049	0.054	0.049	0.070
	(0.02)	(3.15)	(3.90)	(3.15)	(4.18)
$\bar{R}^2$	0.29	0.25	0.40	0.39	0.41

Dependent Variable is the annual log change in real GDP. Weighted by the reciprocal of the square root of the data quality variable reported in Summers and Heston (1988).

Table 4: Cross-Section Regression Estimates

Var.	[1] Entire Sample (N=107)	[2] Africa (N=37)	[3] Latin Amer. (N=24)	[4] Developed (N=21)	[5] Developing (N=86)	[6] All But Africa (N=70)
I/Y	0.177	0.192	0.109	0.046	0.206	0.165
	(10.03)	(7.35)	(3.99)	(1.93)	(12.02)	(7.27)
$\dot{L}/L$	0.328	0.218	0.289	0.304	0.337	0.482
	(4.15)	(1.66)	(2.09)	(1.82)	(4.24)	(4.10)
$\dot{g}$	-0.104	0.193	-0.249	-0.364	-0.105	-0.242
	(1.74)	(1.82)	(3.80)	(2.76)	(1.67)	(3.62)
$\dot{\tau}$	-0.166	-0.025	-0.092	-0.013	-0.060	-0.312
	(2.05)	(1.13)	(0.60)	(0.12)	(1.37)	(3.20)
g	-0.108	0.110	-0.703	-0.000	-0.125	-0.085
	(5.89)	(3.67)	(1.97)	(0.01)	(6.31)	(3.88)
τ	-0.014	-0.021	-0.113	0.115	-0.044	-0.023
	(1.95)	(0.35)	(3.00)	(0.66)	(1.76)	(1.06)
LY	-0.008	-0.012	-0.006	-0.019	-0.009	-0.012
	(3.76)	(2.84)	(1.45)	(4.83)	(3.57)	(4.79)
C	0.071	0.087	0.071	0.177	0.077	0.096
	(4.33)	(3.13)	(2.10)	(4.98)	(4.22)	(5.25)
$\bar{R}^2$	0.39	0.20	0.51	0.43	0.36	0.56

Dependent Variable is the annual log change in real GDP. White (1980) standard errors in OLS regressions. Variables are weighted by the reciprocal of the data quality variable reported in Summers and Heston (1988).

Table 5: Cross-Section Regression Estimates: Alternative Model

Var.	[1] OLS	[2] OLS	[3] 2SIV	[4] 2SIV	[5] 2SIV
I/Y	0.091	0.087	0.110	0.165	0.122
	(5.55)	(5.58)	(6.00)	(4.29)	(7.28)
$\dot{L}/L$	0.208	0.138	0.269	0.572	0.192
	(3.37)	(2.27)	(3.32)	(2.56)	(2.24)
ΔG/Y	1.333	1.360	0.376	0.579	0.626
	(7.22)	(9.35)	(1.43)	(2.49)	(2.63)
$\dot{\tau}$		-0.361	-0.637	-0.395	-0.422
		(7.20)	(6.25)	(3.42)	(4.08)
g(I/Y)				-0.046	
				(0.30)	
$g(\dot{L}/L)$				-1.166	
				(1.71)	
τ(I/Y)				-0.162	
				(1.63)	
$\tau(\dot{L}/L)$				-0.661	
				(0.79)	
g					-0.056
					(3.56)
τ					-0.060
					(3.42)
C	-0.002	0.008	-0.011	0.004	0.028
	(0.58)	(2.11)	(2.01)	(0.67)	(4.41)
$\bar{R}^2$	0.32	0.42	0.28	0.43	0.44

Dependent Variable is the annual log change in real GDP, sample size is 107. White (1980) standard errors in OLS regressions. Variables are weighted by the reciprocal of the square root of the data quality variable reported in Summers and Heston (1988).

Figure 1: GDP Growth Rate and the
Share of Government Expenditure 1970-85

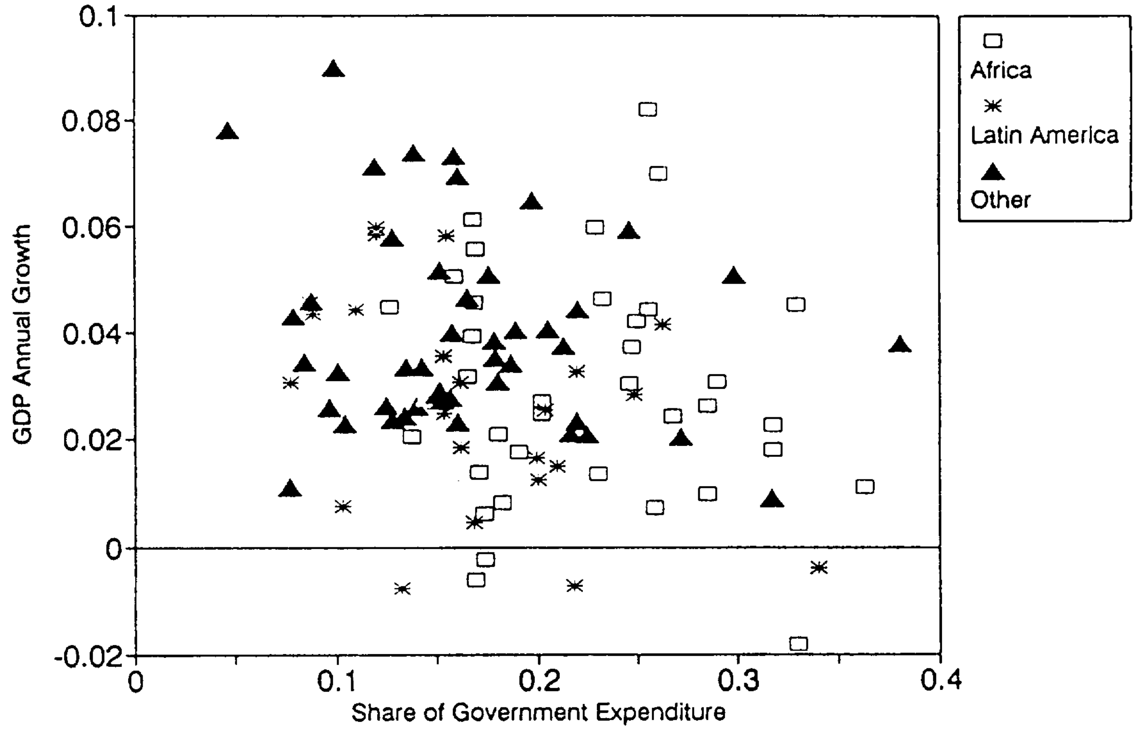

Figure 2: GDP Growth Rate and the
Government Expend. Growth Rate: 1970-85

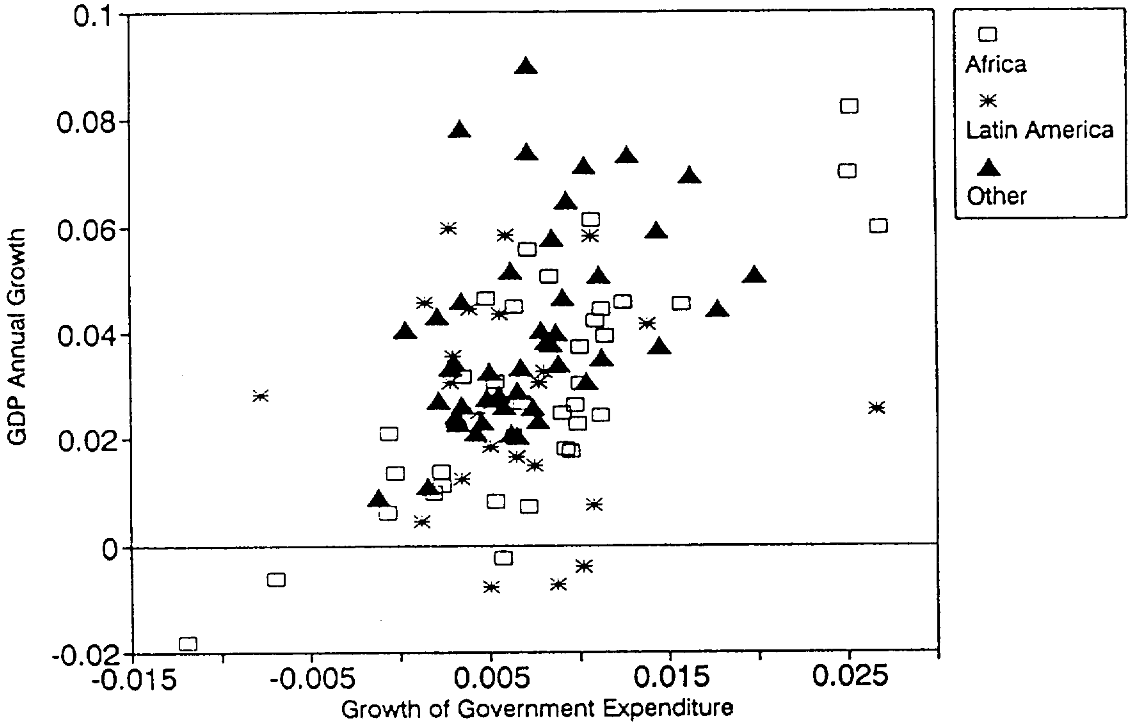

Figure 3: GDP Growth Rate and the Average Tax Rate: 1970-85

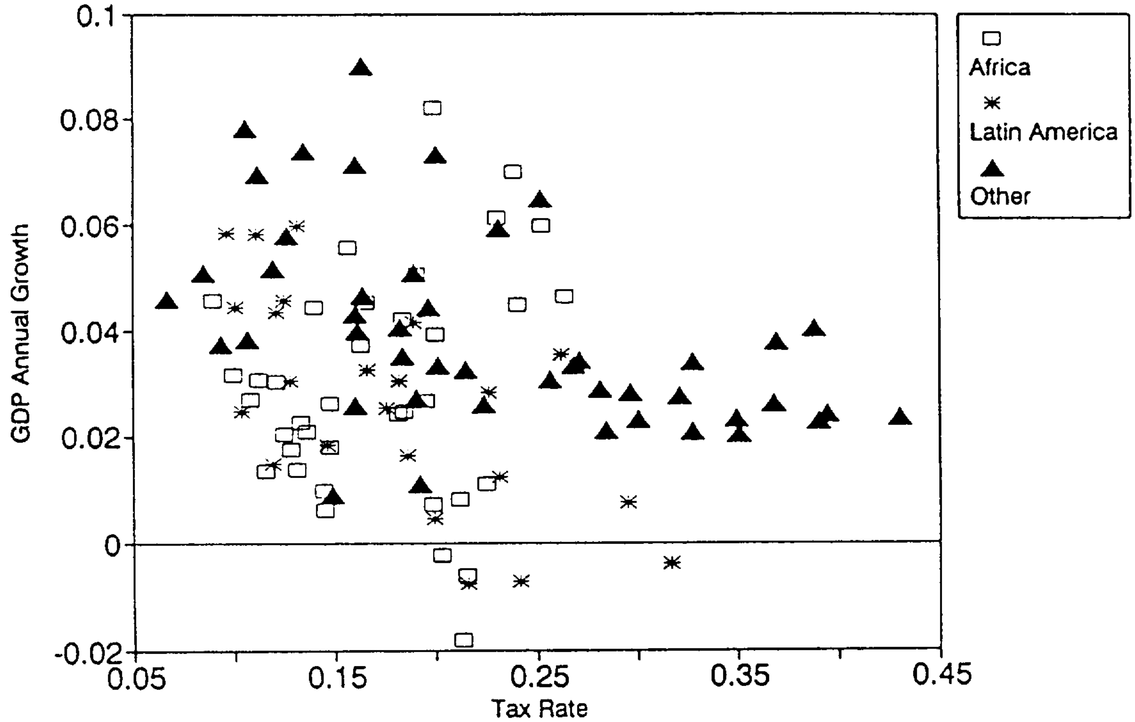

Figure 4a: Private Investment and Tax Rates, 1970-85
[Weighted by Sqrt(population)]

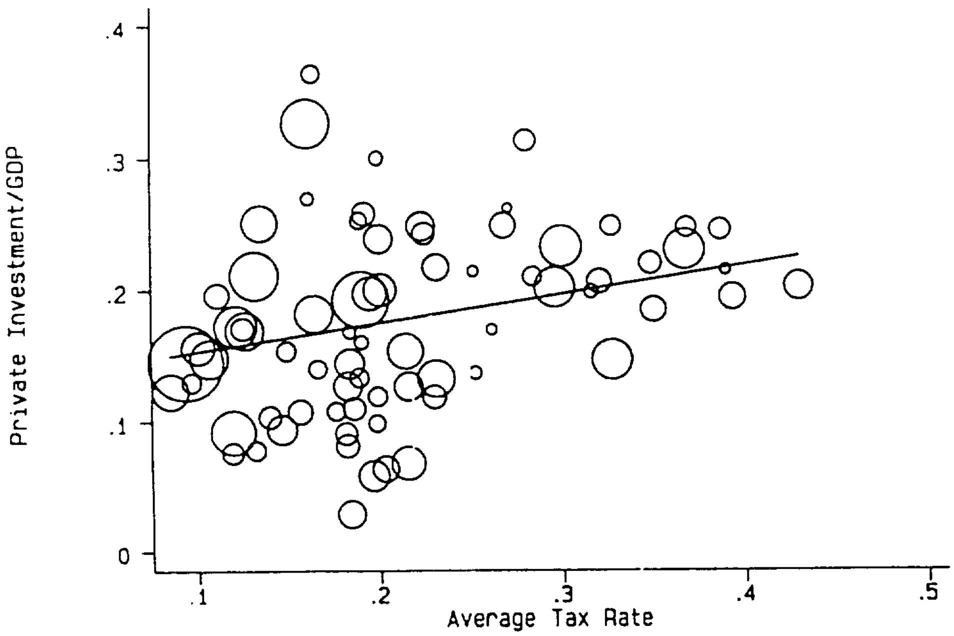

Figure 4b: Private Investment and Tax Rates, 1970-85
[Weighted by Sqrt(per capita income)]