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# TAXATION AND OUTPUT GROWTH: EVIDENCE FROM AFRICAN COUNTRIES

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# Taxation and Output Growth: Evidence From African Countries

## ABSTRACT

There is considerable debate over the appropriate role for tax policy in developing economies. In one view, tax hikes reduce deficits and ease budgetary pressures, thereby encouraging long-term growth. An alternative view emphasizes the distortionary effects associated with increased taxation and the positive benefits of a carefully designed tax system.

This paper tests these propositions by measuring the impact of government taxation and expenditure on aggregate output growth. A theoretical model is derived which shows that the impact of tax distortions on output growth is usually negative. The theoretical model is tested using a pooled cross-section time-series data set for 31 sub-Saharan African countries during 1965-73 and 1974-82.

The regressions imply that the positive benefits of government investment during 1965-73 outweighed the distortionary effects of taxes necessary to finance them. By 1974-82, however, the marginal productivity of government investment had fallen; tax-financed public investment was predicted to have reduced output growth. The empirical results also imply that a revenue neutral shift from the import, corporate, and personal tax to a sales/excise (or consumption) tax will encourage output growth.

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## I. Introduction

What is the appropriate role of tax policy for encouraging economic growth in developing countries? One view is that tax hikes reduce current account deficits and ease budgetary pressures, thereby encouraging investment and long-term growth. In this view, it is less important whether trade, personal, or excise taxes are used to raise revenue, since the effect of tax-induced distortions are thought to be small relative to institutional constraints such as price controls, foreign exchange allocations, and trade quotas.

An opposing view is that high marginal tax rates discourage work effort, squelch new investment, limit foreign trade, and thereby present a major hurdle to economic development. The long-run benefits of low rates, or at least a carefully designed tax structure, are thought to offset the disadvantage of temporary budget deficits (or expenditure cutbacks), and to provide the developing country with the necessary and perhaps sufficient environment to stimulate economic growth.

This paper tests these competing hypotheses in a model that measures the effect of taxation and government expenditures on output growth. Previous studies have developed, and estimated, models of output growth and government expenditure alone (Ram, 1986), or calculated the impact of tax distortions in general equilibrium models (deMelo, 1978; Taylor and Black, 1974; Henderson, 1982). The model presented below provides an integrated framework in which the impact on GDP growth rates of government expenditures, public and private capital accumulation, and sectoral tax distortions are derived in a theoretical model, and estimated using pooled cross-section time-series data for sub-Sahara Africa during 1965-82.

Any study which attempts to relate government fiscal policies with output growth rates must confront the theoretical problem that while taxes and an inefficient government sector may reduce the *level* of GDP, it it is not clear that the *rate of growth* of GDP should be affected. Lucas (1985), and Mãnas-Anton (1985) have emphasized that taxation and (most) government policy will have no effect on long-term growth rates. The first question to be addressed, then, is why should tax rates affect output growth rates?

The answer is that static tax distortions do affect output growth along a transition path -- or a sequenced change in the level of output -- by encouraging the flow of investment and labor supply into sectors which largely escape taxation. The expansion of these lightly taxed (or even subsidized) sectors will lead to lower sector-specific capital and labor productivity. Hence for a given rate of investment and labor supply growth, output growth is likely to decline. If the economy is on a steady-state growth path (although this seems unlikely in Africa), taxation will have no effect. Alternatively, if the lightly-taxed sectors provide positive benefits (e.g., industrial production for export, or which substitutes for imports), then taxes which direct more resources into these socially productive activities can augment output growth rates. Ultimately, the effect of taxation on output growth is an empirical question.

While Landau (1983, 1986) has found an often negative impact of the level of government spending on growth rates, Ram (1986) has emphasized that the *change* in government spending is the theoretically correct factor in explaining a *change* in output. Regressions which follow Ram's formulation indicate that during the period 1965-73, the high marginal return from government investment more than offset the distortionary costs of taxation. During the sharp economic downturns of 1974-82, however, the regression coefficients suggest that public investment did not contribute to GDP growth; hence a tax-financed increase in government investment equal to 5 percent of GDP is predicted to have reduced output growth by nearly 0.6 percentage points. The productivity of private investment remained relatively constant during both periods.

The average increase in tax effort by the Sub-Sahara African countries between 1965-73 and 1974-82 is predicted to have reduced output growth, even after accounting for the positive effects of the additional government spending. However, this is not to suggest that all tax instruments are equally inefficient. Personal and corporate tax rates, for example, are estimated to have a significant and negative direct effect on output growth. Trade taxes have little direct effect on output growth -- holding private investment constant -- but they are predicted to reduce investment and thereby indirectly attenuate output growth rates. Finally, sales and excise taxes are found to be generally neutral with respect to both output growth and investment. These results have two implications. The first is that government expenditures financed by sales or excise taxation may have a positive effect on output growth. The second is that a revenue-neutral shift from trade and direct taxes to sales or excise taxation can increase output growth rates.[1]

The traditional view of direct versus indirect taxation is that direct taxes creates dynamic distortions by reducing savings and investment, while indirect taxation leads to static distortions. The results presented below suggest a different view. Direct taxes are estimated to cause a "static" distortion, while trade taxes are predicted to reduce investment. These results can be explained by noting that developing countries often concentrate direct taxation on a very limited number of large-scale firms (such as those in manufacturing and mining); if in turn these taxes are passed along to the output price (as suggested by Brent, 1985), the direct tax could resemble a "static" excise tax. Similarly, companies may be discouraged from investing because of heavy export taxes on processed outputs, or the taxation of intermediate imports.

The remainder of the paper is organized in the following way. Section II discusses previous studies of tax distortions, shortcomings of cross-country regression models, and the econometric growth model. Section III presents the regression results, while Section IV concludes. An appendix is also provided which discusses aspects of the theoretical model in more detail.

## II. The Theoretical Model

It is useful to review three approaches to the issue of how tax policy affects output growth. The first adopts a neoclassical growth model, most

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[1] This model cannot assess the distributional impact of such a tax change.

commonly with a single good and with infinitely-lived individuals (Lucas, 1985; Mãnas-Anton, 1985). In such a model, taxes have no effect on output growth in the long-run since steady-state output growth is determined by exogenous factors such as population growth and technological change.

During the transition path between the two steady-state equilibria, growth rates will be affected. Lucas (1985) suggests that the fundamentally "static" tax distortions might account for only 0.5 percentage point differences in growth rates along the transition path. However, a 0.5 percentage point jump in annual growth rates would have represented a 90 percent improvement over the average real per capita growth rates in Sub-Sahara Africa during 1974-82.[2]

There is little reason to believe that African (or other) countries are in steady-state equilibrium. Only 5 sub-Sahara African countries had achieved independence before 1960, and regime changes will presumably lead to differing growth paths. Furthermore, the transition path is lengthy; the "grand traverse" of the U.S. from a low capital intensity to a high capital intensity economy took most of the 19th century (David, 1977).[3] A model which allows for the possibility of transition paths seems appropriate for the analysis of developing economies.

A second approach uses computable general equilibrium (CGE) models of specific countries to test the effect of static tariff or sectoral tax

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[2]This represents an unweighted average per capita growth rate.

[3]Life cycle simulation models also suggest a transition path in excess of 30 years (Auerbach, Kotlikoff, and Skinner, 1983; Seidman, 1984).

inefficiencies.[4] These models compare the output (or income distribution) of an economy using baseline parameters with the outcome using the counterfactual alternative policy parameters. One drawback of these models is that parameters necessary for policy recommendations, such as the impact of government spending and investment on sectoral output, are not always estimable. The dynamic specification of these simulation models presents a particular problem (see Chamley, 1983).

The third alternative approach compares tax policy and country growth rates in cross-section empirical analysis. For example, Marsden (1983) matched ten high-tax countries, such as Zambia, Britain, Chile, and Zaire, with 10 low-tax countries such as Singapore, Korea, Uruguay, and Japan. He found in comparing the 20 countries that higher overall tax effort led to lower output growth. Two disadvantages with this study are the lack of an underlying theoretical model, and the subjective procedure by which countries are matched together.

A number of studies have used cross-country regressions to measure the impact of government expenditures and taxation on output growth. Martin (n.d.) found that while tax effort (the ratio of tax revenue to GDP) depressed output growth, deficits reduced it by even more, suggesting that tax hikes could, by cutting back deficits, encourage output growth rates.[5]

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[4]See Henderson (1982), Taylor and Black (1974), and DeMelo (1978) for simulation models of developing countries, and Fullerton, King, Shoven, and Whalley (1981) for a model of the United States.

[5]The causality between deficits and output growth is not clear. Countries typically run deficits during economic downturns and surpluses during economic booms. Under this interpretation, declining GDP growth rates would "cause" deficits, and not conversely.

He also found that income/corporate and trade/indirect taxes (defined as ratios of the specific tax revenue to GDP) reduced output growth.

Landau (1983,1986) has performed extensive cross-country regressions to measure the impact of government expenditures, revenue, and deficits on output growth. While some components of government spending may have had a positive effect on GDP growth rates, the combined effects of taxation to finance the expenditures, and crowding-out of private investment, usually offsets any positive effects. The question remains why a large and inefficient government sector should necessarily affect the *growth rate*, rather than simply the level, of GDP.

To address this theoretical difficulty, Ram (1986) derived an expression for output growth as a function of growth rates in government spending. He found a strong, positive impact of government current consumption on output growth. The goal of this section is to build on work by Robinson (1971), Feder (1983), and Ram (1986), to develop a theoretical framework for measuring the impact of taxation, government expenditures, capital, and labor supply on output growth, and to test this model using empirical data.

Before deriving the model, it is useful to review some shorcomings of cross-country regression analysis. The usual criticism of these comparisons is that countries are sufficiently dissimilar that they cannot be pooled together in a single data set; it makes little sense to interpret regression estimates based on, e.g., France and Burundi. While this paper restricts its attention to Sub-Sahara Africa, the criticism is a general one for all regressions -- do the observations, whether of individuals, countries, or years, behave according to a similar structural model? If yes, then the reported regression results will provide estimates of the average, or representative parameters values. If not, the diversity should be readily reflected in insignificant regression coefficients.

A second, more serious, problem with any regression is the possibility that measured independent variables proxy for the true, but unmeasured, factors which determine output growth. For example, countries with large mining sectors often rely heavily on corporate taxation. Downturns suffered by some mining industries during 1974-82 could therefore have led to a measured, but spurious, negative effect of corporate taxation on output growth. To correct at least partially for this problem, the regressions include non-government variables which affect output growth, such as whether the country produces oil or mining outputs.

An additional problem is the proper measurement of effective tax rates. Developing countries often rely on non-tax constraints such as industrial licenses, foreign-exchange and price controls, quotas, and marketing boards, all of which cannot be reflected in standard measures of tax rates. If the measured tax rates are inaccurate, then the regression results will indicate little or no role for these measured tax rates in determining output growth.

The most serious shortcoming of cross-country regression models is the potential endogeneity of the independent variables. Rapidly-growing countries may also experience high investment rates and government spending. While the 9-year accounting framework adopted by this paper corrects in part for for short-run endogeneity in the independent variables, correcting for longer-term endogeneity is far more difficult.

To simplify the theoretical analysis, I assume that the output of the economy is comprised of an untaxed (or, more generally, a lightly-taxed) sector and a taxed sector. For example, the untaxed sector might include services, small-scale production, the informal sector, and smallholder agriculture. The government sector is included in the untaxed sector because the payroll taxes assessed on government wages are simply returned to the government, so the government pays only net wages. The taxed sector includes large-scale manufacturing and export industries. In many countries, the distinction between the two sectors is not sharp. The smallholder agricultural sector, for example, will escape the payroll (i.e., personal) and corporate tax, but the marketing board may impose an implicit output tax by paying farmers less than world prices.

Let the taxed sector be x, and the untaxed n. Output (or GDP) is written

$$Y = P_n Q_n + P_x Q_x \tag{1}$$

where $P_n$ and $P_x$ are the (fixed) prices to retailers or consumers in the untaxed and taxed sectors, respectively, and $Q_n$ and $Q_x$ are the equivalent quantities produced in each sector.

Value added in each sector is affected by government investments in infrastructure and other projects, and by government spending for current services. Let output in each sector be a function of these government activities, plus private inputs;

$$Q_n = F(K_n, L_n, K_g, G) \tag{2}$$

$$Q_x = H(K_x, L_x, K_g, G)$$

where $K_n$ and $K_x$ represent private capital in the untaxed and taxed sector, $L_n$ and $L_x$ measure labor in each sector, $K_g$ measures public capital, and G is current government consumption (excluding debt repayment). Total capital is $K_T = K_x + K_n + K_g$, while total labor supply is $L = L_n + L_x$. As discussed by Ram (1986), G is included in both sectors owing to possible external effects of government activity. Additionally, government capital, which appears as a "public good" in each production function, may affect output differently from private capital.

Many developing countries rely heavily on commodity taxes such as import, export, and sales taxation. The primary impact of each of these taxes is to drive a "wedge" between the producer price and consumer price of the output. In the case of sales or excise taxes, the tax would usually affect domestically produced goods, while export taxes would affect large-scale exports. Import taxes might provide a subsidy for domestic import-substituting industries, thereby artificially attracting resources into the "taxed" sector. For the purpose of the two-sector model presented below, assume that a single commodity tax, $t_y$, is imposed on the taxed sector.

Output taxes can be shifted forward, though higher consumer prices, or shifted backwards, through a reduction in wages and interest rates. If the GDP price deflator is calculated properly, the consumer price distortion (or forward-shifting) of an excise tax should reduce GDP, since the value of the distorted consumption bundle, evaluated at factor prices, is less than the value of the undistorted consumption bundle. The derivations that are presented below focus less on consumption distortion, and more on production distortions by backward-shifted taxes, although the empirical estimation procedure is perfectly general with respect to the incidence of the tax. Regression coefficients measure the combined impact of the tax (whether forward- or backward-shifted) on output growth.

Direct taxes such as the corporate and income tax will also affect the allocation of investment and labor supply. The income tax is a combination of a payroll tax on wages and an interest income tax, while the corporate tax is imposed only on corporate accounting profits, and hence falls (nominally) on capital. In combination, these two taxes drive varying degrees of "wedges" between the gross and net interest rate and wage rate. Like the output tax $t_y$, the tax on capital, $t_k$ and the tax on labor, $t_\ell$ may be shifted back onto wages and interest rates, or forward onto higher consumer prices for the outputs. There is a strong equivalence between the two taxes; the combined tax wedge between the net and gross return on capital is $\tau_k = 1 - (1-t_y)(1-t_k)$ and for labor, $\tau_\ell = 1 - (1-t_y)(1-t_\ell)$. That is, a 10 percent tax commodity tax has the same effect on incentives as a 10 percent tax on capital and labor (if there are profits, the commodity tax will raise more revenue). In the model below, the "capital" tax $\tau_k$ and the "labor" tax $\tau_\ell$ are used to summarize the combined distortions of direct and indirect taxes, although in the empirical section, each tax instrument will be entered separately.

Assume that total (private) capital $K = K_n + K_x$ and labor $L = L_n + L_x$ are in fixed supply, but the share of the input in each sector depends on the vector of taxes $\tau = \{\tau_k, \tau_\ell\}$;

$$K_n = \mu_k(\tau)K \qquad (3)$$

$$L_n = \mu_\ell(\tau)L$$

$$K_x = (1-\mu_k(\tau))K$$

$$L_x = (1-\mu_\ell(\tau))L$$

where $\mu_k(\tau)$ and $\mu_\ell(\tau)$ are the shares of K and L, respectively, in the untaxed sector. Next, a linear approximation of equation (1) is taken to derive a measure explain output growth. With the difference operator denoted by $\Delta$, and prices $P_n$ and $P_x$ set to 1.0 without loss of generality, the change in output is written

$$\Delta Y = \beta_k(\tau)\Delta K + \tilde{\beta}_\ell(\tau)\Delta L + \gamma_\kappa \Delta K_g + \gamma_g \Delta G \tag{4}$$

where

$$\beta_k(\tau) = \mu_k(\tau)F_k + (1-\mu_k(\tau))H_k$$

$$\tilde{\beta}_\ell(\tau) = \mu_\ell(\tau)F_\ell + (1-\mu_\ell(\tau))H_\ell$$

$$\gamma_\kappa = F_\kappa + H_\kappa$$

$$\gamma_g = F_g + H_g$$

where $F_j$ and $H_j$, $j=k,\ell,\kappa,g$ are production function derivatives with respect to the four inputs: private capital, labor, government capital, and government consumption. The interpretation of each coefficient is straightforward. The parameter $\gamma_\kappa$ measures the combined shift in output of both sectors caused by a one-unit increase in the stock of government capital. Similarly, $\gamma_g$ measures the combined or "externality" effect on sectoral output of government consumption (e.g., government services).

The parameters $\beta_k$ and $\tilde{\beta}_\ell$ measure the average of the gross (or social) marginal factor productivity of capital and labor, weighted by the input shares in the untaxed and taxed sectors. Rearranging $\beta_k$ and $\tilde{\beta}_\ell$ yields:

$$\beta_k(\tau) = \beta_k(\bar{\tau}) + (F_k-H_k)[d\mu_k/d\tau](\tau-\bar{\tau}) \tag{5}$$

$$\tilde{\beta}_\ell(\tau) = \tilde{\beta}_\ell(\bar{\tau}) + (F_\ell-H_\ell)[d\mu_\ell/d\tau](\tau-\bar{\tau})$$

where $\bar{\tau}$ is the average, or representative tax vector for the country sample, and $d\mu_k(\tau)/d\tau$ and $d\mu_\ell(\tau)/d\tau$ are 2x1 matrices measuring the (linear) impact of the country-specific tax vector $\tau$ on the share of capital, and of labor, in the untaxed sector. That is, each country-specific coefficient $\beta_k$ and $\beta_\ell$ consists of a measure of marginal productivity $\beta(\bar{\tau})$ which is common to all countries, plus an addition term which measures the tax-induced effects on aggregate marginal productivity. This second term has a straightforward interpretation: the change in the share of capital and labor flowing out of the taxed sector and into the untaxed sector, times the difference in marginal productivity of the untaxed versus the taxed sector. For example, if a high tax rate on capital caused the share of new capital (or equivalently, investment), in the taxed sector to fall by 5 percent, total capital productivity would change by 5 percent times the <u>difference</u> between the marginal return to capital in the taxed, and in the untaxed, sectors. To the extent that the <u>net</u> after-tax returns to each factor tend towards equilization, the gross return $H_k$ or $H_\ell$ is likely to exceed the gross return $F_k$ or $F_\ell$. Given $H_k > F_k$, and $H_\ell > F_\ell$, and making the assumption that the "own price" effect of a tax on capital or labor reduces its share in the taxed sector; $\partial\mu_k/\partial\tau_k$, $\partial\mu_\ell/\partial\tau_\ell > 0$, it is clear that the second terms on the RHS of (5) imply that increasing $\tau_k$ or $\tau_\ell$ reduces the marginal productivity of capital or labor, respectively.

While I have argued above that the difference in marginal productivity, $F_k - H_k$, and $F_\ell - H_\ell$, are negative, the existence of external or "spillover" effects can lead to positive values (Feder, 1983). For example, if the untaxed sector generates sufficient positive externalities, (for infant industry or export led growth reasons), then $F_i - H_i > 0$, $i=k,\ell$. Tax policies, or Pigovian subsidies, which attract factors into the untaxed sector can enhance, rather than retard, output growth.

The growth equation presented above is also consistent with a neoclassical growth model in the steady state. Given a constant proportional growth rate in capital and labor equal of $\theta$, the appendix demonstrates that the proportional growth rate of output will be $\theta$, regardless of the structure of taxes.

Dividing through by Y, and rearranging, yields the following expression for the rate of growth in GDP, $\dot{Y}$,

$$\dot{Y} = \beta_0 + \beta_k(\tau)[I_p/Y] + \beta_\ell \dot{L} + \gamma_\kappa[I_g/Y] + \gamma_g[G/Y]\dot{G} \tag{6}$$

where proportional changes are denoted $\dot{x} \equiv \Delta x/x$, $x = Y,L,G$, $\beta_0$ measures unbiased productivity change and other factors, private investment $I_p \equiv \Delta K$, government investment $I_g \equiv \Delta K_g$, $\beta_\ell = \tilde{\beta}_\ell(L/Y)$, the overall output elasticity with respect to labor, and $\beta_k$, $\gamma_\kappa$, and $\gamma_g$ retain their original definition since they are unit-free.

The next step is to specify how tax rates enter the estimation equation. Substituting from (5) into (6), defining

$$\delta_{kj} = (F_k - H_k)\partial\mu_k/\partial\tau_j \tag{7}$$

$$\delta_{\ell j} = [L/Y](F_\ell - H_\ell)\partial\mu_\ell/\partial\tau_j \qquad j = k,\ell$$

the econometric specification becomes

$$\dot{Y} = \beta_0 + [\bar{\beta}_k + \delta_{kk}\tau_k + \delta_{k\ell}\tau_\ell](I_p/Y) + [\bar{\beta}_\ell + \delta_{\ell k}\tau_k + \delta_{\ell\ell}\tau_\ell]\dot{L} + \gamma_\kappa(I_g/Y) + \gamma_g(G/Y)\dot{G} \tag{8}$$

with the coefficients $\bar{\beta}_k$ and $\bar{\beta}_\ell$ reflecting the interactive terms involving $\bar{\tau}$; $\bar{\beta}_i = \beta_i(\bar{\tau}) - \delta_{ik}\bar{\tau}_k - \delta_{i\ell}\bar{\tau}_\ell$, $i=k,\ell$.

The theoretical model therefore implies that individual tax rates enter interactively with $(I_p/Y)$, and with $\dot{L}$, in the output growth equation. However, with a large number of tax rates, and possible errors in measurement for $I_p$, $\dot{L}$, and the effective tax rates, it may also be useful to consolidate the interactive tax terms into a linear expression, either for each individual tax rate, or for an overall measure of the tax "burden" given by the ratio of tax revenue to GDP;

$$\dot{Y} = \beta_0 + \overline{\beta}_k(I_p/Y) + \overline{\beta}_\ell\dot{L} + \gamma_\kappa(I_g/Y) + \gamma_g(G/Y)\dot{G} + \theta_k\tau_k + \theta_\ell\tau_\ell \qquad (9)$$

and $\theta_i = \delta_{ki}(I_p/Y) + \delta_{\ell i}\dot{L}$, $i=k,\ell$. (The two tax terms can be further consolidated into a single term summarized by the overall tax effort.)

Finally, the third method of including taxation in an output growth equation is to focus on the <u>net</u> return to factor inputs. Output growth can be expressed as a function of net factor returns, plus the change in tax revenue R, written

$$\Delta R = H_k\tau_k\Delta K_x + H_\ell\tau_\ell\Delta L_x + \tau_y[H_g\Delta G + H_\kappa\Delta K_g] \qquad (10)$$

The first two expressions on the RHS are the traditional increases in tax revenue caused by growth in capital and labor in the taxed sector. The third expression, in brackets, measures the increased revenue generated by positive externalities on the taxed sector from government activities.

At this point, we assume that net wages, or the net return on capital, are equal between the two sectors. If workers, or investors, are allowed to choose between the taxed and the untaxed sectors, their preference for higher net wages or interest rates will tend to drive such rates in each sector to equality. Using this property that $F_i = H_i(1-\tau_i)$, $i=k,\ell$, substituting in (10) and rearranging (9), output growth is expressed as

$$\dot{Y} = \beta_0 + \beta_k^*(\tau)(I_p/Y) + \beta_\ell^*(\tau)\dot{L} + \gamma_\kappa^*(I_g/Y) + \gamma_g^*(G/Y)\dot{G} + \psi\dot{R}(R/Y) \qquad (11)$$

where $\dot{R} = \Delta R/R$, and the net factor returns are defined to be $\beta_k^* = F_k$, $\beta_\ell^* = F_\ell(L/Y)$, $\gamma_\kappa^* = F_\kappa + H_\kappa(1-\tau_y)$, and $\gamma_g^* = F_g + H_g(1-\tau_y)$. That is, the coefficients with astericks measure the after-tax factor productivity, whether for private returns $\beta_k^*$ and $\beta_\ell^*$, or for government "external" effects $\gamma_g^*$ and $\gamma_\kappa^*$. Note that the net returns to government programs need only subtract the output tax $\tau_y$, since they do not affect the taxes paid on factors, $\tau_k$ and $\tau_\ell$. A coefficient $\psi$ on the revenue term is introduced to allow for the imperfect linkage between tax collections and measured "constant price" GDP.

Even <u>net</u> labor and capital productivity are likely to depend on the tax vector $\tau$. Given a fixed level of capital, a capital tax in sector x will reduce the net return on capital when labor is held constant (althought the problem becomes more complicated when labor is allowed to vary; Harberger, 1962). Hence $\alpha^*$ and $\beta^*$ continue to be written as functions of $\tau$, and interactive terms involving $I_p/Y$ and $\tau$, and $\dot{L}$ and $\tau$, will continue to be used in the empirical section. Strictly speaking, the impact of $\tau$ on $\alpha^*$ and $\beta^*$ is a second-order effect; hence squared terms involving capital and labor should also be included in the regressions. Empirical results which include these squared terms sharply reduce degrees of freedom, but have little effect on the other coefficent estimates.

In the next section, the model is generalized to include trade taxes, personal taxes, and sales or excise taxes, and the derivation of appropriate tax bases is discussed. Additional factors which may have affected output growth during the period are also explored.

## III. Empirical Implementation of the Theoretical Model

The assumption of a two sector model is an obvious simplification, and it is shown in the appendix that the results derived above carry over to many sectors. Corporate and personal taxes will likely affect the manufacturing and mining sectors, while the import tax is expected to provide protection for import-substitution industries. The export tax will affect export industries, while the sales/excise tax may distort the use of market goods versus home production. Each tax is entered separately in the regressions to reflect potentially different effects on output growth. The tax rates required for the empirical estimation are discussed as follows.

Import Tax: The most straightforward tax to calculate is the import tax, defined to be the ratio of import tax revenue to total imports. Error may be involved measuring this tax, since imports for government or foreign aid use may not be taxed, while non-tax exchange constraints could lead to unmeasured "shadow" tax rates. The sources of data are the Government Financial Statistics collected by the IMF, and World Bank's World Tables.

Export Tax: The export tax is measured as export tax revenue divided by the export tax base. It is therefore an output tax on the export sector. The measured tax will likely be biased downward, since marketing boards often collect an implicit tax on exported agriculture.

Corporate Tax: The corporate tax is expected to reduce the net return on capital in the coporate sector. Because many corporations are involved in manufacturing and exports (e.g., minerals, large-scale agriculture), the corporate tax base is defined to be manufacturing value added plus export sales. This tax base is a hybrid of value added (in manufacturing), which can proxy for corporate profits, and export sales, which may include the value of inputs purchased from other sectors. (Value added in export industries would be a better measure, but it is unavailable.) There is little chance of double counting, since less than 4 percent of African manufacturing is exported.

Personal Tax: The personal or individual tax is typically a payroll tax, often for workers in larger establishments, and for government workers. Thus the assumed personal tax base is the manufacturing sector plus government consumption (which proxies for the government wage-bill). The tax base will be biased upward to the extent that not all manufacturing is subject to payroll tax, but biased downward since some export-oriented firms are subject to taxation.[6]

Sales Tax: The sales and excise tax is calculated as the ratio of sales and excise taxes to manufacturing value added plus imports, reflecting the usual targets of sales and excise taxes; imported goods and domestically manufactured products.

Tax Effort: The tax effort is the average ratio of tax revenue to

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[6]While government workers are assumed to be in the untaxed sector (since taxes collected are paid back into the government) the proper calculation of the tax rate in the taxed (private) sector requires that government consumption be included in the tax base.

GDP. Tax effort can proxy for the overall level of tax distortion (as in Marsden, 1983). Alternatively, a higher tax effort conditional on fixed marginal tax rates could also reflect an expansion of the effective tax base when more revenue is collected at the same tax rates.

Additional variables measuring the change in output, government expenditure, capital, labor, and other factors, are calculated in the following way:

GDP Growth ($\dot{Y}$): The growth rate is defined to be the average log growth in GDP measured at constant factor cost, or if factor cost measures were unavailable, at constant market prices. The change in output was taken over a 9-year period (or 8 or 7 years if recent data were unavailable) 1965-73, or 1974-82.

Weighted Government Growth ($[G/Y]\dot{G}$): This variable is the share of government consumption to GDP multiplied by $\dot{G}$, the percentage change in government consumption over the 9-year period. Government consumption from the national accounts do not include debt service, a budget item with presumably little productive value. Note that in the empirical section, the weighted variable may be decomposed into Government Consumption, defined as [G/Y], and Government Growth, $\dot{G}$.

Private Investment ($I_g/Y$): This measure of the change in the private capital stock was calculated by accumulating the ratio of annual private investment to GDP over the 9 year period, depreciated at a yearly 8 percent rate. Annual private investment was calculated first by measuring $\lambda$, the average ratio of public investment (defined as total minus current government expenditures) to total investment over the 9 year period.

Private gross investment in each year is then measured as (1-λ) times total gross investment. Private capital growth over the 9-year period is written

$$\Delta K/Y = \sum_{i=1}^{9} \left[(1-\lambda)[V(i)/Y(i)](1.08)^{9-t}\right]/9 \qquad (12)$$

where V(i) and Y(i) are investment and GDP in year i.[7] Note that this procedure cannot account for the loss of existing capital stock through depreciation.

<u>Government Investment</u> ($\Delta K_g/Y$): The change in government capital is simply the difference between accumulated total capital and accumulated private capital, or λ/(1-λ) times the RHS of (12).

<u>Labor Supply Growth</u> ($\dot{L}$): Because there is little consistent data on changes in workforce size, population growth (denoted <u>Population</u>) is used to proxy for the change in labor supply.

<u>Inflation</u>: The inflation rate is measured as the average annual growth rate in the GDP deflator. This variable is used in the investment regressions to proxy for a measure of real interest rates. If nominal rates are fixed, higher inflation rates could lead both to lower real borrowing costs, and higher returns to physical capital accumulation.

<u>Other Variables</u>: It is important to control for as many additional non-tax factors as possible that may affect the output of the economy. For

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[7] There is an alternative procedure for calculating ΔK/Y, which is to accumulate real investment over the 9 year period, and then divide by the initial year GDP. However, such a procedure introduces simultaneity bias, since even if all countries had constant investment to GDP ratios, countries which happened to enjoy high growth rates would also experience a higher ratio of accumulated investment to initial GDP, leading to a spurious correlation between capital accumulation and output growth.

example, a sharp decline in the terms-of-trade will lead to a fall in real GDP, independent of the tax system or of investment behavior. Similarly, countries which discovered and exploited oil resources (The Congo, Gabon, Cameroon, and Nigeria) are likely to have enjoyed higher growth rates through 1982, conditional on factor inputs and tax policy. Political instability can disrupt economic growth both through the destruction of property and capital, the flight of skilled workers, and the loss of new investment (Schneider and Frey, 1985; Stewart and Venieris, 1985). A variable measuring the number of "successful" coups during the period is included (Griffiths, 1984). Although coups are potentially endogenous (declining economic fortunes spur coup attempts), Wheeler (1984) finds that political disruption Granger-causes output changes, but not conversely. In the next section, sources of data are described, and regression results are reported.

## IV. Empirical Results

The data set described below will be used to estimate both the output growth model developed in Section III, and also to estimate investment demand equations. The data come from national accounts and government financial statistics. To abstract from short-term fluctuations, income growth is averaged over 9 years, 1965-73 and 1974-82.[8] The period 1973-74 represents a significant transition for many countries from relatively stable growth to uneven development as rising oil prices and worldwide

[8] In a few countries, 1974-81 growth rates were calculated; for Somalia, 1974-79 rates were measured.

recessions led to declining export prices and increased debt. Although some export prices rose later in the 1970s, the second oil price increase in 1979-80, subsequent economic slumps, and increasing debt burdens all led to increasing stress on government tax collection efforts. Despite these downturns, government investment during 1974-82 was high relative to the previous period (Shalizi, Ghandi, and Ehdaie, 1985). Overall tax effort increased for Sub-Sahara African countries during this period, although stepped-up government expenditures more than offset the additional revenue, leading to increased deficits (Shalizi, Ghandi, and Ehdaie, 1985).

Wheeler (1984) used a number of variables to explain the economic downturns in many Sub-Saharan African countries. Important factors were outbreaks of violence (or more exactly, years of peace), the terms of trade, the diversity of exports, whether the country exported minerals, the existence of foreign exchange controls, and a "habit" parameter that measures how imports respond to declines in foreign exchange. While the results presented below do not include all of his explanatory variables, they do generally confirm the effects of political instability and terms of trade on output growth. A study by Kormendi and McGuire (1985) which used data from both developed and developing economies, suggest that other variables, such as the variability in money growth, the growth in exports, and the standard deviation of real output growth, can also explain differences across countries in output growth rates.

The sample of countries was selected by including all those which reported complete information on tax, output, and investment variables. A total of 56 observations remained; 27 countries from 1965-73 and 29 countries from 1974-82.[9] This pooled cross-section time-series data set compares the growth experience of similar countries over time, and provides a larger number of observations than a simple cross-section data set. For some coefficients, such as the marginal product of capital, interactive terms are introduced which allow marginal productivity to differ across periods.

Table 1 presents regression results for the model in which taxes are entered linearly rather than interactively. Column (1) describes an output growth equation similar to that estimated by Ram (1986). Government investment is estimated to be highly productive during the period 1965-73; its marginal productivity is estimated to be a substantial 0.534, which is significant at the .10 level, and larger than the corresponding marginal productivity for private investment. However, the dummy variable for the period 1974-82 interacted with public investment (<u>Public Investment 74-82</u>) indicates a dramatic fall in the productivity of government capital during this latter period -- from .532 to -.077. By contrast, the marginal productivity of private capital exhibited no consistent change during this period.[10]

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[9] In 1965-73, the countries were Benin, Cameroon, Chad, Congo, Gabon, Gambia, Ivory Coast, Liberia, Mali, Nigeria, Senegal, Sierra Leone, Burkina Faso, Botswana, Burundi, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Rwanda, Somalia, Sudan, Swaziland, and Zaire. In 1974-82, the Gambia, Guinea, Niger, and Zambia were included, while Madagascar and Gabon were dropped.

[10] The interpretation of the private and public investment coefficients as "marginal productivities" is consistent with a production function model in which output depends, in the long run, on the supply of inputs. In a traditional Keynesian model, autonomous investment will be a function of Y, which reverses the causal relationship posited above. I hope to correct for this reverse causation by (i) using a

Column (2) provides a simple measure of cumulative tax distortions with the use of <u>Tax Effort</u> which is interacted with <u>Private Investment</u> and with <u>Population</u> (this is roughly equivalent to assuming that $\tau_k = \tau_\ell$). The predicted effect of a 3 percentage-point increase in tax effort is to reduce output growth by 1/2 percentage points, an estimate which is significant at the .05 level.[11]

Recall that <u>Weighted Government Growth</u> measures $[G/Y]\dot{G}$. Assuming an average 5.7 percentage point growth rate $\dot{G}$, the regression in column (2) predicts that a permanent three percent increase in G/Y financed by increasing the tax effort will <u>reduce</u> output growth rates by 0.3 percentage points, although this prediction is not significant at conventional levels.

The third column once again uses <u>Tax Effort</u> to proxy for the overall degree of tax distortions, although in this case it is entered linearly, as in (9), rather than interactively. The coefficient is negative and significant.

Column (4) expands the regression to include different measures of tax

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nine-year period, and (ii) using I/Y to measure investment, so that an increase in Y which causes an autonomous, equal percentage increase in I will have no effect on the independent variable.

Even for the case in which investment is exogenous, it is still not clear whether the coefficients measure a "multiplier" effect or a marginal productivity. The implication of policies which either reduce the marginal productivity, or dampen the "multiplier", are similar -- they reduce output growth rates.

[11]The sample means of $I_g/Y$ and $\dot{L}$ are 11.5 and 2.7 percent, respectively. The effect of a 5 percent increase in tax effort is therefore 5(-.005×11.5 +-.048×2.7). The test of joint significance of both coefficients is significant at the 0.08 level. While the taxation t-statistics are insignificant, they are irrelevant for testing the hypothesis that taxation is important.

distortion. The tax rates are entered linearly (Table 2 below presents results using the interactive specification of equation (8)). The most notable aspect of these equations is the significant and negative impact of direct taxation (corporate and personal) on output growth rates. A 1 percentage point increase in the personal tax (equivalent to a 17 percent increase in personal tax rates) is predicted to reduce output growth rates by 0.36 percentage points. The coefficients for the import, export, and sales taxes, however, are insignificant, with coefficients near zero.

The possibility that mineral exporting countries (Liberia, Sierra Leone, Zaire, Guinea, and Zambia; see Wheeler, 1984) subject to high corporate tax rates suffered output downturns because of trade-related problems rather than high corporate tax rates was tested by including a minteral exporting dummy variable. The regression (not reported) showed only minor differences in the taxation coefficients.

Landau (1983; 1986) has suggested that the ratio of government consumption to GDP, G/Y, be entered as a component in GDP growth rates. While it is difficult to justify its inclusion on a theoretical basis (as discussed in the previous section), it is included nonetheless in the final "portmanteau" regression in Table 1. The coefficient on G/Y is negative and significant, suggesting that this ratio may itself proxy for other factors, such as an active regulatory presence, that affects growth rates adversely.

Table 2 presents regression results when the tax rates are interacted both with capital accumulation and with population (or labor supply) growth. The coefficients on these interacted terms are interpreted as the effect of a one percentage point increase in the tax rate on the marginal product of capital, or of labor. To begin, column (1) in Table 2 interacts the tax rates only with the growth in capital, since population may be an imperfect proxy for labor supply growth. The results are consistent with the previous regressions; a 1 percentage point increase in the corporate tax rate (or a 17 percent increase in rates) and a 1 percentage point increase in the personal tax rate (or an 18 percent hike in rates) is predicted to reduce the marginal product of capital by 1.0 percentage point and 2.4 percentage points, respectively. The other taxes are insignificant and small in magnitude.

When the tax variables are interacted with both capital and labor growth (column 2), it appears that the t-statistics on the corporate and personal tax are no longer significant. However, the test of whether the individual taxes are significance is given by the combined effect of a given tax on both labor and capital productivity. Evaluated at the sample means, these linear combinations are significant and negative, indicating, as above, that the effect of the corporate and personal tax on output growth is negative and significant at the 0.05 level; other tax measures are insignificant.

Finally, the third column in Table 2 presents coefficient estimates of the net return to factor inputs, along the lines of equation (11). The estimated effects of the different tax instruments are similar to those reported in column (2). The coefficient on the weighted tax variable ($\psi$) is similarly significant, and close to one in value.

As noted previously, there are two paths by which taxes can affect income growth. The first is through the productivity of inputs, as the regressions above have been attempting to measure. The second is through the supply of factors; higher tax rates may reduce labor supply and the supply of investment.

A regression which explains private investment for the sample is presented in column 1 of Table 3. In this first regression, tax variables are excluded; coups have a signficant negative effect on investment, while oil producing countries tended to have investment rates 7.5 percentage points above non-oil producing countries. In addition, the impact of government consumption (e.g., government current expenditures) on investment appears to be positive and significant.

When tax variables are included (column 2) a different story emerges. The effect of government consumption drops from 0.386 (in column 1) to an insignificant 0.028, conditional on overall tax effort. Furthermore, import taxes, export taxes, and corporate taxes all exhibit strong negative effects on investment behavior. The $\bar{R}^2$ rises from .292 to .559 with the introduction of these tax variables.

The corporate tax is likely to reduce equity investment since the tax assessed against corporate profits is often quite substantial unless offset by investment incentives and tax holidays. Similarly, the export tax will reduce the often large-scale investment necessary to develop export-oriented industries; holding total tax revenue constant, a 10 percentage point increase in the export tax is predicted to reduce annual investment by 30 percent. Assuming the marginal product of capital is 12 percent, such an increase in the export tax would (indirectly) reduce output growth by 0.36 percentage points.

The negative impact of import taxation on investment suggests that investment is not necessarily attracted to countries which erect tariff barriers to protect import-substitution industries. If existing import-substitution industries have exploited domestic markets, new investment might be directed towards projects which can be exported as well. Hence high tariffs on intermediate and capital imports could discourage export-oriented investment.

Perhaps the most difficult coefficient to explain is the strong positive effect of overall tax effort on investment. One explanation is that increased tax revenue scales back deficits and, by freeing private savings from government use, increases the supply of funds for private investment purposes. There are two problems with this explanation. The first is that the primary source of private investment is from foreign sources (or retained earnings of partially foreign-owned corporations); domestic savings in most African countries is not large. The second problem with this explanation is that if the supply of investment funds depended on the difference between government expenditures and tax revenue, the coefficient on government expenditures (or consumption) should be negative and of equal magnitude -- which it is not. Different specifications of the tax effort variable (e.g., including its squared value), or excluding extremely high values of tax effort affected the tax effort coefficient only minimally, nor does including both tax effort and tax growth (column 3) affect the strong positive impact of tax effort on capital accumulation.

Taxes affect output directly by changing the marginal productivity of capital and labor, and indirectly, by changing the supply of factors. The combined effects may be estimated using Column (4) in Table 1 (the direct effect) and Column (2) in Table 3 (the indirect effect). The private marginal product of capital in 1974-82 from Column (4), 0.12, is used to translate the effect of differences in accumulated capital on output. For example, the effect of changing the import tax by one percentage point is simply the direct effect, -0.014, plus the indirect effect -0.12(0.249), or -0.04. Since the average import tax was 16.1 percent, a 20 percent increase (or a 3.2 percentage point increase) in the import tax would lead to a 0.14 percent decline in output growth.[12] A 20 percent increase in the personal tax is predicted to reduce output growth by 0.41 percentage points, a 20 percent increase in the corporate tax is estimated to dampen output growth by 0.17 percentage points, while the export tax is expected to cut back output growth by a trivial 0.06 percentage points. The sales tax is estimated to have no effect on GDP growth or investment.

These estimates can be used to predict how output growth would be affected by a revenue neutral change in the structure of taxation. The effect on output growth of cutting the import, export, personal, and corporate tax rates by 20 percent and replacing the lost revenue by the domestic sales tax is simply the measures calculated above since output growth is predicted to be unaffected by the sales or consumption tax. A revenue neutral shift from the personal tax to the sales tax, for example,

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[12] These estimates are based on holding revenue (or tax effort) constant.

is estimated to increase output growth by 0.40 percentage points.

What were the costs of the increased tax effort between 1965-73 and 1974-82? Evidence from column (2) in Table 1 suggests that the tax instruments that governments used to increase tax effort lead to a sharp decline in output growth; the direct effect of increasing the tax effort by 5 percentage points was a 0.9 percentage point decline in output growth rates (5×.187, from above). Accounting for the indirect positive effect of tax revenue on investment attenuates this measure by 0.3 (5×.498×.12, where .498 is the coefficient from Column 2, Table 3 and .12 is the marginal product of capital); hence the total effect of the increased tax revenue between 1965-73 and 1974-82 was to reduce output growth by 0.6 percentage points each year. Had this revenue been used to finance government investment projects during 1965-73, growth rates are predicted to have been augmented substantially. However, during the later period 1974-82, the marginal productivity of government investment was negligible, so a 5 percent increased tax effort to finance public investment during this period would have reduced output growth rates by the same 0.6 percentage points. A similar calculation reveals that using the revenue to finance government consumption during the entire period 1965-82 would have lead to a small decline in output growth rates.

## IV. Conclusion

This paper has presented a framework for measuring how the structure of taxation and government spending affect output growth. It is shown that when countries are not following a steady-state growth path, static and dynamic tax distortions will affect output growth. In particular, taxes can affect output by (1) reducing the marginal productivity of capital and labor, and (2) reducing the supply of capital and labor.

Government expenditures also provide positive benefits; thus even tax-induced distortions may be justified by the positive benefits of government programs financed by the additional revenue. This paper allows this this tradeoff to be evaluated by including both government spending and tax variables in an econometric model explaining output growth.

The model was tested using 31 African countries during the periods 1965-73 and 1974-82. It was found that the tax structure was an important determinant of output growth; personal and corporate taxation reduce output growth, while import, export, and coporate taxes discourage investment. Although the costs of tax-financed government investment were justified by its high marginal productivity during the period 1965-73, the sharp decline in marginal productivity after 1973 suggested that tax-financed public investment during 1974-82 reduced output growth rates.

The distortionary costs of taxation differ depending on whether trade, indirect, or direct taxation is used. In particular, a revenue neutral shift away from personal, corporate, and import taxes to domestic sales (or consumption based) taxes is predicted to increase output growth.

One difficulty with this estimation exercise is the accurate construction of the data. In particular, the effective tax base is difficult to derive; even if, for example, corporate profits could be determined, the appropriate corporate tax base would still be adjusted by depreciation allowances and investment tax credits. Furthermore, tax rates are rarely proportional so that the calculated average ratios may understate the effective marginal rate.

All studies explaining how government expenditure and tax policies "explain" GDP growth rates suffer from a potential endogeneity problem, since government policies themselves will be strongly affected by economic conditions. Bolnick (1978) has made a first step in this direction, but a full simultaneous model of government policy and output growth remains to be developed.

This paper indicates that differences in tax policy can explain a substantial degree of variation in output growth among African countries. While measurement error and the potential for excluded variables suggest that the regression results be interpreted cautiously, the results imply that the structure, and not simply the level, of taxation can play a important role for encouraging growth in developing economies.

## Appendix: The Theoretical Model

This appendix discusses in more detail theoretical and empirical aspects of models which measure the effect of government fiscal policies on output growth rates.

### 1. The Production Function Model and Basic Results

There are two sets of assumptions that one can make about the production functions H and F. The first is that they exhibit constant returns to scale, which ensures a balanced growth path in the neoclassical paradigm. The disadvantage of this assumption is that if factor shares are equal, only one or the other sector will produce anything at all, except in the knife-edge case where output prices lead to both goods being produced. If factor shares do differ, then tax-induced sectoral output shifts will be accompanied by changes in the relative price of capital and labor, depending on whether the taxed sector is more or less capital intensive than the untaxed sector. It is these shifts in relative prices which can lead to the seemingly paradoxical result that an output tax can increase the marginal productivity of capital, although the marginal product of labor will fall by a sufficient amount that total output will still be reduced by the distortionary tax.

The alternative assumption about F and H is that there is an implicit fixed factor -- say, land, or human capital -- that leads to decreasing returns to scale. This assumption gives rise to a concave production possibility frontier (holding factor prices constant) between the output of F and the output of H. While this assumption has intuitive plausability, its steady-state properties are undesirable unless one assumes that the fixed factors grow over time at the exogenously determined population growth rate.

2. Properties of the Output Growth Equation in the Neoclassical Steady State

Is the model developed in the text consistent with the neoclassical growth model? First assume that both F and G are linear homogeneous in all inputs, including government capital and government expenditures, a necessary assumption for a balanced growth path. Next consider a constant steady-state growth rate of population (or population plus neutral productivity growth) equal to $\theta$. For the steady-state to hold,

$$\Delta K/K = \Delta L/L = \Delta G/G = \Delta K_g/K_g = \theta \tag{A.1}$$

where the country specific subscripts are ignored. Because of linear homogeneity,

$$Y = \beta_k K + \beta_\ell L + \gamma_g K_g + \gamma_c G \tag{A.2}$$

Dividing each side of (A.2) by Y,

$$\Delta Y/Y = \left[ \beta_k K \frac{\Delta K}{K} + \beta_\ell L \frac{\Delta L}{L} + \gamma_\kappa K_g \frac{\Delta K_g}{K_g} + \gamma_g G \frac{\Delta G}{G} \right] / Y \tag{A.3}$$

Substituting from (A.1) and (A.2), it is apparent that $\Delta Y/Y = \theta$, regardless of what $\tau$, and hence $\beta_k$ and $\beta_\ell$, are.

In the econometric specification, it may appear that taxes affect output growth, even in the steady state. That is, rewriting (A.2),

$$\Delta Y/Y = \beta_k[\Delta K/Y] + \beta_\ell[\Delta L/L] + \gamma_\kappa[\Delta K_g/Y] + \gamma_c[\Delta G/Y] \tag{A.4}$$

If $\beta_k$ and $\beta_\ell$ differ systematically because of different tax policies, that the predicted growth rate of output will also vary, depending on tax policies -- even in the steady state. The apparent contradiction can be resolved by noting that (for example) $\Delta K/Y = [\Delta K/K][K/Y]$, which in the steady state is simply $\theta K/Y$. For a country with a distortionary capital tax, $\beta_k$ is lower than average. Since distortionary taxation leads to a lower <u>level</u> of output, Y in the country with a distortionary tax is also less than average. Hence for a given proportional growth in capital $\theta$, $\Delta K/Y$ is higher than average when $\beta_k$ is lower than average; on net, the two effects cancel out. Note that this problem does not arise in the case of labor supply, since the elasticity is measured. In some respects, assumptions about what is held constant is motivated by what data are available.

In sum, the model indicates that tax policy will have no effect on output growth in the steady state when both direct effects (conditional on $\Delta K/Y$ and $\Delta L/Y$) and indirect effects (through differences in $\Delta K/Y$ and $\Delta L/Y$) are accounted for.

### 3. Application of the Model to Three or More Sectors

The extension to many sectors is straightforward. Consider, for example, a third sector, manufacturing, with a production function $M(K_m, L_m, K_g, G)$, a price $P_m = 1$, and there is a single output tax $\tau_m$; $\Delta K = \Delta K_n + \Delta K_x + \Delta K_m$, and equivalently for labor. Then the output growth equation is written (for $\tau = \{\tau_k, \tau_\ell, \tau_m\}$),

$$\Delta Y = [F_k\mu_k(\tau) + M_k\mu_k^*(\tau) + H_k(1-\mu_k(\tau)-\mu_k^*(\tau)]\Delta K + \qquad (A.5)$$
$$[F_\ell\mu_\ell(\tau) + M_\ell\mu_\ell^*(\tau) + H_\ell(1-\mu_\ell(\tau)-\mu_\ell^*(\tau))\Delta L +$$
$$[F_\kappa + M_\kappa + H_\kappa]\Delta K_g + [F_g + M_g + H_g]\Delta G$$

where $\mu_k^*(\tau)$ and $\mu_\ell^*(\tau)$ are the shares of capital and labor used in the manufacturing sector. It is straightforward to extend this model to derive the results presented in the text; thus more sectors does not change the basic results of the simpler two period model.

One complication that should be mentioned is the presence of revenue from, for example, an import tax. In the context of the three period model above, the import tax would have two effects. First, it would provide revenue on a tax base which is not measured in GDP. One way to handle this problem is to consider exports as an "input" into the purchases of imported goods. To the extent that imports are purchased using foreign currency obtained from exports, a higher tax on imports simply implies that more exports must be sold to purchase a given quantity of imports.

The second effect is that an import tax will distort the price of the domestic manufactured goods by providing protection. Thus if domestic manufacturing and imported manufacturing were perfect substitutes, the import tax would be equivalent to a subsidy for the manufacturing sector, so that an increase in domestic manufacturing output would effectively reduce tax revenue from imports.

4. Issues in the Measurement of Constant Price GDP

One difficulty with the estimation of GDP equations is the definition of constant prices. In the example above, import tariffs lead to higher prices for tradeable goods. However, if the tariffs had been in effect since the price indices were begun, then the value of domestic manufacturing would be overstated, since they would be valued at the protected price rather than the world (or potential import) price (Kreuger, 1984).

A related problem with the constant price series is the manner in which changes in tax rates are reflected in the price index. If income taxes are collected in the taxed sector, some of the tax will be shifted to the firm; and in turn some of that tax will ultimately be shifted to consumers. If such a price rise is corrected in the constant price series, then the reported price $P_x$ will appear not to rise. Hence the methods used for calculating constant price series, and the extent to which indirect taxes are shifted to consumers, can potentially affect the estimation results in ways that are difficult to determine.

Whether GDP should be measured at factor cost or at market prices is a difficult question. This paper uses factor cost measures where available to follow the convention that factor cost measures output measured at producer prices, and not at potentially arbitrary consumer prices reflecting any indirect tax rates.

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Table 1: GDP Growth Regressions, Sub-Sahara Africa 1965-82

| [Variable] | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Oil | 1.684 | 1.861 | 1.869 | 2.238 | 1.412 |
| | (1.41) | (1.61) | (1.68) | (1.80) | (1.22) |
| Coups | -0.943 | -1.016 | -1.116 | -0.824 | -0.769 |
| | (1.99) | (2.39) | (2.50) | (1.79) | (1.79) |
| Private Investment | 1.050 | 0.213 | 0.150 | 0.052 | 0.137 |
| | (0.85) | (0.73) | (1.20) | (0.40) | (1.12) |
| Priv Invest 74-82 | -0.043 | 0.037 | 0.039 | 0.069 | 0.104 |
| | (0.29) | (0.24) | (0.27) | (0.47) | (0.77) |
| Public Investment | 0.534 | 0.744 | 0.828 | 0.635 | 0.862 |
| | (1.82) | (2.50) | (2.83) | (2.29) | (3.25) |
| Public Inv 74-82 | -0.611 | -0.653 | -0.711 | -0.635 | -0.719 |
| | (1.88) | (2.07) | (2.33) | (2.06) | (2.60) |
| Population | 0.665 | 1.651 | 0.814 | 0.475 | 0.342 |
| | (1.21) | (1.03) | (1.58) | (0.86) | (0.66) |
| Terms of Trade | 0.134 | 0.093 | 0.090 | 0.169 | 0.192 |
| | (1.47) | (1.03) | (1.05) | (1.88) | (2.18) |
| Gov Growth x Gov Shr | 0.015 | 0.010 | 0.010 | 0.007 | 0.009 |
| | 2.120 | (1.90) | (2.05) | (1.44) | (2.00) |
| Tax Effort (R/Y) | | | -0.262 | | -0.117 |
| | | | (2.82) | | (1.20) |
| Tax Eff. x Priv. Inv. | | -0.005 | | | |
| | | (0.31) | | | |
| Tax Eff. x Pop Growth | | -0.048 | | | |
| | | (0.61) | | | |
| Import Tax | | | | -0.014 | -0.011 |
| | | | | (0.19) | (0.16) |
| Export Tax | | | | -0.010 | -0.010 |
| | | | | (0.16) | (0.17) |
| Personal Tax | | | | -0.357 | -0.342 |
| | | | | (2.96) | (2.93) |
| Corporate Tax | | | | -0.125 | -0.135 |
| | | | | (2.21) | (2.52) |
| Sales Tax | | | | -0.001 | 0.042 |
| | | | | (0.01) | (0.55) |
| Government Shr | | | | | -0.190 |
| | | | | | (2.67) |
| 1974-82 Interaction | 0.672 | -0.113 | 0.060 | 0.097 | 0.117 |
| | (.36) | (0.06) | (0.34) | (0.05) | (0.06) |
| Constant | -1.460 | -1.674 | 2.117 | 3.502 | 6.311 |
| | (.07) | (0.75) | (1.00) | (1.16) | (2.17) |
| R-Bar Squared | 0.369 | 0.412 | 0.453 | 0.466 | 0.572 |

Note: Dependent variable is average annual logarithmic growth rate of GDP. Absolute value of t-statistics in parentheses.

Table 2: Interacted GDP Growth Equations, Sub-Sahara Africa 1965-82

| | (1) | (2) | (3) |
|---|---|---|---|
| Oil | 2.534 | 3.525 | 3.462 |
| | (2.08) | (2.18) | (2.21) |
| Coups | -0.827 | -0.661 | -0.662 |
| | (1.93) | (1.30) | (1.35) |
| Private Investment | 0.260 | 0.519 | 0.382 |
| | (1.75) | (1.11) | (0.83) |
| Priv Invest. 1974-82 | 0.105 | 0.086 | 0.063 |
| | (0.74) | (0.53) | (0.40) |
| Public Investment | 0.583 | 0.510 | 0.228 |
| | (2.16) | (1.57) | (0.65) |
| Public Invest. 1974-82 | -0.617 | -0.612 | -0.360 |
| | (2.04) | (1.81) | (1.01) |
| Population | 0.532 | 0.128 | 0.379 |
| | (0.94) | (0.06) | (0.20) |
| Terms of Trade | 0.182 | 0.207 | 0.208 |
| | (2.13) | (2.20) | (2.28) |
| Gov Growth x Gov Share | 0.718 | 0.668 | 0.390 |
| | (1.60) | (1.30) | (0.75) |
| Import Tax x Invest | -0.004 | -0.020 | -0.016 |
| | (0.59) | (0.95) | (0.81) |
| Export Tax x Invest | -0.003 | 0.010 | 0.009 |
| | (0.60) | (0.58) | (0.53) |
| Personal Tax x Invest | 0.024 | -0.006 | 0.005 |
| | (2.88) | (0.17) | (0.13) |
| Corporate Tax x Invest | -0.010 | -0.031 | 0.023 |
| | (2.53) | (1.20) | (0.86) |
| Sales Tax x Invest | -0.000 | -0.021 | -0.024 |
| | (0.01) | (0.74) | (0.84) |
| Import Tax x Pop. | | 0.054 | 0.036 |
| | | (0.68) | (0.46) |
| Export Tax x Pop. | | -0.068 | -0.055 |
| | | (0.87) | (0.72) |
| Personal Tax x Pop. | | -0.098 | -0.128 |
| | | (0.55) | (0.74) |
| Corporate Tax x Pop. | | 0.088 | 0.041 |
| | | (0.76) | (0.35) |
| Sales Tax x Pop. | | 0.095 | 0.125 |
| | | (0.69) | (0.93) |
| Tax rate x Tax growth | | | 0.965 |
| | | | (1.79) |
| 1974-82 Interaction | -0.244 | 0.100 | -0.084 |
| | (0.13) | (0.05) | (0.04) |
| Constant | 1.240 | 0.739 | 1.127 |
| | (0.61) | (0.32) | (0.50) |
| R-Bar Squared | 0.505 | 0.465 | 0.469 |

Note: The dependent variable is the annual logarithmic growth rate in GDP. Absolute values of t-statistics are in parentheses.

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Table 3: Private Investment Regressions, Sub-Saharan Africa 1965-82

| | (1) | (2) | (3) |
|---|---|---|---|
| Oil | 7.468 | 4.870 | 4.549 |
| | (4.06) | (2.84) | (2.83) |
| Coups | -1.652 | -0.334 | -0.352 |
| | (2.12) | (0.47) | (0.53) |
| Population | 1.146 | -0.155 | -0.475 |
| | (1.22) | (0.18) | (0.58) |
| Terms of Trade | -0.235 | 0.024 | -0.053 |
| | (1.56) | (0.17) | (0.39) |
| Government Share | 0.386 | 0.028 | 0.047 |
| | (3.19) | (0.24) | (0.41) |
| Government Growth | | | 0.132 |
| | | | (1.25) |
| Tax Effort | | 0.493 | 0.486 |
| | | (3.70) | (3.89) |
| Tax Growth | | | 0.198 |
| | | | (2.10) |
| Import Tax | | -0.249 | -0.234 |
| | | (2.43) | (2.44) |
| Export Tax | | -0.328 | -0.309 |
| | | (3.43) | (3.45) |
| Personal Tax | | -0.208 | -0.052 |
| | | (1.11) | (0.28) |
| Corporate Tax | | -0.171 | -0.161 |
| | | (2.00) | (2.00) |
| Sales Tax | | 0.006 | 0.112 |
| | | (0.05) | (0.93) |
| Inflation | | 0.144 | 0.213 |
| | | (1.52) | (2.26) |
| 1974-82 Interaction | 0.260 | -0.883 | -1.028 |
| | (0.21) | (0.73) | (0.91) |
| Constant | 1.971 | 10.513 | 6.519 |
| | (0.58) | (2.59) | (1.59) |
| R-Bar Squared | 0.292 | 0.559 | 0.616 |

Note: Dependent variable is the share of private investment to GDP. Absolute value of t-statistics in parentheses.