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TAXATION, AGGREGATE ACTIVITY AND ECONOMIC GROWTH: CROSS-COUNTRY EVIDENCE ON SOME SUPPLY-SIDE HYPOTHESES

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ABSTRACT

Using data from 63 countries in the 1970s, we examine the impact of average and marginal tax rates on the level and growth of economic activity. In doing so, we account for (1) potential endogeneity of average tax rates to per capita income and (2) the relation between economic growth and per capita income. Our empirical results reveal that apparent negative effects of tax rates on growth disappear upon controlling for the two factors above. They also reveal, however, that "revenue neutral" marginal tax changes do have negative effects on the level of economic activity, as opposed to its rate of growth. Thus, the evidence supports the hypothesis that "revenue neutral" reductions in marginal tax rates induce a parallel shift upward in the growth path.

Key words--Supply-Side, Taxation, Marginal Tax Rates, Economic Growth, Aggregate Activity, Capital Formation

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I. INTRODUCTION

With the advent of interest in so-called "supply-side" economics, the effects of taxation on aggregate economic activity and economic growth have become important issues at both the scholarly and policy levels. The supply-side hypotheses, that higher rates of taxation inhibit economic activity and/or economic growth, are by now familiar enough for discussion to appear in most basic economics texts.[1] Empirical evidence on the validity of these hypotheses, however, is surprisingly limited.[2]

One commonly cited study is Marsden's [1983] World Bank paper. In that study, Marsden formed ten pairs of countries, each with approximately equal per capita incomes, but with differing ratios of total tax revenue to GDP (i.e., average tax rates). For the 1970s, he found higher growth rates for each of the low-tax countries when compared to its high-tax counterpart. The major problem with Marsden's study is that his choice of countries to be paired seems essentially ad hoc, and for this reason alone a more systematic approach is warranted.

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[1] The hypothesis, of course, derives fundamentally from neo-classical analysis of taxation on economic activity and growth. See, for example, Atkinson and Stiglitz [1980] and their associated references. See also Bartlett [1983] for the supply-side perspective on neo-classical results.

[2] In addition to those papers discussed in the text, there is a related literature on the effects of government spending on growth; see Barth et al. [1987] for a review of this literature.

In the context of a wide-ranging exploratory study, Rabushka [1985] examined the scatter diagram between average tax rates and economic growth for 49 LDCs and, contrary to Marsden, found a slight positive relation. In another LDC study of 31 Sub-Sahara African countries, Skinner [1987] investigated the effects of average tax rates, broken down by type, on economic growth and found negative effects for average total tax rates and also for average personal and corporate tax rates. In an attempt to examine marginal rather than average tax rates, Reynolds [1985] ranked countries within groups on the basis of their top legislated marginal income tax rate and corresponding income threshold. His tables generally reveal a negative association between his marginal tax rankings and his reported rates of economic growth.

In this paper, we undertake a systematic cross-country analysis of the effects of both average and marginal tax rates on the growth path of economic activity. In this regard, we address not only the effects of taxation on the rate of growth of economic activity (the "shape" of the growth path) but also on the level of economic activity (the "location" of the growth path). Previous empirical research has analyzed only the shape of the growth path while neglecting its location. Any attempt to analyze the impact of taxation on the level of economic activity, however, must face the problem of endogenous demand for government sector activity (manifested in the taxation that finances such activity) in relation to per capita income discussed and documented in Peltzman [1980] and Rabushka [1985]. Because we develop measures for both marginal and average tax rates we are able to control for the Peltzman-Rabushka relation between average tax rates and income per capita and thereby to isolate the effects of "revenue neutral" changes in marginal tax rates on the level of per capita income.

In the context of our analysis of the growth effects of taxation, we uncover an important interaction between (1) the endogeneity of average tax rates to per capita income discussed in Peltzman and Rabushka and (2) the negative relation between per capita income and economic growth discussed in Landau [1983], Barro [1984], Kormendi & Meguire [1985], and Baumol [1986]. We show that a failure to account for this interaction can easily produce spurious negative effects of tax rates on economic growth. Our empirical results, in fact, reveal that when this interaction is accounted for, no effects of either average or marginal tax rates on growth can be found. Our results do reveal, however, a negative effect of marginal tax rates on the level of economic activity. Taken together, these results provide evidence in support of the hypothesis that "revenue neutral" marginal tax rate reductions induce a parallel upward shift in the growth path.

The rest of the paper is organized as follows. In Section II, using a data base consisting of the full set of countries (63) for which there exist at least five consecutive years of tax revenue and GDP data during the 1970-79 decade, we develop measures of marginal tax rates for each country from the time series regression of tax revenue on GDP, and check the reliability of the estimates by comparing them to Reynolds' [1985] ranking of top legislated marginal tax rates. In Section III, we examine the relation between taxation and economic growth along with the effects of taxation on labor force growth and capital accumulation. In Section IV, we analyze the effect of taxation on per capita income, i.e., on the level of economic activity as opposed to its growth. In Section V, we summarize results.

II. AVERAGE AND MARGINAL TAX RATES

Supply-side theory often distinguishes between the effects of average tax rates and marginal tax rates on the economy. In particular, one variant of the hypotheses alluded to in Section I would hold that "revenue neutral" reductions in marginal tax rates would benefit both the level and growth of economic activity.[3] In this paper, we analyze the effects of average and marginal tax rates in the context of a cross-country regression study. The details of the cross-country methodology, and the specific interpretations of the tests will be discussed in the next two sections. Here we focus on our method for estimating average and marginal tax rates.

Systematic, comparable data on tax revenue from a large number of countries is available from the Government Financial Statistics Yearbook. However, such tax data are generally not available prior to 1970, and for only 63 countries (excluding communist and oil exporting countries) does data on tax revenues exist for at least five consecutive years. The basic data set for this paper is drawn from these 63 countries. All data used are described in the Data Appendix.

To compute our measure of average tax rates for the 1970s, we obtained the corresponding data on GDP for the same 63 countries and calculated AVGTAX as the mean over the available years of the ratios of tax revenues to GDP. To estimate marginal tax rates for each country, we regressed the overall total tax revenues (TAXREV) against GDP, with tax revenues and GDP in own currency and 1975 prices, over the available data for the 1970s:

$$(1) \qquad TAXREV_t = a_0 + a_1 GDP_t + e_t$$

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[3] Bartlett [1983], pp. 26-27 discusses the distinction that the supply-side hypothesis makes between average and marginal tax rates. This distinction is crucial for policy questions such as the effects of "revenue neutral" marginal tax rate reductions.

The slope coefficient a_1 in (1) is a linear approximation of the increment to tax revenues associated with an increment to GDP, and in this sense it constitutes a measure of the average marginal tax rate for a given country in the 1970s.[4] Henceforth, we denote this estimate of the marginal tax rate as MARTAX.[5]

Any measure of marginal tax rates will have problematic aspects, and this one is no exception. Thus, it is important to examine it for reliability and consistency. The regressions that produce MARTAX have an average R^2 of 0.77, an average t-statistic for a_1 of 8.5, and an average t-statistic for a_0 of 2.5. In Table 1, we present for the 63 countries in our data set the values of AVGTAX and MARTAX. MARTAX is larger than AVGTAX for almost all countries (54 of 63), which corresponds to the intuition that countries typically have progressivity in their taxation. For these countries, the intercept in equation (1) was negative, which indicates that some part of GDP is generally "excluded" from taxes. The median percentage of GDP "excluded" from taxes is 34%, which strikes us as a fairly reasonable value.[6]

The non-zero intercept also provides the basis for testing whether our estimates of MARTAX and AVGTAX differ significantly. If $a_0 = 0$ in equation (1)

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[4]Strictly speaking, this method assumes a constant tax rate structure over the estimation period. Our measure of the marginal tax rate will be biased if tax rate changes are an important determinant of the time series variation in GDP over the estimation period. The greater the fraction of the time series variance of GDP that is exogenous to whatever tax structure changes that do occur, the better is our measure of marginal tax rates.

[5]We also derived an alternative measure of MARTAX as the a_1 coefficient from the regression $TAXREV_t/GDP = a_0/GDP + a_1 + e_t$. The two measures were highly correlated across countries (corr. = 0.98), and yielded virtually identical results throughout.

[6]To calculate the percentage of GDP excluded from the tax base, the a_0 coefficient in equation (1) was divided by a_1 times average real GDP over the 1970s.

then MARTAX=AVGTAX. The average t-statistic for a_0 in equation (1) is 2.5, which supports the hypothesis that MARTAX and AVGTAX do differ significantly on average over the data set.[7] It, nevertheless, appears that AVGTAX and MARTAX are quite correlated across countries. The correlation coefficient is 0.76 and highly significant. The corresponding cross-country regression of MARTAX on AVGTAX yields:[8]

$$(2)\quad MARTAX_j = \underset{\substack{(0.046)\\[1.56]}}{-0.072} + \underset{\substack{(0.22)\\[9.07]}}{1.96}\ AVGTAX_j + e_j$$

$R^2 = 0.574$ adjusted $R^2 = 0.567$
standard error of regression = 0.146 N = 63

When the apparent outliers, Israel and Zaire, are removed the slope coefficient decreases to 1.55 which suggests that across countries marginal tax rates average about one-and-a-half to two times average tax rates.[9]

Although MARTAX seemingly has many reasonable features, it is of considerable interest to validate it against an independent estimate of marginal tax rates. In particular, since MARTAX and AVGTAX are highly correlated, one should question the incremental information content of MARTAX for tax structure, although the intercept analysis does suggest that MARTAX should be incrementally informative. Fortunately, an independent data source is

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[7] For the 23 countries with fewer than 8 observations, the average t-statistic was still 1.7. Moreover, the results in the cross-country analysis are robust to the inclusion of these countries. Thus, we retained these in our analysis.

[8] The standard error of the coefficients are shown in parentheses, and the t-statistic in brackets below their respective coefficients.

[9] Excluding Israel and Zaire yields the following regression:

$$MARTAX_j = \underset{\substack{(0.03)\\[-0.40]}}{-\ 0.01} + \underset{\substack{(0.15)\\[10.17]}}{1.55}\ AVGTAX_j + e_j$$

$R^2 = 0.637$ adjusted $R^2 = 0.631$
standard error of regression = 0.097 N = 61

available and has been used by Reynolds [1985] to assess the marginal tax environment of many of the countries in our data set.

Using Price Waterhouse data on legislated top income tax brackets and the corresponding income thresholds, Reynolds ranked 16 industrialized and 8 semi-industrialized countries in terms of their marginal tax burdens. For the 20 countries that overlap those in our data set, we assigned ranks (20 to the highest tax country through 1 to the lowest tax country) by merging Reynolds' rankings, and denoted these as RENRK. A positive correlation between MARTAX and RENRK would indicate that high values of MARTAX are associated with high tax countries as ranked by Reynolds.[10] A regression yielded a positive coefficient with a t-statistic of 4.3, with a corresponding correlation coefficient of 0.71.[11]

The key issue for our measure of MARTAX is whether it is incrementally informative over AVGTAX in characterizing a country's marginal tax environment. To address this question, we present the regression of RENRK on both AVGTAX and MARTAX:

$$(3)\quad RENRK_j = \underset{[-0.41]}{\underset{(3.78)}{-1.56}} + \underset{[0.85]}{\underset{(17.94)}{15.32}}\, AVGTAX_j + \underset{[2.57]}{\underset{(7.37)}{18.95}}\, MARTAX_j + e_j$$

$R^2 = 0.529$ adjusted $R^2 = 0.473$
standard error of regression = 4.294 N = 20

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[10] The conditions under which RENRK and MARTAX would be correlated are (1) a stable tax structure over time (see footnote 4), and (2) top marginal tax rates and income thresholds that are representative of the overall tax structure.

[11] The regression for all 20 industrial countries yields:

$$RENRK_j = \underset{[0.375]}{\underset{(2.419)}{0.906}} + \underset{[4.31]}{\underset{(5.38)}{23.21}}\, MARTAX_j + e_j$$

$R^2 = 0.508$ adjusted $R^2 = 0.481$
standard error of regression = 4.262 N = 20

The regression shows that MARTAX with a t-statistic of 2.6 dominates AVGTAX, in determining Reynolds' [1985] independent ranking of countries by top marginal income tax rates. This supports the hypothesis that MARTAX is a better indicator of marginal income tax rates than AVGTAX in industrial countries. In principle, one could use the Price Waterhouse data for LDCs as well. However, in LDCs, where export taxes and other non-income based taxes are more important,[12] one would not expect a ranking of marginal income taxes to be a good indicator of the overall marginal tax rate. In this sense, MARTAX should provide marginal tax rates that are more comparable across our whole data set than measures based on Price Waterhouse data.

III. TAXATION AND ECONOMIC GROWTH

In this section, we will focus on the hypothesis that taxation adversely affects the rate of economic growth, i.e., the "shape" of the growth path. As discussed in the introduction, this hypothesis has already been empirically investigated by Marsden [1983], Rabushka [1985], Reynolds [1985], and Skinner [1987]. We proceed by examining a series of cross-country regressions that progressively refine the hypothesis under test.

Consider first the simple regression of economic growth on tax rates over the 63 countries in our data set. Our measure of economic growth (GDPGR) is the growth in real GDP from 1970 to 1979. Our measures of tax rates are AVGTAX and MARTAX discussed in Section II. The regressions are:

$$(4) \qquad GDPGR_j = \underset{\substack{(0.007)\\[8.26]}}{0.060} - \underset{\substack{(0.034)\\[-2.18]}}{0.074}\ AVGTAX_j + e_j$$

$R^2 = 0.072$ adjusted $R^2 = 0.057$
standard error of regression = 0.023 N = 63

[12] See Rabushka [1985].

$$(5) \qquad GDPGR_j = \underset{[10.48]}{\underset{(0.005)}{0.053}} - \underset{[-1.87]}{\underset{(0.013)}{0.025}} MARTAX_j + e_j$$

$R^2 = 0.054$ adjusted $R^2 = 0.038$
standard error of regression = 0.023 N = 63

These results reveal the existence of a negative relation between growth and both average and marginal tax rates over our sample of countries. This is consistent with Marsden's [1983] results for ten matched pairs of countries using average tax rates, Reynolds' [1985] results for several groupings of countries using top legislated marginal tax rates and Skinner's [1987] results for Sub-Sahara Africa. The result that average rates appear stronger than marginal rates is not consistent with those forms of the supply-side hypotheses that stress the importance of marginal tax rates in affecting growth. It should be pointed out, however, that such results may be the consequence of greater noise in MARTAX relative to AVGTAX.

We now attempt to control for other factors that theory suggests determine the growth rates of countries in our sample. This was the explicit methodology employed by Kormendi & Meguire [1985] in their work on the determinants of economic growth and we follow that route, subject to the limitations of data availability.[13]

Two separate issues come together to make it particularly important to control for per capita income in the context of the hypothesis currently under investigation. The first is evidence from Landau [1983], Barro [1984], Kormendi & Meguire [1985], and Baumol [1986] that reveals a pervasive negative

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[13] Skinner [1987] applies a similar methodology but uses a somewhat different set of control variables than those in Kormendi & Meguire [1985] or here. His results are also confined to Sub-Sahara data. Others have adopted this methodology for interpreting the effects on economic growth of (1) government spending (Landau [1983], Kormendi & Meguire [1985], Ram [1986], Barth [1987]), (2) exports (Balassa [1976], Tyler [1981], Feder [1982], Kormendi & Meguire [1985]), and (3) foreign aid (Mosley [1980] and Kormendi, Lavy, and Meguire [1986]).

effect of initial per capita income on subsequent economic growth. This effect would result, for example, if either (1) countries in the transition to steady state growth grow faster the further they start from the steady state (i.e. the lower is initial per capita income)[14] or (2) if technological diffusion from richer to poorer countries will generally cause the latter to grow faster.[15] The second issue concerns evidence from Peltzman [1980] and Rabushka [1985] that reveals that the size of the government sector, measured either by the ratio of government spending to GDP (Peltzman) or the ratio of taxation to GDP (Rabushka), is positively correlated with the level of per capita income in a country. Neither Peltzman nor Rabushka argue that this strong correlation represents beneficial effects of taxation (or government sector activity) on economic prosperity, but rather that it represents an endogenous demand for public sector activity in response to greater prosperity. In other words, the income elasticity of demand for the output of the government sector is greater than unity.

We can confirm that these distinct effects characterize our data set with the following pair of regressions, where YPC is per capita income in 1970 as defined in the appendix:

(6) $$GDPGR_j = \underset{(0.004)\ [13.10]}{0.057} - \underset{(0.015)\ [-3.52]}{0.053}\ YPC_j + e_j$$

$R^2 = 0.169$ adjusted $R^2 = 0.155$
standard error of regression = 0.022 N = 63

(7) $$AVGTAX_j = \underset{(0.013)\ [9.51]}{0.128} + \underset{(0.046)\ [6.32]}{0.293}\ YPC_j + e_j$$

$R^2 = 0.396$ adjusted $R^2 = 0.386$
standard error of regression = 0.067 N = 63

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[14] See Barro [1984] and Kormendi & Meguire [1985] for further discussion and Romer [1986] for an interesting theoretical paper on relative issues.

[15] See Kormendi & Meguire [1985] and Baumol [1986] for further discussion.

The consequence of these two findings for isolating the effects on economic growth of high average tax rates in particular (but marginal tax rates as well) is critical. The strongly significant effects of YPC in equations (6) and (7) are of opposite signs and hence could easily produce the negative simple correlations exhibited in (3) and (4) above. To address this possibility one must control for YPC in the growth regression.[16] Doing so, of course, controls for the general stage of economic development as well. The results are:

$$(8) \quad GDPGR_j = \underset{[8.34]}{0.058} - \underset{[-2.65]}{0.052}\ YPC_j - \underset{[-0.11]}{0.005}\ AVGTAX_j + e_j$$

(0.007) (0.019) (0.042)

$R^2 = 0.169$ adjusted $R^2 = 0.142$

standard error of regression = 0.022 N = 63

$$(9) \quad GDPGR_j = \underset{[11.4]}{0.060} - \underset{[-3.03]}{0.048}\ YPC_j - \underset{[-0.87]}{0.011}\ MARTAX_j + e_j$$

(0.005) (0.016) (0.013)

$R^2 = 0.179$ adjusted $R^2 = 0.152$

standard error of regression = 0.022 N = 63

When Israel and Zaire are excluded from the regression, the t-statistic of MARTAX decreases to -0.10. Thus, by controlling for per capita income, the apparent negative effects of both average and marginal tax rates disappear.

In a sense, these results for 63 countries are in direct opposition to those of Marsden [1983], because his matched pairings for 20 countries attempt to control for per capita income, among other things. Our results conform more to those of Rabushka [1985] who, in examining only LDCs, found an insignificant positive simple correlation between average taxes and growth. Stratifying our data set into LDC and non-LDC sub-samples, produces similar results in (8) and (9). Controlling for population growth as well (as in

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[16] See Kormendi, Lavy, and Meguire [1986] for similar issues that arise in assessing the growth impact of foreign aid.

Kormendi & Meguire [1985]) has little effect on the results. Controlling for Gastil's ordinal measure of civil liberties (discussed in both Kormendi & Meguire [1985] and Rabushka [1985]) does not materially affect the results either. Controlling for the neo-classical variables of capital accumulation and labor force growth does not fundamentally change the results.[17]

Because of the lack of a negative effect of taxation on economic growth, it is of interest to proceed a step deeper and to investigate whether adverse effects of taxation are apparent in either capital accumulation or labor force growth. To this end, we present a pair of regressions in which gross domestic investment as a fraction of income (GDIGDP) is the dependent variable in one, and labor force growth (LABGR) in the other. In both regressions, we again control for initial per capita income in order to maintain comparability with the growth results above. In the labor force growth regression, we control

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[17] Testing taxation within a neoclassical type production function yields the following results:

$$GDPGR_j = \underset{[-0.038]}{\underset{(0.014)}{-\ 0.001}} \underset{[-2.25]}{\underset{(0.18)}{-\ 0.041}}\ YPC_j + \underset{[3.45]}{\underset{(0.065)}{0.224}}\ GDIGDP_j + \underset{[1.89]}{\underset{(0.346)}{0.655}}\ LABGR_j \underset{[-0.65]}{\underset{(0.042)}{-\ 0.027}}\ AVGTAX_j + e_j$$

$R^2 = 0.405$ adjusted $R^2 = 0.363$
standard error of regression = 0.019 N = 63

$$GDPGR_j = \underset{[-0.13]}{\underset{(0.013)}{-\ 0.002}} \underset{[-2.59]}{\underset{(0.017)}{-\ 0.044}}\ YPC^j + \underset{[4.03]}{\underset{(0.062)}{0.249}}\ GDIGDP_j + \underset{[1.82]}{\underset{(0.320)}{0.582}}\ LABGR_j \underset{[-1.85]}{\underset{(0.012)}{-\ 0.023}}\ MARTAX_j + e_j$$

$R^2 = 0.434$ adjusted $R^2 = 0.395$
standard error of regression = 0.018 N = 63

(continued on next page)

for population growth as well, which yields a participation interpretation.[18]

We present only the results for MARTAX as the results for AVGTAX are similar:

$$(10) \quad GDIGDP_j = \underset{[18.44]}{\underset{(0.010)}{0.179}} + \underset{[1.75]}{\underset{(0.030)}{0.052}}\ YPC_j + \underset{[2.55]}{\underset{(0.025)}{0.063}}\ MARTAX_j + e_j$$

$R^2 = 0.190$ adjusted $R^2 = 0.163$
standard error of regression = 0.04 N = 63

$$(11) \quad LABGR_j = \underset{[-0.30]}{\underset{(0.003)}{-\ 0.001}} + \underset{[2.89]}{\underset{(0.005)}{0.014}}\ YPC_j + \underset{[11.92]}{\underset{(0.083)}{0.986}}\ POPGR_j +$$

$$\underset{[-1.51]}{\underset{(0.003)}{-\ 0.004}}\ MARTAX_j + e_j$$

$R^2 = 0.819$ adjusted $R^2 = 0.809$
standard error of regression = 0.004 N = 63

The main results of interest are the coefficients on MARTAX. Contrary to the supply-side contention, marginal tax rates have a significant positive relation to gross domestic investment.[19] Note, however, that since we are not

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17(continued) The apparently large negative coefficient on MARTAX is due completely to two large outliers, Israel and Zaire. Upon excluding them, the t-statistic of MARTAX falls to -0.250 and no significant effect of taxes can be found. These results are of interest for several reasons. First, they reveal the expected neo-classical results: (1) a positive impact of GDIGDP, (2) a negative impact of YPC (expected in the path to the steady state), and (3) a positive coefficient of LABGR (but not one-to-one with growth). A similar relation was found by Kormendi & Meguire [1985]. Second, they indicate that controlling for more variables does not affect the results in equation 9. Third, because GDIGDP and LABGR are held constant, the coefficient on taxation bears the interpretation of tax induced changes in the efficient utilization of factors of production. Finally, Skinner [1987] controls for investment in his analysis of 31 sub-Schema African countries and found negative effects of average tax rates on growth. He did not, however, control for YPC. Moreover, our rate of return to investment (the GDIGDP coefficient) is on the order of 22-25%, whereas Skinner finds an 87% return to public investment, which strikes us as rather high.

[18]If the coefficient of population growth is 1.0, the growth in labor force participation, LABGR - POPGR, would emerge directly.

[19]Skinner [1987] found similar results for average tax rates in Sub-Sahara countries.

separately measuring public vs. private investment, the positive effect of high tax rates on total investment may be capturing tax revenue financing of public investment in excess of the adverse effects on private investment. On the other hand, marginal evidence of a negative effect of MARTAX on labor force growth seems to emerge.

The coefficients on YPC reveal lower capital accumulation and labor force growth in lower income countries. The approximately unitary effect of population growth on labor force growth is also a sensible result. Thus, while we do not wish to make too much of the results for MARTAX in these two equations, the reasonable results for the other coefficients are comforting when interpreting the evidence for the effects of marginal tax rates. The evidence does suggest that higher marginal tax rate environments are related to a shift in factor utilization from labor to capital.[20] The net effect on economic growth of such factor shifting, however, appears to be zero as no effect of MARTAX could be found in equation (9). This implies that the factor shifting effects are largely offsetting.[21]

IV. TAXATION AND ECONOMIC ACTIVITY

Our failure to find a significant negative relation between tax rates and economic growth still leaves open the question of the effects of tax rates on the level of economic activity. That these are separable hypotheses can be seen in the case of a pure consumption tax which would generally have little

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[20] In the neo-classical framework, the effects of tax rates depend upon the relative weight of capital taxes vs. other taxes. Thus, it would be of interest to decompose MARTAX (based on an induced AVGTAX decomposition) and refine the tests further. For theoretical discussion related to these issues see Feldstein [1974] and Atkinson & Stiglitz [1980].

[21] See Kormendi & Meguire [1985] for further discussion of the appropriate interpretation of such results in terms of channels of growth. See also the discussion in footnote 17 of the efficient utilization of factor resources.

distortionary impact on the intertemporal allocation of resources, i.e., the rate of growth, but could well adversely impact the level of output, thus shifting down the whole growth path parallel to itself. The fundamental problem in testing for such a level shift is the Peltzman-Rabushka hypothesis concerning the potential endogeneity of the size of the government sector to a country's income per capita. In this regard, adverse causal effects of tax rates on economic activity may be swamped by the endogenous derived demand for government output implicit in its average tax rates. In fact, as we saw in equation (7), the simple correlation between AVGTAX and YPC is very strongly positive (corr. = 0.62), and the same holds but to a lesser extent for the MARTAX - YPC correlation (corr. = 0.32).

Fortunately, the very fact that we have measures for both average and marginal tax rates provides a method of testing the hypothesis that <u>tax structure</u> affects the level of economic activity. If we control for the relation between the average level of taxation and income per capita, we can in principle isolate the effects of marginal tax rates on YPC. One interpretation of such a test is as the effect of a "revenue neutral" change in marginal tax rates on the level of economic activity. Thus, although we cannot uncover the effects of the general level of taxation on the level of activity for Peltzman-Rabushka reasons, we can uncover the effects of revenue neutral changes of the marginal tax structure.

Consider, then, the regression of YPC on both MARTAX and AVGTAX as a basis for testing the isolated effects of marginal tax rates on the level of economic activity. The results are:

$$(12) \quad YPC_j = \underset{\substack{(0.044)\\[-1.26]}}{-\ 0.056} + \underset{\substack{(0.317)\\[5.99]}}{1.899}\ AVGTAX_j - \underset{\substack{(0.123)\\[-2.28]}}{0.280}\ MARTAX_j + e_j$$

$R^2 = 0.444$ adjusted $R^2 = 0.425$

standard error of regression = 0.14 N = 63

Including AVGTAX controls for the general positive relation between AVGTAX and YPC, but since the relation is in inverted form the coefficient value cannot be directly interpreted. The coefficient on MARTAX, however, does measure the size of the "revenue neutral" effects of marginal tax rates on the level of economic activity. In this regard, it is related to the corresponding partial correlation between YPC and MARTAX, controlling the AVGTAX. That partial correlation coefficient is -0.27 with a t-statistic of -2.3. When outliers are removed the partial correlation increases to -0.42 with a t-statistic of -3.8. Controlling in addition for the average ratio of government consumption to GDP (obtained from the IFS Yearbook and defined analogously to AVGTAX) yields quite similar results, as does stratifying the sample into LDC and non-LDC subsamples.

Interpreting the above test of the MARTAX coefficient depends on two conditions holding. First, our measure of marginal tax rates must carry incremental information over and above average tax rates about the structure of taxation. We addressed this issue in Section II, but note here that a lack of such informational content would bias the MARTAX-YPC partial correlation towards zero. The second condition is that the endogeneity of the government sector must manifest itself primarily in terms of the average level of taxation. However, if more prosperous countries endogenously choose not only a relatively larger government sector, but choose to finance this with a greater reliance on high marginal tax rates, this would bias results against finding negative effects of MARTAX. In both respects, finding of no effect of MARTAX would not be conclusive, but our finding of a negative effect is strengthened.

The negative relation between MARTAX and YPC, controlling for AVGTAX, is evidence in favor of the supply-side hypothesis that high marginal tax rates

adversely affect the level of economic activity. It is also evidence that marginal rates have distinct effects from average rates of taxation as per supply-side theory. Finally, it bears the interpretation of the effects of "revenue neutral" marginal tax rate changes on aggregate activity. Together with the absence of effects of tax rates on economic growth, these results reveal that "revenue neutral" marginal tax rate reductions (increases) are associated with a parallel upward (downward) shift in the whole growth path.[22]

Although we have so far focused only on the partial correlation, we can interpret the size of this negative effect from the MARTAX coefficient in equation (12). The MARTAX coefficient of 0.280 reveals that a 10% decrease in marginal tax rates, holding average tax rates constant, would increase per capita income by $280 in 1975 U.S. dollars. When the sample is stratified into LDC and non-LDC subsets the size of the effects are $107 and $236 with t-statistics of 2.1 and 1.6 respectively. Given that the average YPC is $833 and $3838 within the two subsets, a 10% MARTAX reduction thus yields approximately a 12.8% increase in LDC per capita income and about a 6.1%

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[22] We did not include both MAXTAX and AVGTAX in the growth rate analysis in Section III, because holding YPC constant enables a direct analysis of AVGTAX itself. Including both rates, however, yields a "revenue neutral" interpretation for the MARTAX coefficient. The results (excluding Israel and Zaire) are:

$$GDPGR_j = \underset{(0.007)\ [8.43]}{0.058} - \underset{(0.019)\ [-3.25]}{0.063}\ YPC_j + \underset{(0.065)\ [0.47]}{0.030}\ AVGTAX_j - \underset{(0.028)\ [-0.415]}{0.012}\ MARTAX_j + e_j$$

$R^2 = 0.226$ adjusted $R^2 = 0.185$
standard error of regression = 0.021 N = 61

These should be compared to the results in (8) and (9). The low t-statistics for both the average tax and marginal tax variables indicate the absence of any significant relationship of tax rates with growth. In particular, revenue neutral marginal tax rate changes have no significant effects on growth.

increase in non-LDC per capita income. Thus, the relative benefits of revenue neutral marginal tax rate reductions are greater for LDCs than for developed countries, but significant for both.

V. CONCLUSION

We have undertaken a systematic cross-country analysis of the effects of average and marginal tax rates on the level and growth of economic activity. To this end, we constructed a data base consisting of all 63 countries for which at least five years of continuous data exists for the 1970s for the purpose of estimating average and marginal tax rates. Our estimates of marginal tax rates were then obtained for each country from the time-series regression of tax revenues on GDP. The slope coefficient, which can be interpreted as the increment to revenues obtained from increments to income, constituted our measure of marginal tax rates, denoted MARTAX. Our measure of the average tax rate, AVGTAX, was taken to be the average ratio of revenues to GDP over the 1970s.

For most countries in our data base (54 of 63), we found that MARTAX was greater than AVGTAX, which indicates a pervasive progressivity of taxes. In this regard, we found that MARTAX averaged one-and-a-half times the size of AVGTAX and, correspondingly that approximately 34% of income on average is excluded from the tax base. We established that MARTAX and AVGTAX, though correlated across countries, differ significantly over our data base. Finally, we found that an independently developed ranking (Reynolds [1985]) of legislated "top" marginal tax brackets from Price Waterhouse data was better explained by MARTAX than by AVGTAX. This latter result helped to establish the incremental information content of our MARTAX measure for the work that followed.

Turning to the issue of economic growth, we first established that a significantly negative simple correlation exists between economic growth and both MARTAX and AVGTAX, results which conform to the evidence in Marsden [1987], Reynolds [1985], and Skinner [1987]. We showed, however, that such an apparent negative relation depends crucially upon the interaction of two effects: (1) the endogenous positive relation between average tax rates and per capita income discussed in Peltzman [1980] and Rabushka [1985], and (2) the pervasive negative relation between economic growth and per capita income discussed in Landau [1983], Barro [1984], Kormendi and Meguire [1985], and Baumol [1986]. Controlling for this interaction, in fact, removed the negative effects of both AVGTAX and MARTAX on growth, a result which was shown to be robust to the inclusion of various other controlling variables as well.

Going a step deeper, we then examined the tax rate effects on capital accumulation and labor force growth. We found that high marginal tax rates seem to be associated with lower labor force growth, but greater capital accumulation. The first result is expected from supply-side theory, but the second is not. In this regard, high marginal tax rate environments seem to be associated with a shift of resources, away from labor and towards capital, but with neither beneficial nor adverse net effects on growth. Two open questions that remained were the extent to which the observed increase in capital formation is concentrated in the public sector and the extent to which high marginal tax rate environments are characterized by relative subsidies to capital formation.

Having found no effects of tax rates on growth, we turned to examine the effects on the level of economic activity. No prior research has focused on such level effects, presumably because the simple correlation between income per capita and average tax rates is very strongly positive, reflecting the

Peltzman-Rabushka endogeneity. To solve this problem, we refined the supply side hypothesis under test to address the "revenue neutral" effects of marginal tax rates on the level of economic activity. Thus, by controlling for AVGTAX, we were able to isolate the relation between MARTAX and the level of activity and found a significantly negative revenue neutral effect of MARTAX on income per capita. We then calculated the size of this effect for both LDC and non-LDC subsets of countries. These calculations showed that a 10% revenue neutral reduction (increase) in marginal tax rates would yield a 12.8% increase (reduction) in per capita income for LDCs and a 6.1% increase (reduction) in per capita income for non-LDCs.

The combined effect of our results for the level and growth of economic activity can be summarized as follows. Higher (lower) revenue neutral marginal tax rates generally are associated with downward (upward) parallel shifts in the whole growth path, and with shifting resource use away from labor and towards capital.

TABLE 1

COUNTRY	MARTAX	AVGTAX	GDPGR	YPC	GDIGDP	LABGR	POPGR
ARGENTINA	0.2225	0.1069	0.025	0.2750	0.2225	0.014	0.016
AUSTRALIA	0.3534	0.2078	0.032	0.5552	0.2382	0.018	0.015
AUSTRIA	0.5136	0.3066	0.037	0.4154	0.2587	0.008	0.001
BELGIUM	0.7235	0.3777	0.032	0.4771	0.2162	0.007	0.002
BOLIVIA	0.0771	0.0880	0.052	0.0915	0.1645	0.023	0.025
BRAZIL	0.2198	0.1768	0.087	0.1225	0.2226	0.022	0.022
BURMA	0.2180	0.0874	0.043	0.0320	0.1249	0.015	0.022
CANADA	-0.0087	0.1686	0.042	0.5703	0.2234	0.020	0.011
CHILE	0.3359	0.2220	0.019	0.2090	0.1238	0.019	0.017
COLOMBIA	0.1336	0.1051	0.060	0.1355	0.1980	0.036	0.023
COSTA RICA	0.2068	0.1567	0.060	0.1601	0.2254	0.036	0.025
DENMARK	0.2372	0.3058	0.028	0.5530	0.2227	0.006	0.004
DOMINICAN REP.	0.0534	0.1833	0.075	0.1113	0.2101	0.034	0.029
ECUADOR	0.0333	0.1040	0.083	0.0954	0.2059	0.033	0.033
EGYPT	0.2597	0.2701	0.076	0.0755	0.2125	0.020	0.020
EL SALVADOR	0.2215	0.1243	0.049	0.0902	0.1770	0.028	0.029
ETHIOPIA	0.2750	0.1004	0.019	0.0336	0.1024	0.017	0.021
FINLAND	0.3579	0.2670	0.028	0.4549	0.2665	0.011	0.005
FRANCE	0.5483	0.3405	0.037	0.5041	0.2267	0.010	0.006
FED. REP. GER.	0.3638	0.2511	0.026	0.5356	0.2333	0.007	0.001
GHANA	0.0010	0.1137	-0.001	0.1080	0.0968	0.024	0.030
GREECE	0.4721	0.2569	0.049	0.2672	0.2336	0.005	0.006
GUATEMALA	0.1529	0.0876	0.059	0.1133	0.1561	0.030	0.029
HONDURAS	0.2023	0.1250	0.035	0.0910	0.2133	0.031	0.033
INDIA	0.1544	0.1037	0.034	0.0450	0.1763	0.017	0.021
INDONESIA	0.3210	0.1675	0.076	0.0391	0.1853	0.025	0.023
IRELAND	0.4255	0.2996	0.037	0.2717	0.2580	0.010	0.011
ISRAEL	1.4186	0.4154	0.046	0.3419	0.2903	0.025	0.027
ITALY	0.6185	0.2852	0.029	0.3655	0.2026	0.007	0.006
KENYA	0.2771	0.1608	0.065	0.0431	0.2121	0.028	0.034
KOREA	0.2078	0.1416	0.103	0.1112	0.2742	0.028	0.019
MALAYSIA	0.2995	0.1940	0.079	0.1242	0.2397	0.026	0.022
MALAWI	0.2075	0.1184	0.063	0.0257	0.2484	0.022	0.028
MEXICO	0.2751	0.1266	0.051	0.2005	0.2171	0.030	0.029
MOROCCO	0.3307	0.1837	0.061	0.0956	0.2116	0.030	0.029
NETHERLANDS	0.6148	0.4513	0.031	0.4767	0.2255	0.013	0.008
NEW ZEALAND	0.4693	0.2732	0.024	0.4137	0.2251	0.021	0.015
NICARAGUA	0.1547	0.1169	0.026	0.1246	0.1574	0.033	0.033
NIGERIA	0.4116	0.1876	0.075	0.0936	0.2378	0.017	0.025
NORWAY	0.3881	0.3456	0.048	0.4511	0.2947	0.007	0.005
PAKISTAN	0.1546	0.1131	0.045	0.0564	0.1505	0.026	0.031
PANAMA	0.3314	0.1904	0.034	0.1804	0.2545	0.024	0.023
PARAGUAY	0.1334	0.1025	0.083	0.1004	0.2075	0.031	0.029
PERU	0.1604	0.1443	0.031	0.1626	0.1474	0.030	0.027
PHILIPPINES	0.1783	0.1055	0.062	0.0781	0.2204	0.024	0.026
PORTUGAL	0.5081	0.2385	0.045	0.2126	0.1881	0.011	0.014
SIERRA LEONE	0.0875	0.1548	0.016	0.0580	0.1369	0.018	0.025
SOUTH AFRICA	0.2818	0.1878	0.036	0.2239	0.2627	0.026	0.027
SPAIN	0.3328	0.1888	0.044	0.3231	0.2179	0.011	0.010
SRI LANKA	0.3936	0.1790	0.038	0.0765	0.1882	0.020	0.017

COUNTRY	MARTAX	AVGTAX	GDPGR	YPC	GDIGDP	LABGR	POPGR
SWEDEN	0.6786	0.3202	0.020	0.6025	0.2108	0.003	0.003
SWITZERLAND	0.2198	0.1562	0.002	0.5958	0.2448	0.005	0.003
SYRIA	0.1376	0.1157	0.090	0.1041	0.2131	0.033	0.036
TANZANIA	0.1877	0.1534	0.049	0.0394	0.2017	0.027	0.034
THAILAND	0.1357	0.1173	0.077	0.0791	0.2405	0.027	0.024
TUNISIA	0.3896	0.2292	0.076	0.1016	0.2543	0.030	0.021
TURKEY	0.2821	0.1748	0.066	0.1408	0.1949	0.022	0.025
UNITED KINGDOM	0.2129	0.3018	0.021	0.4216	0.1862	0.003	0.001
UNITED STATES	0.2366	0.1757	0.031	0.6629	0.1811	0.018	0.010
URUGUAY	0.2239	0.1997	0.025	0.2648	0.1371	0.001	0.003
VENEZUELA	0.2899	0.2011	0.055	0.3667	0.2647	0.040	0.033
ZAIRE	0.7918	0.2181	-0.007	0.0413	0.2100	0.021	0.027
ZAMBIA	0.3588	0.2249	0.015	0.0722	0.2845	0.024	0.030

APPENDIX

VARIABLES

$NTAXREV_t$ = Annual nominal tax revenue in own currency from the Government Financial Statistics Yearbook for the period 1970-79.

GDP_t = Annual real gross domestic product for the period 1970-79 in own currency from the International Financial Statistics Yearbook in 1975 prices.

$NGDP_t$ = Annual nominal gross domestic product for the period 1970-79 in own currency from the International Financial Statistics Yearbook.

$TAXREV_t = NTAXREV_t * (GDP_t / NGDP_t)$

$AVGTAX_j = \sum_{t=1..n} (TAXREV_t / GDP_t) \; / \; n$ n = number of consecutive observations

$MARTAX_j = a_1$ in the regression of $TAXREV_t = a_0 + GDP_t \; a_1 + e_t$

$RENRK_j$ = ranking of 20 industrial countries in accordance with rankings in Reynolds [1985] who ranked countries by their top legislated marginal income tax rates and their corresponding thresholds. A value of 20 was assigned to the highest ranked country and a value of 1 to the lowest ranked country.

$GDPGR_j$ = the mean rate of growth in real gross domestic product from 1970 to 1979 from the World Development Report.

YPC_j = Real 1970 GDP per capita in US$ at 1975 international prices from Summers and Heston [1984], divided by 10,000.

$NGDI_t$ = Annual nominal gross domestic investment in own currency in the 1970s from the International Financial Statistics Yearbook.

$GDIGDP_j$ = the mean of the the first, middle and last data point available during the 1970s of the ratio of $NGDI_t / NGDP_t$.

$LABGR_j$ = the mean growth in the labor force from 1970 to 1979 from the World Development Report.

$POPGR_j$ = the mean growth in population from 1970 to 1979 from the World Development Report.

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