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How do National Policies Affect Long-run Growth?

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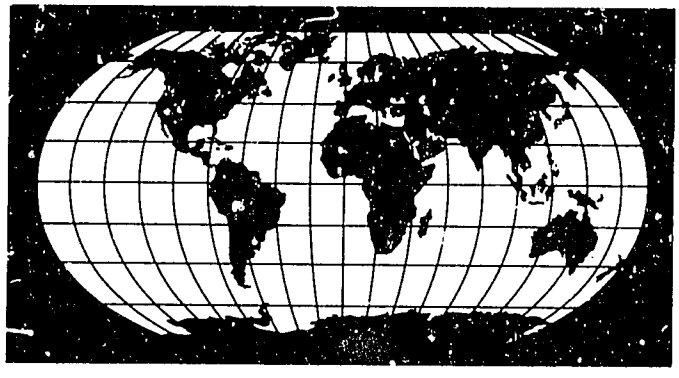

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"Fiscal Policy and Economic Growth: an Empirical Investigation"

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FISCAL POLICY AND ECONOMIC GROWTH: AN EMPIRICAL INVESTIGATION

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ABSTRACT

This paper describes the main empirical regularities concerning the relation between fiscal policy variables, the level of development and the rate of growth of the economy. We use historical data going back to 1870 as well as recent cross-section data, including newly constructed series for public investment. We show that the data is broadly consistent with the theoretical predictions of growth models concerning the effects of taxation and public investment on economic growth. We find that investment in transport and communication is consistently correlated with growth with a coefficient that implies a high return to public investment. We also find evidence that public enterprise investment crowds out private investment. The collinearity between the fiscal structure and the level of income makes it difficult to isolate the effects of taxation on growth. Finally, there seem to be scale effects related to the size of population that affect the character of the fiscal system.

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I. INTRODUCTION

This paper uses historical data going back to 1870 as well as recent cross-section data, including newly constructed series for public investment, to describe the main empirical regularities concerning the relation between fiscal policy variables, the level of development and the rate of growth of the economy.

The influence of fiscal policy on the rate of economic growth has been a subject of active research during the past three decades. Researchers such as Sato (1967), Krzyzaniak (1967), and Feldstein (1974a,b) used versions of the Solow (1956) model to study the dynamic impact of taxation. More recently, Chamley (1986) and Judd (1985), among others, have used the neoclassical growth model with an endogenous savings rate developed by Cass (1965) and Koopmans (1965) as a laboratory to study fiscal policy. Diamond's (1965) overlapping generations version of the neoclassical model has also been extensively used, by Summers (1981), Auerbach and Kotlikoff (1987) and others, to examine the dynamic effects of fiscal policy.

Since in the neoclassical model steady state growth is driven by exogenous factors--the dynamics of population and of technological progress--fiscal policy can only affect the rate of growth during the transition to the steady state. Because of this fact, the conventional wisdom based on the neoclassical model has been that differences in tax systems and in debt and expenditure policy can be important determinants of the level of output but are unlikely to have an important effect on the rate of growth.[1]

In contrast, the models proposed in the recent growth literature generally predict that fiscal policy can be one of the main determinants of the observed differences in growth experiences. The past few years have witnessed the development of a large literature that uses endogenous growth models to examine the importance of fiscal policy in setting the pace of economic development.[2] The theoretical predictions produced by

[1]In the standard neoclassical model with a conventional value for the share of capital in output the transitional dynamics can only be important if the real interest rate takes on implausibly high values (King and Rebelo (1993)).

[2]A partial list of the papers that examine the effect of different fiscal policies on

this literature will be one of the main focuses of this paper.[3] In particular we will examine two of the strongest predictions to emerge from this theoretical research: that high income taxes lower the rate of growth and that high public spending in infrastructure investment raises growth.

Our discussion is organized in seven short sections. Section II reviews the main theoretical implications of the recent literature for the relation between fiscal policy and growth. Section III describes the data that we employed and discusses the main measurement problems associated with fiscal variables. Section IV describes some stylized facts concerning the relation between fiscal policy and the level of income using historical data for the period from 1870 to 1988. Section V explores post-war data to discuss the interaction between fiscal policy, private investment and growth. Section VI describes how a new series for consolidated public investment is related to growth performance. Section VII summarizes the main findings.

economic growth in infinite horizon models include Jones and Manuelli (1990), King and Rebelo (1990), Barro (1990), Rebelo (1991), Barro and Sala-i-Martin (1991), Kim (1991), Faig (1991), Easterly (1990,1991), and Rebelo and Stokey (1992). Alogoskoufis and van der Ploeg (1991) and Saint Paul (1992) are examples of investigations of the role of fiscal policy in endogenous growth models with an overlapping generations structure.

[3]Prior empirical analyses of the relation between fiscal policy and growth include Landau (1983), Plosser (1992), Grier and Tullock (1989), Koester and Kormendi (1989) and Skinner (1992).

II. THEORETICAL PREDICTIONS

There are three approaches to investigating the relation of fiscal policy instruments with both the level and the rate of growth of income: (i) to view government policy as exogenous; (ii) to assume that governments follow optimal policies; (iii) to treat policy as the outcome of a political process. By making policy endogenous the last two approaches point to very few exogenous factors that can be used in the empirical analysis.

The current generation of dynamic optimal fiscal policy models is not a promising starting point to design an empirical investigation because the optimal policies associated with most growth models are clearly counterfactual. For example, the optimal tax policy associated with most dynamic models implies that only taxes on labor and consumption should be used in the steady state.[4] There are two aspects missing in this literature that might be important in making its predictions consistent with the facts about the evolution of fiscal systems described in the next sections.

The first aspect involves moving beyond representative agent models in order to introduce redistribution considerations.[5] We will later see that the data suggests that income taxes and the public provision of education are used as redistribution tools by the government.

The second aspect that may help generate realistic fiscal policies is the consideration of the costs of administering different tax systems. The implementation of a tax system involves social costs that are largely independent of the revenue that the government plans to collect. The taxation of firm's profits, for example, requires that standardized accounting procedures be implemented and that trained tax inspectors be employed to check the accuracy of tax reports. Considering this type of costs may allow us to explain two of the facts that we document in the next sections: the scale effect of population on the character of the fiscal system as well and the link between

[4]See Chamley (1986), Lucas (1990), Yuen (1990), King (1991), Jones, Manuelli and Rossi (1992), and Correia (1992) for discussions of optimal taxation in dynamic models.

[5]The optimal tax policy in economies in which there is a redistribution motive has already been studied in the static optimal taxation literature, see Auerbach (1985).

a country's fiscal structure and its level of development.[6]

Models that incorporate aspects of the political system are a promising line of research which tends to generate more realistic policies than the current generation of dynamic optimal tax models. However, the study of this class of models is still in its infancy and a paradigm that is general enough to guide empirical work is at present not available.[7] For this reason we will treat fiscal policy as exogenous throughout most of the paper. However, we study in section V whether fiscal variables exhibit different behavior in democracies and non-democracies as well as the relation between fiscal policy and the distribution of income.

The effects of various fiscal policy instruments on the rate of growth are described in Table 1. These predictions are consistent with the transitional dynamics of the neoclassical growth model as well as with the steady state behavior of a variety of endogenous growth models, e.g. a version of Romer's model (1986) that admits steady state growth, the economies with convex technologies explored by Jones and Manuelli (1990) and Rebelo (1991), and the 'lab equipment model' of Rivera-Batiz and Romer (1991). While these models share the same qualitative implications, the strength of the effects of fiscal policy levers on growth varies significantly from model to model, depending heavily on aspects of the technology to accumulate human capital and to create new goods about which very little is currently known (see Rebelo and Stokey (1992)).

To isolate the effect of each fiscal instrument we assume in Table 1 that the impact of changes in the different fiscal variables on government revenue or expenditures are compensated with lump sum taxes or subsidies. Furthermore, we consider only permanent changes in the various fiscal policy instruments.

In models with exogenous labor supply it is obvious that a tax on consumption has no growth effects, since it does not distort the relative price of consumption today

[6]The administrative and compliance costs of taxation are not small. In a study for Canada, Vaillancourt (1989) estimated that the total private and government operating costs associated with the income tax and the social security payments represent 7.1% of the revenue collected. In a similar study for the U.K. in the period 1986-87, Sandford, Godwin and Hardwick (1989) estimated that these costs represent 4.93% of revenue.

[7]Persson and Tabellini (1991), Cohen and Michel (1991) and Alesina and Rodrick (1991) are examples of the recent literature on politics and growth.

versus tomorrow, leaving unaffected the incentive to accumulate capital. Under plausible conditions it can also be shown that a tax on consumption does not affect the rate of growth even in economies with an endogenous labor supply (see Rebelo and Stokey (1992)).

TABLE 1

THEORETICAL PREDICTIONS

Variable	Effect on Growth	
Consumption Taxes	no effect	
Investment Taxes	-	
Income Taxes	-	
Inflation Tax	-	
Government Consumption	no effect	
Government Investment	+	
Deficits	∞ horizon Ambiguous	OLG -

A '+' means that the variable has a positive effect on the rate of growth, while a '-' denotes a negative effect.

The inflation tax and the taxes on investment and income all reduce growth through the same channel: a reduction of the private returns to accumulation.[8]

[8]In a cash-in-advance model the inflation tax can only reduce the rate of growth if money has to be used to purchase investment goods. See Mino (1989) and Wang and Yip (1991) for a discussion.

The steady state growth rate is in general independent of the level of government consumption and positively related to public investment since this enhances the returns to private investment.

The effects of government deficits are more complex. In OLG models government deficits tend to reduce the savings rate and the rate of growth (see Alogoskoufis and Ploeg (1991)). In infinite horizon models the effects of deficits depend on the variables that have to be adjusted in the future to compensate for the deficits. If a higher deficit today will later be compensated by higher consumption or income taxes the rate of growth will decline. It is less clear what happens when reductions on government investment or taxes on labor are used to compensate for a temporary deficit.

Table 1 isolates the effect of each individual instrument on the steady state growth rate. A natural way searching for the effects predicted in Table 1 is to regress the rate of growth on the first six variables in Table 1 and exclude government deficits. We will later see that in practice this strategy is plagued by multicollinearity problems.

III. DATA SOURCES AND MEASUREMENT PROBLEMS

Before we explore in more detail the theoretical implications that we propose to examine it is useful to describe our data sources and to discuss some potential problems with the data that we have available.

III.1 DATA SOURCES

Our long-term data on fiscal policy is a panel that comprises the period from 1870 to 1988 and includes a total of 28 countries.[9] This data was spliced together from various sources: Mitchell (1980, 1982, 1983), Maddison (1982), and Liesner (1989). To obtain a long term series for real per capita GDP we used the Summers and Heston (1991) data for the period 1950-1988 and extended it backwards in time using the growth rate of real per capita GDP implied by our historical sources.[10]

Our post-war data consists of the Summers and Heston (1991) data set complemented with data from Barro and Wolf (1989), from the Government Financial Statistics (GFS) and from the International Financial Statistics (IFS). A complete list of the fiscal variables that we employed, as well as their sample means and standard deviations, is included in the Appendix (missing in this version of the paper). The sample period available for GFS statistics is 1970-1988. Unless we state otherwise all fiscal variables are expressed as percentages of GDP and correspond to averages over the 1970-1988 period. We will explore mainly the cross section dimension of the data because Easterly, Kremer, Pritchett, and Summers (1992) show that the variability over time of country characteristics adds little explanatory power in terms of the growth rate.

To deal with the measurement problems associated with public investment discussed below we constructed new measures of public investment through a large scale data collection exercise on aggregate and sectoral consolidated public investment. Our data

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[9]The countries in our sample are: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Finland, France, Germany, Greece, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Peru, Portugal, Spain, Sweden, Switzerland, United Kingdom, Uruguay, USA, and Venezuela.

[10]An appendix, available upon request, describes in detail our data sources and the process used to construct the real per capita GDP series.

source was the large collection of World Bank reports on public investment in individual countries since 1960. An earlier exercise (Pfeffermann and Madarassy (1991)) collected consolidated public investment from a selection of these reports. We expanded this list to more countries and more years. More importantly, we collected data on sectoral public investment and investments by levels of government from these reports, the first time we are aware that this has been done comprehensively. We have supplemented the data we collected for aggregate public investment with other sources, including Pfeffermann and Madarassy (1991), the World Development Report (1991) and the United Nations national accounts. A detailed description of the public investment data can be obtained in Clark, Easterly and Rebelo (1992).

III.2 MEASUREMENT PROBLEMS

We will first discuss the method that we used to compute rates of growth and then turn to the two most important measurement problems specific to fiscal data: the measurement of the relevant marginal tax rates and of the level of public investment.

Computing Growth Rates

We follow Levine and Renelt (1992) in using World Bank data instead of Summers and Heston (1991) data to construct per capita income growth rates. This procedure reduces the possibility of the negative coefficient on initial income, typically found in Barro (1991)-type regressions, being an artifact of measurement error in income. All growth rates were computed by running a least squares regression of the logarithm of income on time instead of calculating the geometric growth rate. Watson (1992) has shown that the least squares growth rate is more robust to differences in the serial correlation properties of the data than the geometric rate of growth.

Measuring Marginal Tax Rates

The most important obstacle to an empirical investigation of the effects of fiscal policy on growth is that marginal tax rates and subsidies--which are the relevant

variables according to theory--are not observable. We have explored four approaches to measuring tax rates, each with its own problems.[11]

Statutory tax rates on income are available for a cross section of developing countries (see Sicat and Virmani (1988)). We include these tax rates in our data set, but given that tax evasion is an important phenomenon in LDC's, we suspect that these rates grossly overestimate the distortions associated with income taxation. Ideally, we would use the methodology of Barro and Sahasakul (1983,1986) to estimate marginal tax rates. However, this requires information on individual incomes and taxes that is currently publicly available only for a small set of developed countries.

We use the revenue from different types of taxes expressed as a fraction of GDP as a measure of the tax distortions. In the case of the income tax this would only correspond to the marginal tax rate on income if the tax were proportional. Even stronger assumptions are needed to guarantee that the fraction of revenue in GDP correspond to marginal tax rates in the case of taxes on investment and on consumption. For this reason, we also construct tax rates as the ratio of a specific type of revenue to the corresponding tax base (e.g. trade tax revenue/total trade or personal income tax/personal income).

In Easterly and Rebelo (1992) we discuss a method to compute income-weighted marginal income tax rates for a subset of the countries included in the Sicat-Virmani (1988) data set. The key assumption that we employ is that the marginal income tax schedule follows a logistic functional form. We compute the four parameters in the tax schedule by combining information on the lowest and the highest statutory tax rates, on the level of income for which taxes are zero, on the distribution of income and on the income tax revenue collected. Since we found our income-weighted marginal income tax measures to be highly correlated with the ratio of income tax revenue to personal income we employ this variable as a proxy for the income-weighted marginal tax rate in this

[11]We also explored the possibility of computing statutory effective marginal tax rates on capital income along the lines of King and Fullerton (1984), taking advantage of the software developed by Dunn and Pellechio (1990) which can produce effective marginal tax rates for various developing countries. We found, as is common in this literature, that the effective marginal tax rates were very sensitive to the mix of assets involved in the project as well as to the choice of financing arrangements.

paper.

We also computed "marginal" taxes rates by regressing the revenue from each type of tax on its tax base, as in Koester and Kormendi (1989). Unfortunately, the results of some of these regressions tend to vary significantly with the sample period employed since a significant number of LDC's reformed their tax system in the end of the 1980's.[12] This instability for our ratios of revenue to the tax base or to GDP.

While the statutory tax rates tend to overestimate the distortion effects of taxation, the three types of measures discussed above tend to underestimate those distortion effects. The key piece of information used in constructing those three measures is the revenue collected by the government. Taxes that generate little revenue are implicitly assumed to create small distortions. In practice, however, there are highly distortionary taxes that generate little revenue (the corporate income tax in the U.S., whose revenue is currently 2% of GNP, is often thought to be one such example).

Measuring Public Investment

The concepts of public investment and government deficits used in GFS are highly problematic for LDC's. GFS achieves 'comparability' of these concepts across countries by reporting only the investment and the deficit of the General Government. Since activities that are associated with the General Government in some countries are carried out in other countries by public enterprises, part of the cross-sectional variation in GFS public investment may reflect arbitrary differences in institutional arrangements. To correct for this potential bias we have constructed, using World Bank reports, a series of public investment for the consolidated public sector, which includes the central government and the public enterprises.[13] Figure 1 depicts the relation between

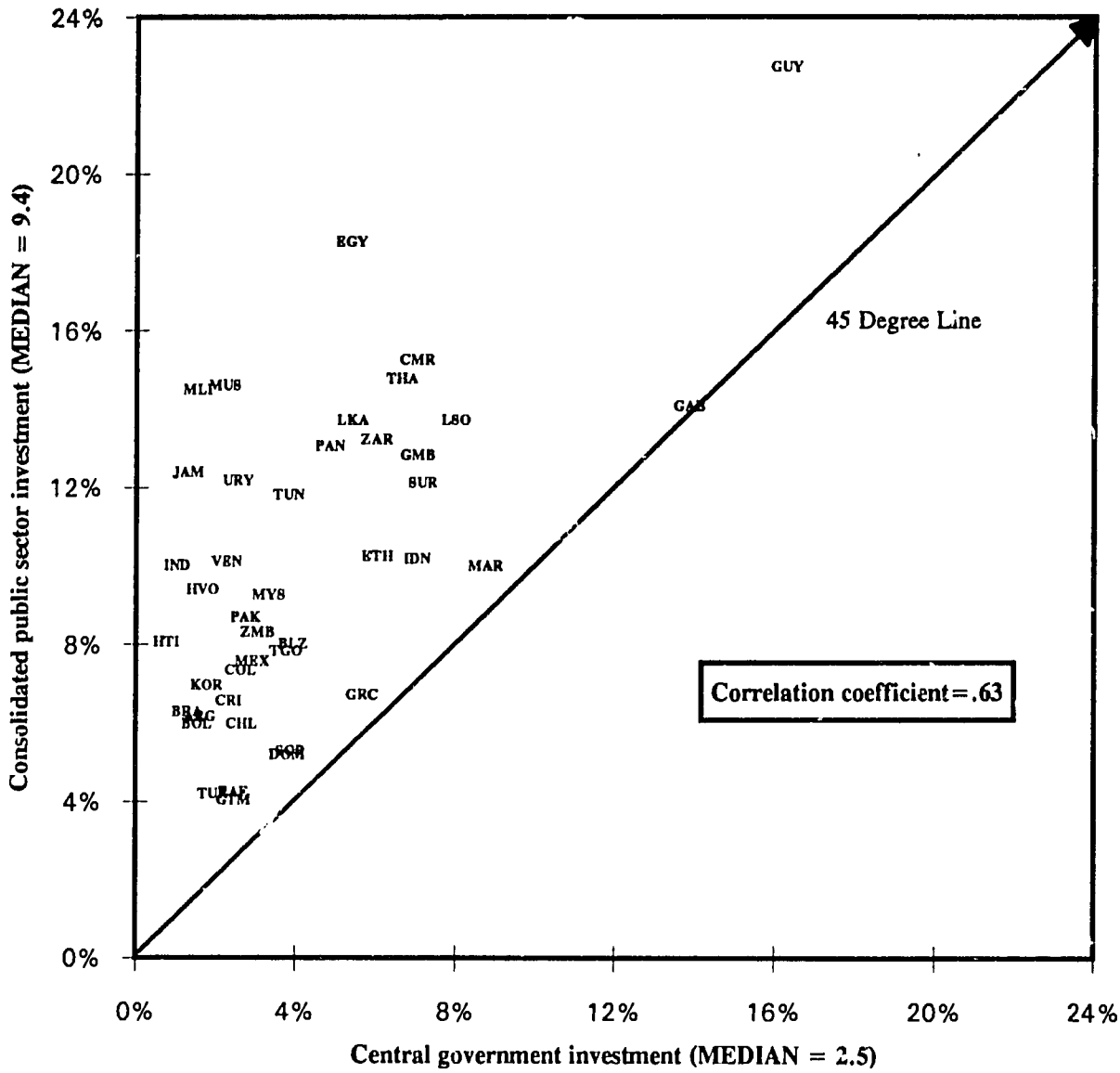
[12]Countries for which the regression coefficients are unstable generally have negative slope coefficients. We discarded the countries from our sample and retained only those with positive "marginal" tax rates.

[13]Our consolidated measure probably overstates the amount of public investment by including investment by public firms that have activities and goals similar to those of the private sector. The error introduced by this fact is probably small compared to the bias introduced in the GFS public investment series by the arbitrary exclusion of various types of infrastructure investment carried out by public firms in LDC's.

General Government Investment in the 1980's and Consolidated Public Sector Investment. The correlation between these two series is .63, while the median difference between the two rates of investment is 7 percentage points of GDP.

We later explore in detail this new public investment series, which we also use together with the Summers and Heston (1991) total investment series to construct a private investment series.

Figure 1: Consolidated public sector versus central government investment, 1980's (percent of GDP)



IV. HISTORICAL EVIDENCE ON FISCAL POLICY

Our historical data panel comprises annual observations for 28 countries for the period 1870-1988. Since it is not possible to construct conditioning variables similar to those used in the growth regressions of the next sections (measures of human capital, of political instability and of other policies) we will not explore the relation between growth and fiscal policy. Instead, we will focus on the link between the level of development and the character of fiscal policy. We will use annual data since for this purpose it does not seem essential to filter out the business cycle frequencies.

We divided income and the various fiscal variables in different classes and plotted the median of income against the median of the various fiscal variables for each class. These classes were constructed so as to have an identical number of observations.

We found three interesting (but not surprising) patterns in the evolution of fiscal variables. Figure 2 shows the remarkable increase in the share of government revenue in national income that has occurred between 1870 and 1988. This increase in the importance of government in the economy has been explored in the large literature on "Wagner's Law".[14]

Figure 3 shows that the importance of custom taxes as a source of government revenue declines sharply with the level of income. This decline is particularly striking in the U.S. where the importance of custom taxes in revenue drops from about 100% in the 18th century to approximately zero in 1988. Figure 4 documents that the importance of the income tax as a source of government revenue rises with income.[15]

Figures 5 and 6 show that, controlling for the level of income, there is a striking association between population size and the importance of taxes on income and on international trade. In these figures population size and income are each classified in three classes; the median share of income and custom tax revenue in overall revenue

[14]Examples of this literature include Lall (1969) and Ram (1987).

[15]Although our historical data on Social Security contributions is sparse, it seems to indicate that the share of Social Security contributions in Government revenue has evolved according to a pattern that is similar to that of the income tax.

Figure 2: Wagner's Law: income and size of government, 1870-1988

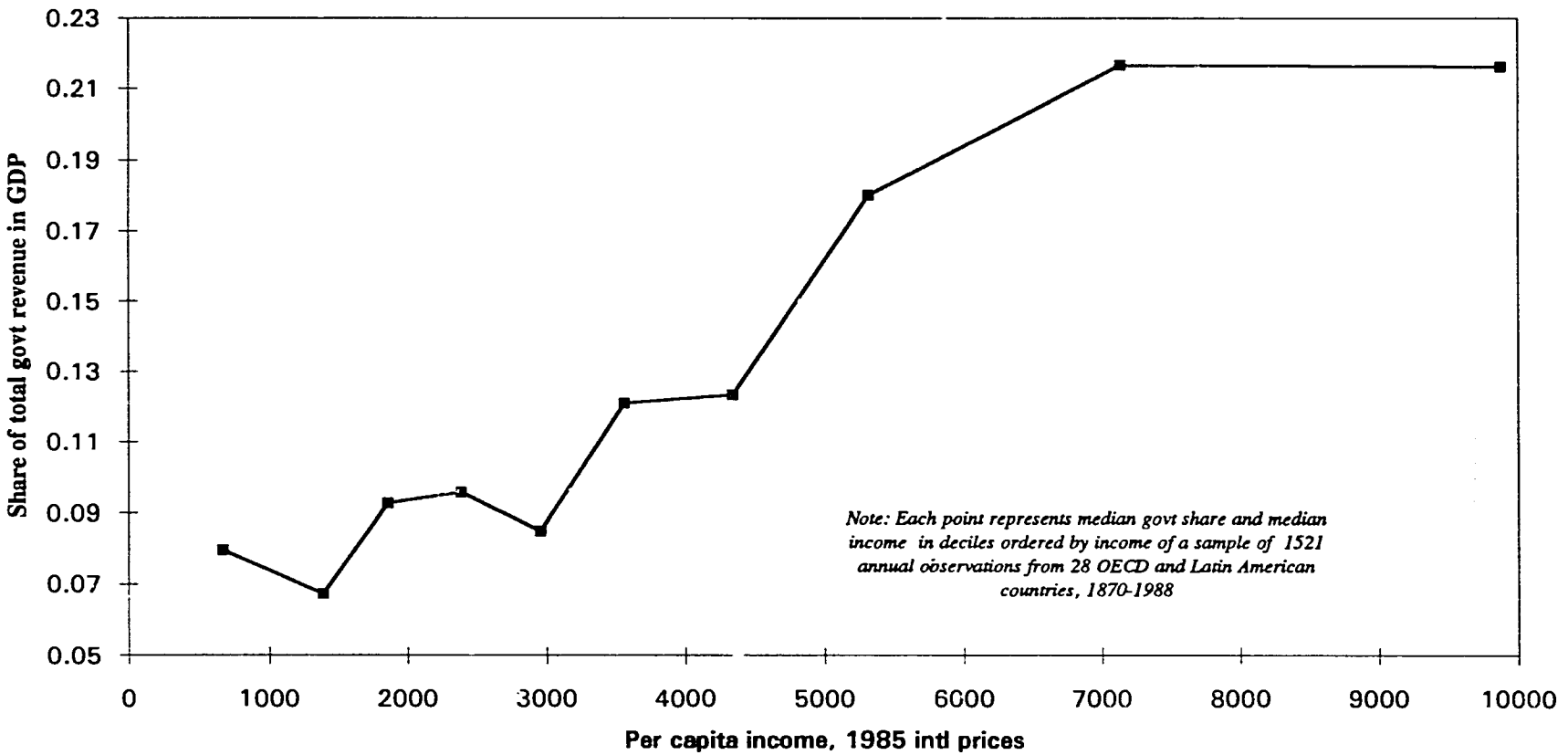


Figure 3: Per capita income and share of custom taxes, 1870-1988

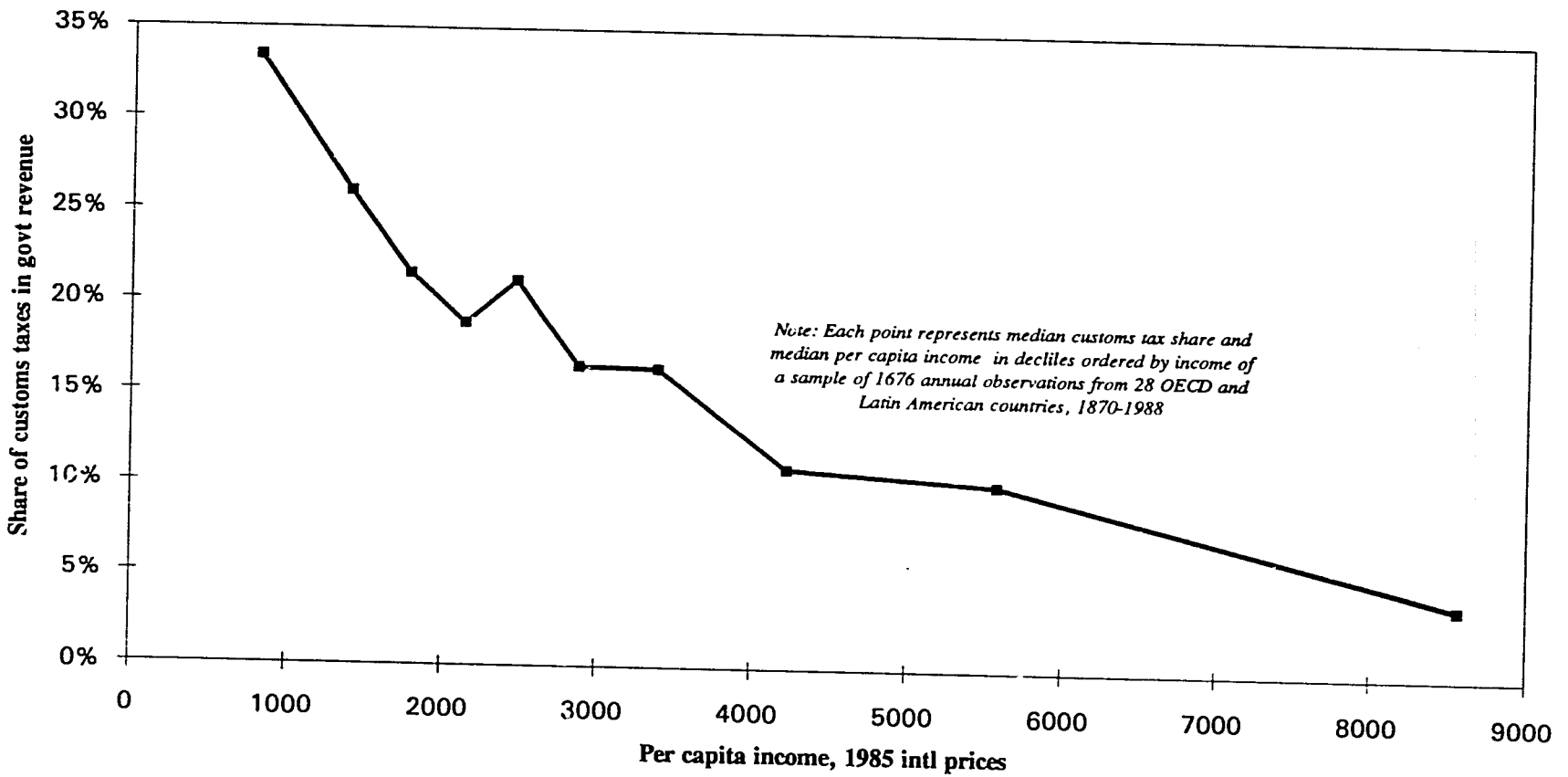


Figure 4: Per capita income and share of income taxes, 1870-1988

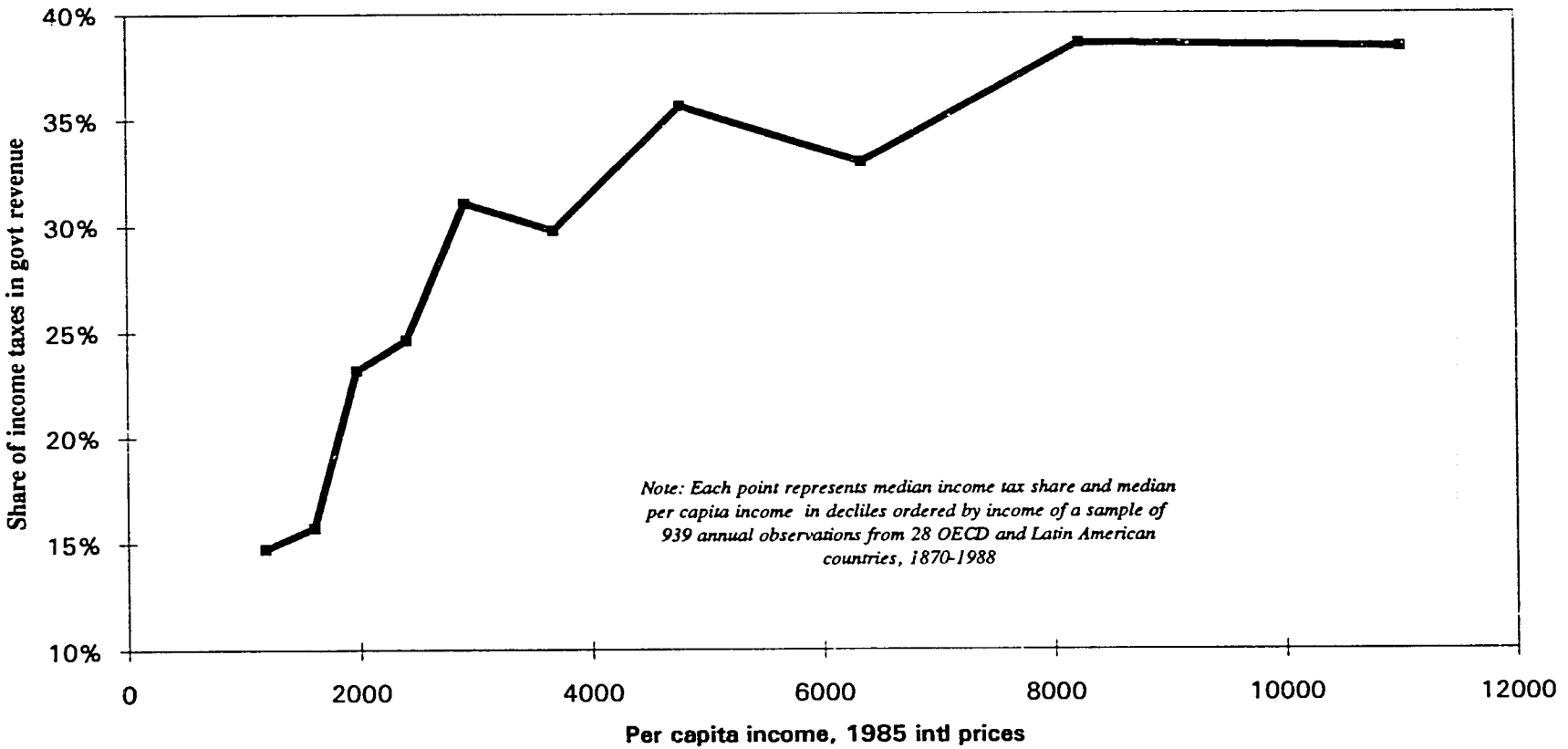
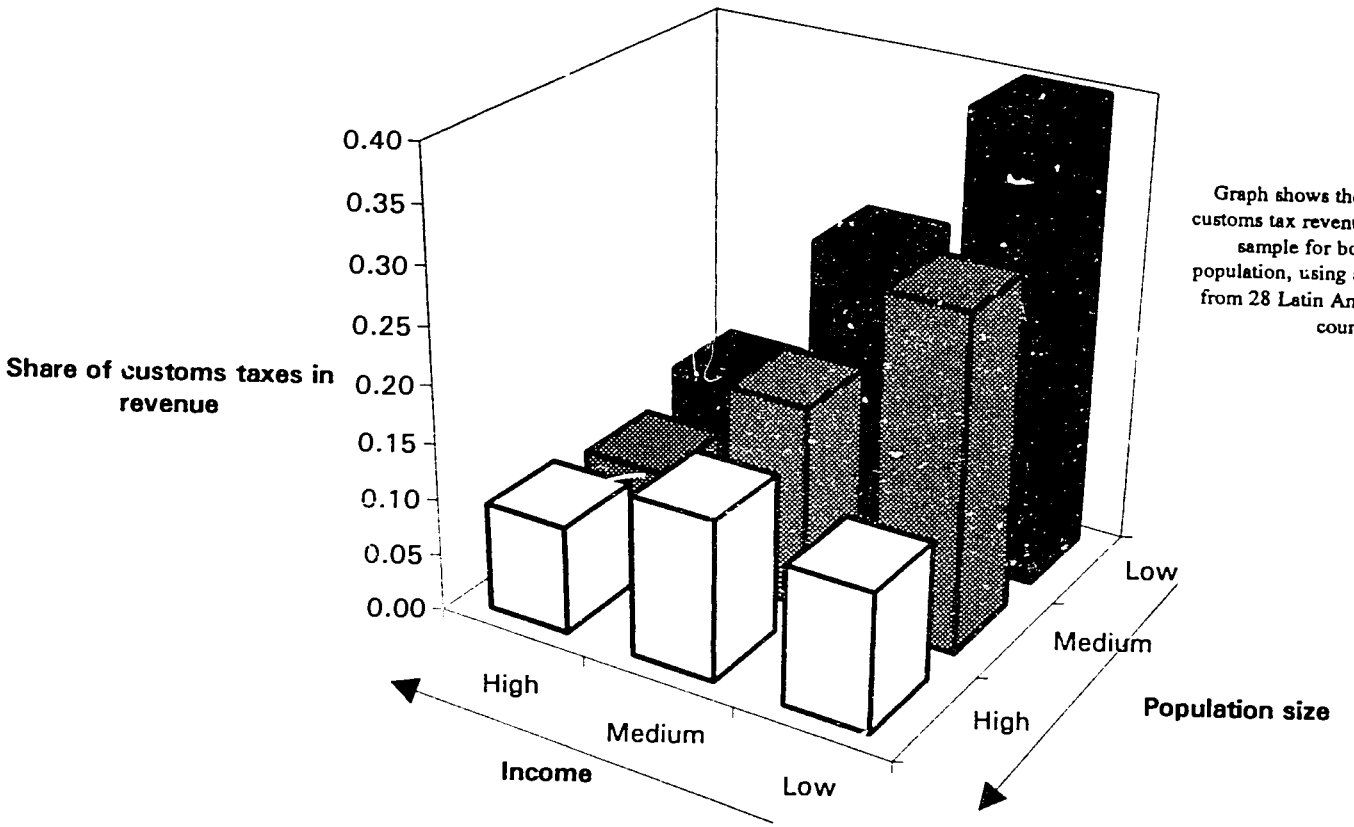
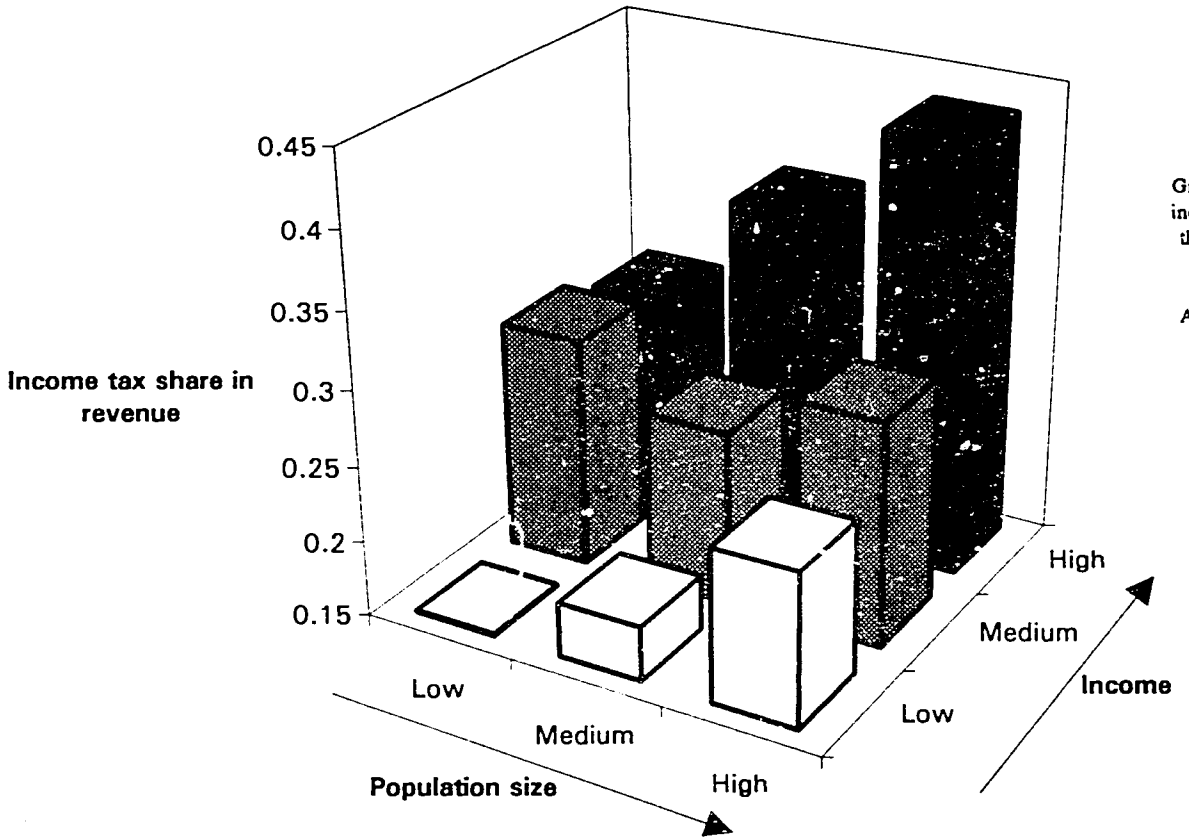


Figure 5: Income, population size, and share of customs in revenue, 1870-1988



Graph shows the median share of customs tax revenue for terciles of the sample for both income and population, using annual observations from 28 Latin American and OECD countries

Figure 6: Income, population size, and share of income taxes in revenue, 1870-1988



Graph shows the median share of income tax revenue for terciles of the sample for both income and population, using annual observations from 28 Latin American and OECD countries

are depicted for the nine resulting classes.

TABLE 2
POOLED CROSS-SECTION TIME SERIES REGRESSION
WITH HISTORICAL DATA: 1870-1988

	Income Tax Revenue / Total Tax Revenue		Customs Tax Revenue / Total Tax Revenue		Government Revenue / GNP
Constant	-3.555 (-6.450)	-0.547 (-0.852)	2.975 (9.540)	5.120 (14.251)	-2.277 (-16.198)
Log of Real Per Capita GDP	0.055 (5.933)	0.091 (8.436)	-0.067 (-9.243)	-0.041 (-5.946)	0.017 (6.283)
Log of Population	0.019 (4.320)	0.031 (5.153)	-0.037 (-11.002)	-0.042 (-11.319)	0.004 (2.699)
World War I	0.098 (3.087)	0.214 (5.204)	0.008 (0.406)	-0.044 (-1.941)	-0.029 (-2.916)
Word War II	0.050 (2.997)	0.037 (1.820)	-0.046 (-3.055)	-0.042 (-2.456)	-0.006 (-0.877)
Time Trend	0.002 (5.553)	-4.18e-6 (-0.011)	-0.001 (-6.241)	-0.002 (-11.304)	0.001 (14.646)
(Exports+Imports) / GDP	-	0.065 (1.921)	-	-0.097 (-6.058)	-
Number of Observations	896	698	1560	962	1383
R^2	0.25	0.26	0.23	0.42	0.37

Table 2 shows the results of a pooled time-series cross-section regressions in which we try to relate the evolution of the shares of income tax revenue and custom tax revenue in total revenue and the share of government revenue in GDP relates to a set of explanatory variables. These variables, measured at the annual frequency, include the logarithm of real per capita GDP, the logarithm of population, dummies for the two World Wars and a time trend. In Table 2, as in all the other significance tests used in this

paper, we employed White's (1982) heteroskedasticity-consistent standard errors.

The coefficient on the logarithm of real per capita GDP has the expected sign: positive for the income tax and government revenue ratios and negative for the share of custom taxes. There is a significant time trend that points to a gradual increase over time in the importance of government revenue in GNP and of income tax revenue in overall revenue. This trend also suggests a gradual decline in the importance of custom taxes. Both World Wars are associated with an increase of the importance of income taxes. The share of customs revenue declined with World War II, while the government revenue-GNP ratio declined with the first World War (although spending, naturally, increased in both wars).

The most surprising finding in Table 2 was already suggested by Figures 5 and 6: the logarithm of population is a significant explanatory variable. Population is positively related to the importance of income taxes and of government revenue, while it is negatively related the custom revenue share. This effect of population does not disappear when we introduce the share of trade in GNP in the regression suggesting the presence of a scale effect associated with population on the character of the tax system.[16]

The effects of the level of income and of the level of population on the character of the fiscal system are surely related to the administrative costs associated with different taxes. It is plausible that custom taxes require little or no overhead expenditures but are costly to administer per unit of tax collected. Income taxes imply high overhead costs for establishing income reporting, surveillance, and withholding systems, but once such overhead costs are paid, the marginal cost of an additional unit of tax collected is low. Under these circumstances, a government in a small scale economy (low population size, low income, or both) would prefer to use custom taxes, while a government in a large economy would find it worthwhile to bear the fixed costs of collecting income taxes.[17]

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[16]The trade share is negatively associated with customs revenue, which suggests that, as one would expect, international trade is important in countries with low customs taxes.

[17]So far we have not examined whether the scale effects associated with population are robust to the inclusion of one of the variables used by Tanzi (19) to explain the character of the fiscal system: the share of agriculture in GDP.

V. RECENT CROSS-SECTION EVIDENCE ON FISCAL POLICY

We will start by describing the main features of fiscal data and then examine whether the data is consistent with the theoretical predictions summarized in section II.

One simple way of looking at the data is to compute the correlation between the various fiscal variables and the rate of growth. The correlations that are statistically significant are reported in Table 3.

Existing theoretical models make no predictions about the sign of unconditional correlations in general and about some of the variables that are significantly correlated with growth (e.g. Tax Revenue, Grants and Non-tax Revenue). However, we will later show that government surplus, public investment, government consumption, the "marginal" tax rate on income (computed with a time-series regression) and the inflation tax continue to be correlated with growth after we control for the effects of other variables.

While fiscal variables are correlated with the rate of growth, they show an even stronger association with the logarithm of real per capita GDP in 1970, as measured by Summers and Heston. These correlations are displayed in Table 4 for the cases in which they are significantly different from zero. This Table shows that developed countries tend to rely more on income, payroll and consumption taxes and less on international trade taxes. These patterns of association between the level of development and the character of the fiscal system are similar to those identified by Tanzi (1987) and to those suggested by the historical fiscal data that we described in the previous section. In addition, the cross-section data suggests that health and social security expenditures increase with the level of income while most other types of government expenditures are negatively associated with the level of development.

TABLE 3

SIMPLE CORRELATIONS OF FISCAL VARIABLES WITH PER CAPITA GROWTH RATE

Government Surplus	0.36
Consolidated Public Surplus	0.36
Revenue Components as Shares of GDP	
Total Revenue	0.27
Tax Revenue	0.20
Non-Tax Revenue	0.34
Capital Revenue	0.28
Current Revenue	0.27
Grants	-0.19
Inflation Tax	-0.31
Social Security Contributions	0.18
Expenditure Components as Shares of GDP:	
Consolidated Public Investment	0.28
Government Consumption	-0.24
General Public Services	-0.30
Expenditures on Social Security	0.19
Other Tax Variables:	
Sicat-Virmani Statutory Tax Rate on 3 x Average Family Income	0.26
"Marginal" Income Tax Rate from Regression of Income Tax Revenue on GDP	-0.26

TABLE 4

SIGNIFICANT CORRELATIONS OF FISCAL STRUCTURE VARIABLES WITH THE LOG OF PER CAPITA INCOME

Aggregate Variable:	
Total Revenue	0.55
Grants	-0.27
Total Expenditure and lending minus repayments	0.35
Revenue Components as Share of Total Revenue (excluding grants):	
Taxes on Income, Profits and Capital Gains	0.32
Social Security Contribution	0.62
Taxes on International Trade and Transactions	-0.73
Expenditure Components as Share of Total Expenditure:	
General Public Services	-0.54
Education	-0.34
Health	0.39
Social Security and Welfare	0.77
Recreation, Culture and Religion	-0.30
Agriculture, Forestry, Fishing and Hunting	-0.54
Fuel and Energy	-0.25
Transportation and Communication	-0.24
Gross Fixed Capital Expenditure	-0.61
Capital Expenditure	-0.52
Sicat-Virmani Statutory Tax Rates:	
On 0.75 x Average Family Income	0.57
On Average Family Income	0.58
On 2 x Average Family Income	0.60
On 3 x Average Family Income	0.58
Tax Rates Computed with Time Series Regression:	
"Marginal" Consumption Tax Rate	0.25
"Marginal" Export Tax Rate	-0.33

TABLE 5

REGRESSIONS OF FISCAL VARIABLES ON THE LOG OF PER CAPITA INCOME, LOG OF POPULATION AND TRADE SHARE IN GDP

Dependent Variable	Log Real Per Capita GDP	Log of Population	Trade Share in GDP
Variables Expressed as Ratios to GDP:			
Total Revenue and Grants	+		+
Total Revenue	+		+
Grants	-	-	
Total Expenditure and Lending Less Repayment			+
Revenue Components as Share of Total Revenue (excluding grants)			
Tax Revenue	+		
Taxes on Income, Profits and Capital Gains			+
Social Security Contribution	+	+	
Taxes on International Trade and Transactions	-	-	-
Expenditure Components as Share of Total Expenditure			
General Public Services	-	-	
Defense		+	
Education	-	-	
Health	+		
Social Security and Welfare	+		
Recreation, Culture and Religion	-		
Agriculture, Forestry, Fishing and Hunting	-	-	
Transportation and Communication	-	-	
Current Expenditure	+		
Gross Fixed Capital Expenditure	-	-	
Capital Expenditure	-	-	

Each line corresponds to a regression of the dependent variable (average over 1970-1988) on the log of population in 1970, the log of per capita income in 1970, and the trade share in 1970. If coefficients are insignificant, cells are left blank; if coefficients are significant their sign is shown. Each regression has between 84 and 87 observations.

The sign of the significant partial correlations in a regression that includes the logarithm of real per capita GDP in 1970, the logarithm of per capita income in 1970, and the average trade share in the 1970-88 period are reported in Table 5. The cross-section data suggests the presence of scale effects of population that are broadly similar to those found in our historical data set. In particular, the ratio of social security contributions to total revenue is positively related to population, while the revenue share of taxes on international trade is negatively related to population.

In the cross section [illegible] we have data on the composition of public expenditures that we did not have in the historical sample. We find strong scale effects here also: the share of public spending on capital formation, transport and communication, education, agriculture and general public services falls with increased population or income. In contrast the share of defense is positively associated with population size. These scale effects associated with government expenditures are likely to be related to non-convexities in either the benefits or the costs of publicly provided goods and services. If a government service has the non-rival consumption property of a pure public good--defense is the classic example--then there is more incentive to provide it in a large scale economy. On the other hand, if there are high setup costs but low marginal costs to providing a particular public service, then the amount of spending per capita for a given per capita level of that service would fall with increased scale.

We continue our exploratory analysis of the data by comparing measures of fiscal policy across democracies and non-democracies. For this purpose we adopted the classification of countries into political regimes of Alesina and Rodrick (1991) and complemented it with the classification provided by Cukierman, Neypati and Weber (1992).[18] The fiscal policy variables that are significantly different between democracies and non-democracies are essentially the same reported in Table 4 as significantly correlated with per capita income. This is due to the high correlation between the democracy dummy and the level of income (0.63). We were surprised to find that the character of the political system does not seem to matter in terms of fiscal

[18]Cukierman, Neypati and Weber (1992) provide a yearly classification of the political regimes for the countries in their sample. We classified a country as a democracy, whenever, during the time period 1970-1988, it was a democracy more than 50% of the time; otherwise it is a non-democracy.

policy once we control for income. We can only find one fiscal variable that is statistically different between democracies and non-democracies after controlling for income: aid revenue (which, presumably, says more about the behavior of donors than recipients).

TABLE 6
SIGNIFICANT PARTIAL CORRELATIONS OF INEQUALITY MEASURES WITH FISCAL VARIABLES CONTROLLING FOR INCOME

Fiscal Variable	Association with Inequality Measures
Ratio of Fiscal Aggregates to GDP:	
Grant Revenue	-
Ratio of Revenue Components to Total Revenue:	
Share of Income Taxes	+
Ratio of Expenditure Components to Total Expenditure:	
Defense	-
Education	+
Transport and Communication	+

Sign shows effect of rising inequality on indicated variable.

Since the distribution of income is a central element in political economy theories we document in Table 6 the relation between fiscal policy variables and the degree of inequality in income distribution. This Table shows the fiscal variables that were significantly correlated at the 5% level (controlling for income) with at least three of the following measures of inequality: the Herfindahl index, the share of the upper decile in income, the ratio of the richest quintile to the poorest 40%, the share of the middle quintile, the Gini coefficient, and the Theil index. These inequality measures were all computed with data prior to 1970 so that the correlations in Table 6

may be interpreted as the effect of inequality on fiscal policy.[19] This Table suggests that countries with greater initial inequality tend to resort to a greater extent to the use of two instruments of redistribution: income taxes and the public provision of education.

Now that we are acquainted with the main empirical regularities of fiscal data we are ready to investigate whether the data accords with the theoretical predictions summarized in section II.

Our point of departure will be a version of the Barro (1991) growth regression in which the growth rate of per capita output is regressed on per capita GDP in 1960, on measures of political instability (assassinations per million, number of revolts and coups and number of war casualties) and on two variables related to human capital (primary and secondary school enrollment):[20]

GROWTH RATE OF PER CAPITA GDP 70-88 =

$$\underset{(0.9)}{0.005} - \underset{(-2.2)}{0.004}\ (\text{PER CAPITA GDP 1960}) + \underset{(2.9)}{0.02}\ (\text{PRIMARY ENROLLMENT 1960}) +$$

$$\underset{(1.5)}{0.02}\ (\text{SECONDARY ENROLLMENT 1960}) - \underset{(-0.9)}{0.003}\ (\text{ASSASSINATIONS PER MILLION})$$

$$- \underset{(-1.6)}{0.02}\ (\text{REVOLUTIONS AND COUPS}) - \underset{(-2.2)}{1.41}\ (\text{WAR CASUALTIES PER CAPITA})$$

The t-statistics, constructed with White (1982) standard errors, are in parenthesis: the R^2 of this regression is 0.26, while the number of observations employed is 104.

In extensions of the neoclassical growth model such as Mankiw, Romer and Weil (1991) and in endogenous growth models such as Lucas (1988) the rate of growth is a function of two state variables: the initial level of physical capital and the initial level of human capital. In models such as those of Becker, Murphy and Tamura (1990) and Azariadis and Drazen (1990) the initial level of human capital is also an important determinant of future growth. The two school enrollment variables are included as

[19]These inequality measures were compiled in Clark (1992).

[20]Data on war casualties is from Easterly, Kremer, Pritchett and Summers (1992).

proxies for the initial level of human capital, while the initial level of income is included in lieu of the initial stock of physical capital. The motivation for the inclusion of measures of political turmoil is obvious.

It is easy to predict what happens when we expand this regression to include our measures of fiscal policy. Since there is a strong correlation between our fiscal variables and the log of per capita income it is difficult to disentangle the effects of fiscal variable from those of the initial level of income. To illustrate the importance of the interaction between the initial level of income and various tax rate variables we show in the top panel of Figure 7 a version of the impressive negative relation between the rate of growth and the ratio of tax revenues to GDP uncovered by Plosser (1992). Even though the dispersion of incomes in OECD countries is much smaller than in the wider set of countries included in the Summers-Heston (1991) database, the bottom panel of Figure 7 shows that the negative relation between tax revenue and growth disappears once we controls for the level of income.[21]

Table 7 reports the significance of various tax rate variables and of the initial level of income in extended versions of the basic regression described above, in which we introduce one tax variable at a time. In these regressions the sign of the coefficients on income and on the tax variables (not reported on the Table) is always negative with the exception of the coefficient on the consumption tax variable. The coefficient on our measures of consumption taxes are always insignificant as predicted by theory. The significance of income is often weakened substantially when tax variables are included in the regression. Eight out of the fourteen tax measures included in this table render the initial level of income insignificant in the regression. The only tax rate variable that is significant at the 5% level is a 'marginal' income tax rate computed by using individual country time series to regress income tax revenue on GDP. This Table shows that it is difficult to disentangle the "convergence" effect discussed by Barro and Sala-i-Martin (1992) from the effects of fiscal policy. This problem remains when we include measures of other policies in the regression or when we include other fiscal variables.

[21]Dowrick (1992) and Engen and Skinner (1992) discuss versions of this result that survive the inclusion of initial income in the regression.

Figure 7A: Per capita growth and income tax rates, OECD countries, 1960-88

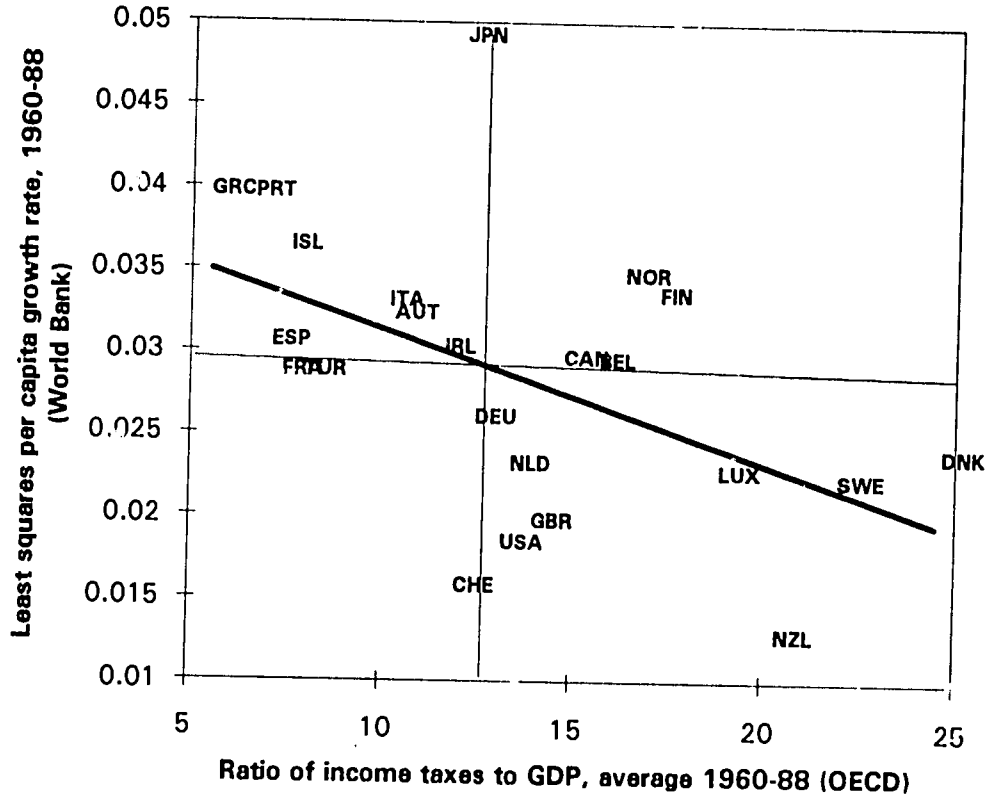


Figure 7B: Per capita growth and income tax ratios, controlling for initial income

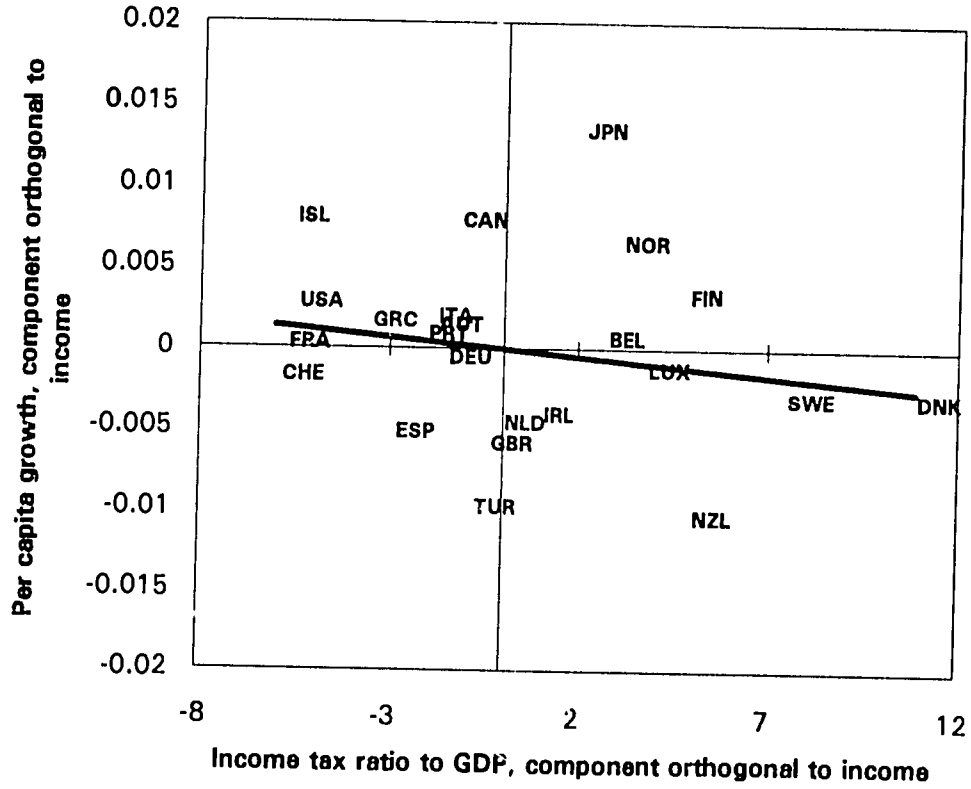


Table 8 reports the complete set of regression coefficients for those regressions in which tax rate coefficients are significant both with the rate of growth and the ratio of private investment to GDP as independent variables. The private investment variable was constructed as total investment from Summers and Heston (1991) minus our own measure of consolidated public investment. Figure 8 depicts the significant association between the income tax rate, growth and private investment.

Including expenditure variables in the regression or more than one tax measure compounds the multicollinearity problems. Table 9 reports the significant partial correlations between private investment, growth and our measures of fiscal policy. In these regressions we used the same conditioning variables as before: the level of income in 1960, primary and secondary enrollment in 1960, and the three measures of political instability (number of assassinations, revolts and coups and war casualties).

Figure 8: Growth, private investment, and income tax rates, 1970-88

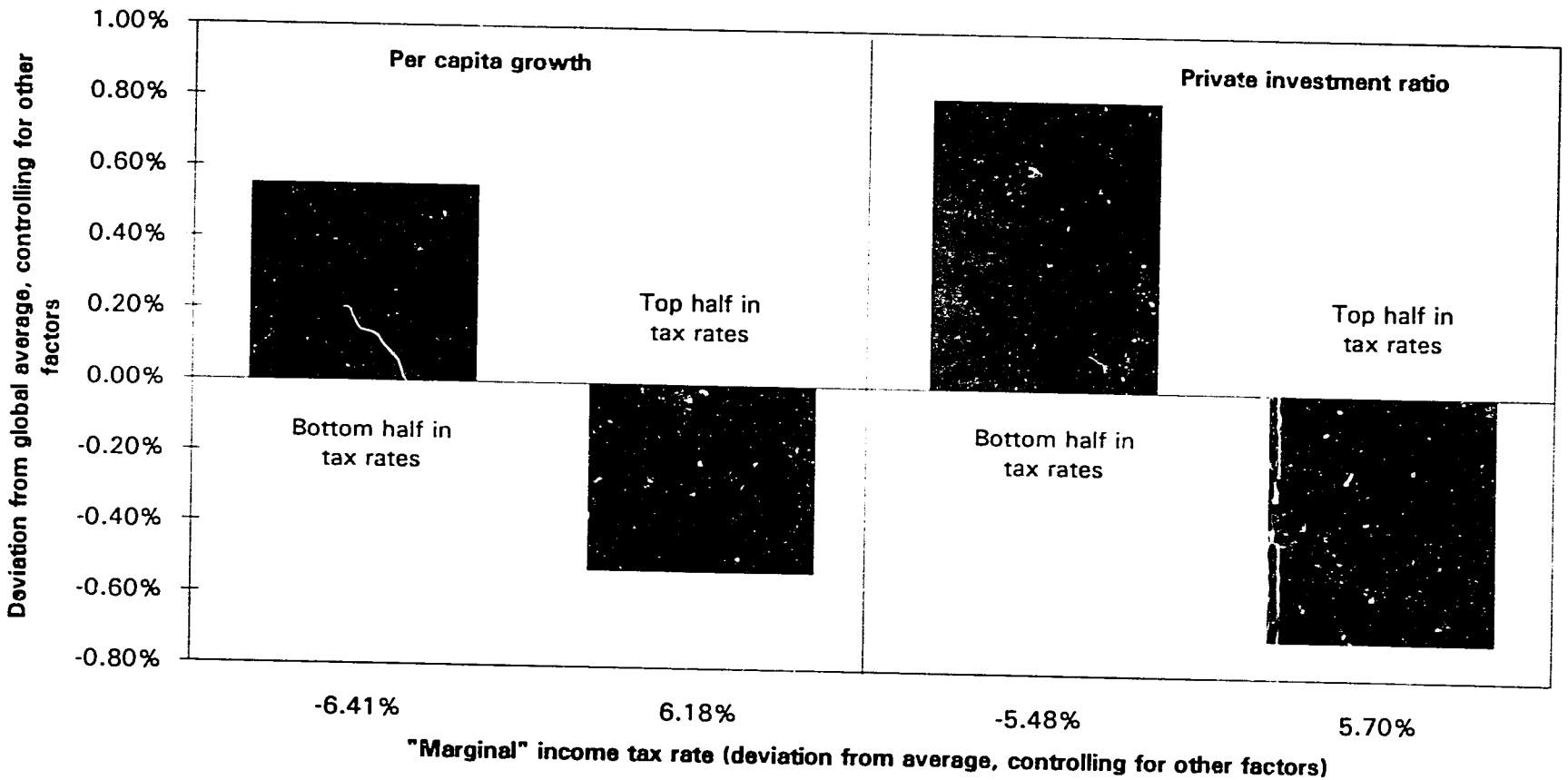


TABLE 7

SIGNIFICANCE OF TAX RATE VARIABLES AND INITIAL INCOME IN BARRO REGRESSION, 1970-88 CROSS-SECTION

Tax Rate	Significance Level of Income	Significance Level of Tax Rate
Tax Rates Computed with Time Series Regressions:		
Koester-Kormendi (1981) "marginal" tax rate	.014	.194
"Marginal" consumption tax rate with respect to private consumption	.059	.512
"Marginal" income tax rate with respect to GDP	.015	.047
"Marginal" total tax revenue with respect to GDP	.013	.121
Tax Rates Computed as Ratios of Tax Revenue to Tax Base:		
Income Tax/GDP	.093	.353
International Trade Taxes/Total Trade	.158	.243
Individual Income Taxes/Personal Income	.057	.098
Sicat-Virmani Statutory Tax Rates:		
On first bracket	.043	.432
On .75 x Average family income	.045	.386
On 2 x Average family income	.074	.958
On 3 x Average family income	.101	.587
On highest bracket	.075	.687
Easterly-Rebelo (1992) Marginal Tax Rate	.077	.880
None	.006	

TABLE 8

TAX RATES, GROWTH AND PRIVATE INVESTMENT

Independent Variables:	Dependent Variable: Growth Rate of Per Capita GDP		Dependent Variable: Ratio of Private Investment to GDP	
Constant	0.010 (1.109)	0.0008 (0.16)	0.086 (4.32)	0.087 (4.127)
GDP per capita, 1960	-6.46e-06 (-2.25)	-2.89e-06 (-1.93)	8.42e-06 (0.91)	-5.8e-6 (-0.79)
Primary enrollment, 1960	0.0247 (2.24)	0.025 (3.01)	0.083 (3.44)	0.073 (2.91)
Secondary enrollment, 1960	0.0439 (2.09)	0.031 (1.95)	-0.051 (-0.53)	-0.022 (-0.36)
Assassinations per million, 1970-85	-65.7 (-1.69)	-65.4 (-2.03)	482.6 (1.55)	-70.3 (-1.07)
Revolutions and Coups, 1970-85	-0.0054 (-0.39)	-0.009 (-1.01)	-0.038 (-1.33)	0.015 (0.509)
War Casualties Per Capita 1970-88	-1.436 (-2.225)	3.28 (1.33)	5.88 (0.993)	-3.63 (-4.77)
"Marginal" Income Tax Rate with respect to GDP	-0.064 (-2.04)			-0.193 (-3.30)
Ratio of Individual Income Taxes to Personal Income		-0.103 (-1.68)		
Ratio of Domestic Taxes to Consumption plus Investment			-0.737 (-2.702)	
Number of Observations	53	74	57	43
R^2	0.362	0.261	0.468	0.378

TABLE 9

PARTIAL CORRELATIONS BETWEEN FISCAL AGGREGATES, GROWTH AND PRIVATE INVESTMENT

Fiscal Variable:	Significant Partial Correlation with Growth	Significant Partial Correlation with Private Investment
Government Surplus	+	+
Public Investment	+	
Government Consumption	-	
General Public Services	-	
Seignorage Revenue	-	
"Marginal" Income Tax Rate with respect to GDP	-	-
Ratio of Domestic Taxes to consumption + investment		-
Ratio of Domestic Taxes to GDP		-

The positive association between government surplus and growth can be given at least three interpretations. The first is tax smoothing which implies that high deficits are associated with periods of low growth. The second is that high deficits may just be proxying for high public debt, which in turn may signal higher taxes and lower public capital in the future.[22] Fischer (1992) discusses a third alternative interpretation of the effects of deficits, which relates to the effects of short-term macroeconomic policy.

[22]Unfortunately, the poor quality of the data on public debt in LDC's prevents us from trying to separate the effects of the deficit from those of the debt.

VI. PUBLIC INVESTMENT AND GROWTH

Barro (1991) and Barro and Sala-i-Martin (1991) have discussed the role of public investment in growth models. Their model implies that the net effect of public investment on growth depends on the form of taxation used to finance this investment. Public investment financed with consumption taxes leads to an increase in the rate of growth. In contrast, the effect of public investment is ambiguous when taxes on income, profits or investment are used as means of financing: while public investment per se raises the incentive for private accumulation, taxation reduces the net real rate of return faced by the private sector.

The best known empirical study of the role of public investment is due to Aschauer (1989), who claimed that the U.S. productivity slowdown can be explained by the slowdown in public infrastructure investment. Aschauers's findings and interpretation have been a source of heated controversy. The most common criticism of his analysis is that his findings may just reflect reverse causation: as productivity declined and growth slowed down government plans for infrastructure investment were pared down. Holtz-Eakin (1992) and Hulten and Schwab (1991) find no impact of public capital on productivity growth after controlling for fixed effects across U.S. states. Canning, Fay and Perotti (1992) tend to confirm Aschauer's results with cross-national data on physical indicators of infrastructure, such as telephones per capita.

Cross-country studies of the role of government investment on economic growth have been hampered by the absence of data on consolidated public expenditures for investment purposes. As we discussed in section III, public enterprises are, in some countries, responsible for investment activities that are carried out by the General Government in other countries. For this reason it is necessary to consolidate the investment of the General Government with that of public firms, which we have done using the World Bank report data described earlier.

We constructed decade-average public investment ratios by sector from this data and entered them into pooled regressions of decade-average per capita growth. We perform regressions using decade averages because of the sparseness of the data. The

information on public investment is available for too few years to allow us to compute meaningful averages over periods that are longer than a decade.

TABLE 10

REGRESSIONS OF PER CAPITA GROWTH ON PUBLIC INVESTMENT AND CONDITIONING VARIABLES

	Basic Regression	Basic Regression with M2/GDP	Basic Regression with M2/GDP and Trade Share/GDP
Total Consolidated Public Investment	0.048 (1.44)		
Sectoral Public Investment:			
Agriculture	-0.208 (-1.07)	-0.34 (-1.50)	-0.304 (-1.36)
Education	0.931 (2.09)	1.10 (1.54)	1.18 (1.61)
Health	-0.055 (-0.09)	-0.37 (-0.54)	-0.36 (-0.49)
Housing and Urban Infrastructure	1.031 (2.05)	0.88 (1.46)	0.91 (1.48)
Transport and Communication	0.663 (2.54)	0.588 (2.53)	0.626 (2.48)
Industry and Mining	0.180 (1.20)	0.087 (0.589)	0.082 (0.53)
Public Investment by Level of Government			
General Government	0.453 (4.13)	0.402 (3.44)	0.387 (3.17)
Public Enterprises	-0.001 (-0.01)	-0.120 (-1.08)	-0.12 (-1.13)

We used the same set of conditioning variables as that used by Barro (1991). This set of variables comprises the initial level of income, and decade averages of: primary and secondary enrollment, measures of political instability (assassinations, revolts and coups and war casualties) and the ratio of government consumption to GDP. We extend

this regression to include one public investment variable at a time. We report three sets of results in Table 9: the basic regression, in which the conditioning variables are the Barro regressors, a version of this regression in which we include the ratio of M2 to GDP as explanatory variable, and yet another version of the regression in which both M2/GDP and the trade share are included in the right hand side. These variables were chosen to hold fixed the effects of other policies on growth because they have been shown to be robustly correlated with growth and investment in Levine and Renelt (1992), King and Levine (1992), and in Levine and Zervos (1992). In Table 11 we repeat the same analysis with private investment as the dependent variable. The financial variable is often (but not always) significant in both the private investment and the growth equation. Trade is sometimes significant (especially in the investment regression), but sometimes takes the wrong (negative) sign in the growth regression.

The main results suggested by these regressions are:

1 - Transport and communication investment seem to be consistently positively correlated with growth with a very high coefficient (between .59 and .66). This type of investment is uncorrelated with private investment suggesting, surprisingly, that it raises growth by increasing the social return to private investment but not by raising private investment itself. Figure 9 dramatizes this result by showing the median of the orthogonal components of both per capita growth rates public transport and communication investment with respect to the conditioning variables used in the basic regression reported on Table 11. In the bottom quartile are countries which, holding fixed our conditioning variables, had decade average infrastructure investment rates which are 2.4% of GDP below those of the top quartile. The bottom's quartile per capita growth, controlling for our conditioning variables, was 1.5% lower than in those countries in the top quartile of infrastructure investment.

2 - Public enterprise investment is consistently negatively correlated with private investment with a coefficient slightly above -0.5. Total public enterprise investment seems to have no effect on growth. Figure 10, which was constructed in the same manner as Figure 9, helps visualize this result. Countries in the bottom quartile of public enterprise investment have rates of private investment 2% higher than average, controlling for other factors. Countries in the top quartile of the public enterprise

Figure 9: Growth and public investment in transport and communications, intercountry comparisons for LDC's

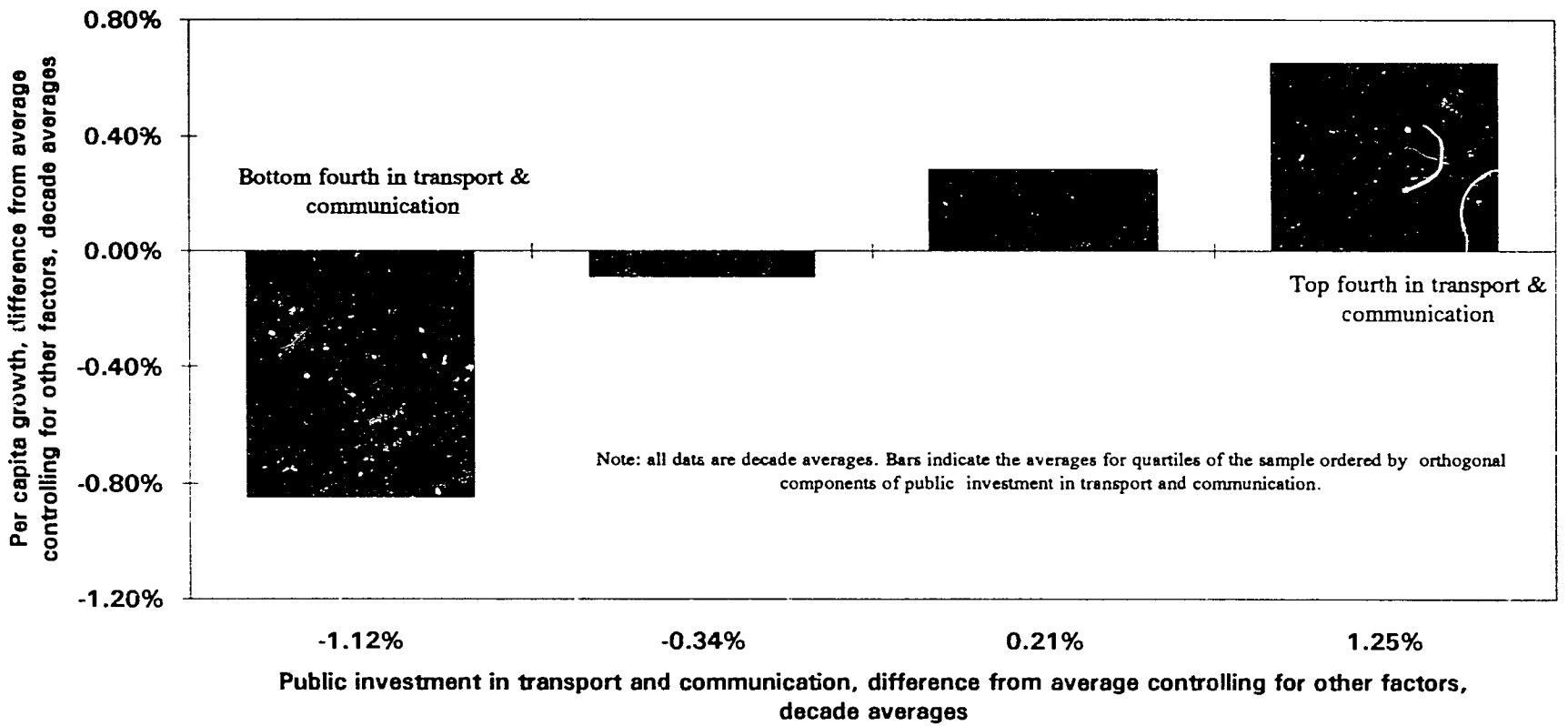
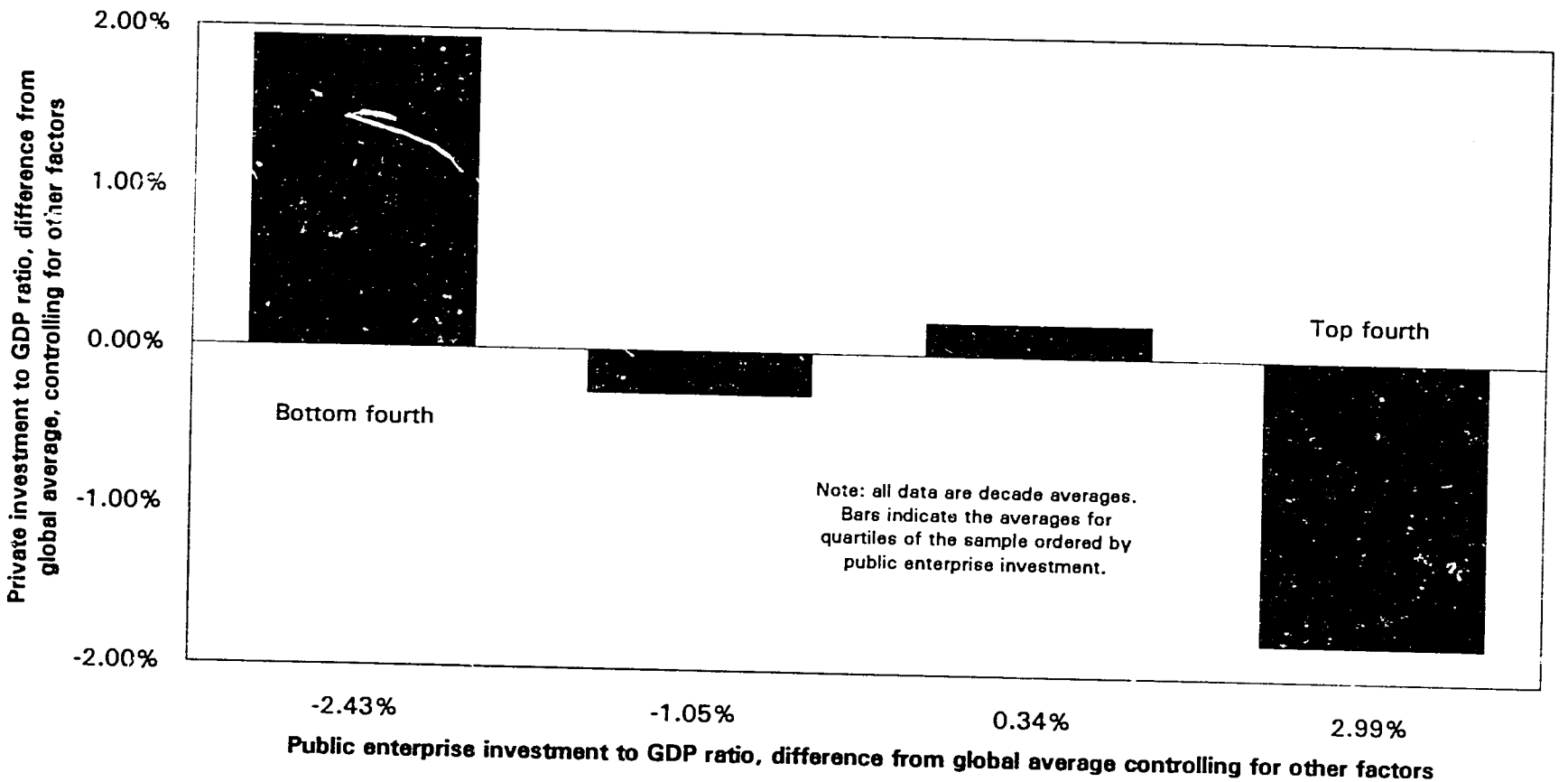


Figure 10: Private investment and public enterprise investment, intercountry comparisons



investment have private investment rates 2% below average.

TABLE 11

REGRESSIONS OF PRIVATE INVESTMENT ON PUBLIC INVESTMENT AND CONDITIONING VARIABLES

	Basic Regression	Basic Regression with M2/GDP	Basic Regression with M2/GDP and Trade Share/GDP
Total Consolidated Public Investment	-0.194 (-2.08)	-0.1997 (-1.41)	-0.224 (-1.6)
Sectoral Public Investment:			
Agriculture	-0.943 (-2.64)	-0.66 (-1.98)	-0.74 (-2.24)
Education	1.987 (1.29)	2.28 (1.56)	1.96 (1.40)
Health	0.027 (0.02)	2.55 (2.31)	2.29 (1.95)
Housing and Urban Infrastructure	2.108 (1.65)	1.26 (1.00)	1.01 (0.85)
Transport and Communication	0.001 (0.00)	0.053 (0.13)	-0.17 (-0.43)
Industry and Mining	-0.315 (-1.35)	-0.449 (-1.37)	-0.359 (-1.14)
Public Investment by Level of Government			
General Government	1.128 (4.57)	0.887 (3.47)	0.86 (3.33)
Public Enterprises	-0.520 (-2.92)	-0.56 (-2.79)	-0.564 (-2.79)

3 - General government investment is consistently positively correlated with both growth and private investment, with a coefficient above .3 on growth and near one on private investment.

4 - Agriculture investment is consistently negatively related to private investment with a coefficient between -0.64 and -0.94.

An important qualification of our results is that we cannot exclude the possibility that the association between public investment and growth is due to reverse causation: public investment is higher in periods of fast expansion. Unfortunately, it is not possible to run the same regressions with lagged public investment; that would reduce dramatically the dimension of our sample since most of our data is for the 1980's. One piece of indirect evidence against reverse causation is that *only* transport and communication investment and general government investment are robustly correlated with growth (the association between education and housing investment and growth is not robust). If the direction of causation were from growth to public investment, we would expect all types of public investment to be associated with growth.

VII. CONCLUSIONS

In this paper we use historical data going back to 1870 and recent cross-section data, from 1970 to the present, to study the main features of fiscal policy and of its relation with the level and the rate of growth in per capita income. The data that we have available has serious limitations, both because of the short time span covered by the post war data and because of the fact that the main variables of interest--marginal tax rates--are very difficult to measure.

Our long run evidence on fiscal policy confirms the well-known increase over time of the importance of government revenue in GNP. It also shows that the importance of income taxes rises with a country's income level while the importance of customs taxes declines with income. These patterns are confirmed by our cross-section data. We also find that the importance of health expenditures seems to rise with income, while most other types of government expenditures are negatively related to income.

We found some surprising scale effects of population on the character of the fiscal system. A higher population seems to be negatively associated with the importance of international trade taxes and positively associated with the role played by income

Motivated by the expanding literature on endogenous public policy, we studied the influence on fiscal policy of the political system and of the inequality in income distribution. We found no significant differences, after controlling for income, in the behavior of fiscal variables across democracies and non-democracies. In contrast, we found that high levels of inequality in income distribution, observed prior to 1970, were associated with higher income taxes and higher publicly provided education in the period from 1970 to 1988.

The large battery of proxies for marginal tax rates that we constructed tend to be highly correlated with the level of income in 1960. There is not enough independent variation of tax rates and income levels in our cross-country panel to allow us to disentangle the effects of the initial level of income and of tax policy on the rate of growth. However, we do find a negative association between growth and one tax variable:

the "marginal" income tax rate computed by regressing each country's time series of tax revenue on GDP.

The multicollinearity problem is less severe for our data on public investment which was constructed by consolidating investment by General Government and by public enterprises. Transport and communication investment seem to be consistently positively correlated with growth but uncorrelated with private investment suggesting, that it raises growth by increasing the social return to private investment but not by raising private investment itself.

General government investment is consistently positively correlated with both growth and private investment, while public enterprise investment is consistently negatively correlated with private investment. Agriculture investment also seems to crowd out private investment.

REFERENCES

Alesina, A. and D. Rodrick, "Distributive Politics and Growth," NBER working paper, N. 3668, 1991

Alogoskoufis, G. and R. van der Ploeg, "Endogenous Growth and Overlapping Generations," mimeo, Birkbeck College, London, 1991.

Aschauer, D. "Is Public Expenditure Productive," *Journal of Monetary Economics*, 23:177-200, 1989.

Auerbach, A. "The Theory of Excess Burden and Optimal Taxation," in Auerbach, A. and M. Feldstein (eds.) *Handbook of Public Economics*, North Holland, 1985.

Auerbach, A. and L. Kotlikoff, *Dynamic Fiscal Policy*, Harvard University Press, Cambridge, MA, 1987.

Azariadis, C. and A. Drazen, "Threshold Externalities in Economic Development," *Quarterly Journal of Economics*, 105: 501-26, 1990.

Barro, R., 1990, "Government Spending in a Simple Model of Endogenous Growth," *Journal of Political Economy*, 98: S103-125.

Barro, R., 1991 "Economic Growth in a Cross Section of Countries," *Quarterly Journal of Economics*, 106: 407-444.

Barro, R. and C. Sahasakul, 1983, Measuring the Marginal Tax Rate from the Individual Income Tax, *Journal of Business*, 56, 419-452.

Barro, R. and C. Sahasakul, 1986, Average Marginal Tax Rates from Social Security and the Individual Income Tax, *Journal of Business*, 59, 555-566.

Barro, R. and Sala-i-Martin, X. "Convergence," *Journal of Political Economy*, 100: 223-51, 1992.

Barro, R. and Sala-i-Martin, X., "Public Finance in Models of Economic Growth,"

Barro, R. and Wolf, S., 1989, "Data Appendix for Economic Growth in A Cross-Section of Countries," Mimeo, Harvard University.

Becker, G., K. Murphy, K, and R. Tamura, "Human Capital, Fertility, and Economic Growth," *Journal of Political Economy*, 98: S12:S37.

Canning, D., M. Fay and R. Perotti, "Infrastructure and Growth," mimeo, Columbia University, June 1992.

Cass, D., 1965, "Optimum Growth in an Aggregative Model of Capital Accumulation," *Review of Economic Studies*, 32: 233-240.

Chamley, C., 1986 "Optimal Taxation of Capital Income in General Equilibrium with Infinite Lives," *Econometrica*, 54: 607-22.

Clark, G., Easterly, W. and S. Rebelo, "Growth and Public Investment," in progress, World Bank.

Cohen, D. and Michel, P., 1991, "Property Rights on Foreign Capital and Long Run Growth," Working paper No. 9106, CEPREMAP.

Correia, I. "Optimal Taxation in Small Open Economies," working paper, Bank of Portugal, 1992.

Cukierman, A., B. Neypati, and S. Webb, "Political Stability, Central Bank Independence and Inflation," work in progress, World Bank, 1992.

De Long, J. and Summers, L., 1991, " Equipment Investment and Economic Growth," *Quarterly Journal of Economics*, 106: 445-502.

Diamond, P. "National Debt in a Neoclassical Growth Model," *American Economic Review*, 55: 1125-1150, 1965.

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

Dunn, D. and A. Pellechio, "Analyzing Taxes on Business Income with the Effective Tax Rate Model," World Bank Discussion Paper 79, The World Bank.

Easterly, W., 1990, "Endogenous Growth in Developing Countries with Government Induced Distortions," in V. Corbo, S. Fischer and S. Webb, *Policies to Restore Growth*, World Bank.

Easterly, W., 1991, "Economic Stagnation, Fixed Factors, and Policy Thresholds," Mimeo, World Bank.

Easterly, W. and S. Rebelo, "Marginal Income Tax Rates and Economic Growth in Developing Countries," forthcoming, *European Economic Review*.

Easterly, W., Kremer, M., Prichett, L. and L. Summers, "Good Policy or Good Luck? Country Growth Performance and Temporary Shocks," mimeo, World Bank, 1992.

Engen, E. and J. Skinner, "Fiscal Policy an Growth," mimeo, University of Virginia.

Faig, M. "A Simple Economy with Human Capital: Transitional Dynamics, Technology Shocks and Fiscal Policies," working paper, University of Toronto, 1991.

Feldstein, M. "The Incidence of a Capital Income Tax in a Growing Economy with Variable Savings Rates," *Review of Economic Studies*, 505-513, 1974a.

Feldstein, M. "Tax Incidence in a Growing Economy with Variable Labor Supply," *Quarterly Journal of Economics*, 88: 551-573, 1974b.

Fischer, S. "Macroeconomic Factors in Growth," mimeo, MIT, 1992.

Grier, K. and G. Tullock, "An Empirical Analysis of Cross-National Economic Growth, 1951-1980," *Journal of Monetary Economics*, 87:225-52, 1989.

Holtz-Eakin, D. "Public Sector Capital and the Productivity Puzzle," NBER Working paper N. 4122, July 1992.

Hulten, C. and R. Schwab, "Public Capital Formation and the Growth of Regional Manufacturing Industries," mimeo 1991.

Jones, L. and R. Manuelli, 1990, A Convex Model of Equilibrium Growth: Theory and Policy Implications, *Journal of Political Economy*, 98, 1008-1038.

Jones, L., Manuelli, R. and Rossi, P., 1990, "Optimal Taxation in Convex Models of Equilibrium Growth," Mimeo, Northwestern University.

Judd, K. "Redistributive Taxation in a Simple Perfect Foresight Model," *Journal of Public Economics*, 28: 59-83, 1985.

Kim, S. "Tax, Growth and Welfare in an Endogenous Growth Model," working paper, University of Chicago, 1991.

King, M. and D. Fullerton, *The Taxation of Income From Capital: A Comparative Study of the United States, the United Kingdom, Sweden and West Germany*, Chicago University Press, Chicago.

King, R. and R. Levine, "Financial Indicators and Growth in a Cross Section of Countries," World Bank Working Paper 819, 1992.

King, R. G. and Rebelo, S. "Transitional Dynamics and Economic Growth in the Neoclassical Model," forthcoming *American Economic Review*, 1993.

King, R. G. and Rebelo, S. "Public Policy and Economic Growth: Developing Neoclassical Implications," *Journal of Political Economy*, 98: S126-S150, 1990.

Koester, R. and R. Kormendi, "Taxation, Aggregate Activity and Economic Growth: Cross-Country Evidence on Some Supply-side Hypotheses," *Economic Inquiry*, 27:367-86, 1989.

Koopmans, T., 1965, "On the Concept of Optimal Economic Growth," in *The Econometric Approach to Development Planning*, Pontific Acad. Sci., Amsterdam: North-Holland.

Kormendi, R. and P. Meguire, "Macroeconomic Determinants of Growth: Cross Country Evidence," *Journal of Monetary Economics*, 16:141-63, 1985.

Krzyzaniak, M. "The Long Run Burden of a General Tax on Profits in a Neo-classical World," *Public Finance*, 22: 472-491, 1967.

Lall, S. "A Note on Government Expenditures in Developing Countries," *Economic Journal*, 1969, 79: 413-416.

Landau, D. "Government Expenditure and Economic Growth: A Cross-Country Study," *Southern Economic Journal*, 49: 783-92, 1983.

Levine, R. and Renelt, D., 1990, "A Sensitivity Analysis of Cross-Country Growth Regressions," *American Economic Review*, September 1992.

Levine, R. and S. Zervos, "Looking at the Facts: What We Known About Policy and Growth from Cross-country Analysis," forthcoming, Pasinetti, L. and R. Solow (eds.) *Economic Growth and the Structure of Long Term Development*, International Economic association.

Liesner, T. *One Hundred Years of Economic Statistics*, The Economist Publications, London, 1989.

Lindauer, D. "The Size and Growth of Government Expenditures," World Bank working paper, 1988.

Lucas, R., 1988, "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22, 1:3-42.

Lucas, R., 1991, "Supply Side Economics: an Analytical Review," *Oxford Economic Papers.*

Maddison, A., 1982, *Phases of Capitalistic Development*, Oxford: Oxford University Press.

Maddison, A., 1983, "A Comparison of Levels of GDP Per Capita in Developed and Developing Countries, 1700-1980," *Journal of Economic History*, 43: 27-41.

Maddison, A., 1987, "Growth and Slowdown in Advanced Capitalistic Economies: Techniques of Quantitative Assessment," *Journal of Economic Literature*, 25: 649-698.

Mankiw, G., Romer, D., and Weil, D., 1991, "A Contribution to the Empirics of Economic Growth," *The Quarterly Journal of Economics*, vol CVI, 2.

Mino, K., "Money and Endogenous Growth in a Cash-in-advance Economy," mimeo, Hiroshima University, 1989.

Persson, T. and G. Tabellini, "Is Inequality Harmful for Growth?: Theory and Evidence," mimeo, Institute for International Economic Studies, Stockholm, Sweden, 1991.

Pfeffermann, G. and A. Madarassy, "Trends in Private Investment in Thirty Developed Countries," International Finance Corporation Discussion Paper N. 6, Washington, D.C. World Bank.

Plosser, C. "The Search for Growth," mimeo, University of Rochester, 1992.

Ram, R. "Wagner's Hypothesis in Time Series and Cross Section Perspectives; Evidence from 'Real' Data for 115 Countries," *Review of Economics and Statistics*, 1987, 194-204.

Rebelo, S., 1991, Long Run Policy Analysis and Long Run Growth, *Journal of Political Economy*, 99:500-521.

Rebelo, S. and N. Stokey, 1992, "Growth Effects of Flat Tax Rates," working paper, University of Chicago.

Rivera-Batiz, L. and P. Romer, 1991 International Trade with Exogenous Technical Change,

European Economic Review, 35: 971-1001.

Romer, P., 1986, "Increasing Returns and Long Run Growth," *Journal of Political Economy*, 94: 1002-1037.

Romer, P., 1989, "Capital Accumulation in the Theory of Long Run Growth," *Modern Business Cycle Theory*, ed. R. Barro. Cambridge, MA: Harvard University Press.

Romer, P., 1990a, "Endogenous Technological Change," *Journal of Political Economy*, 98: S71-S102.

Romer, P., 1990b, "Capital, Labor, and Productivity," *Brookings Papers on Economic Activity: Microeconomics*, 337-420. Washington: Brookings Institution.

Sandford, C., M. Godwin and P. Hardwick, *Administrative and Compliance Costs of Taxation*, Fiscal Publications, 1989.

Sato, K. "Taxation and Neoclassical Growth," *Public Finance*, 22: 346-70, 1967.

Sicat, G. and A. Virmani, 1988, Personal Income Taxes in Developing Countries, *The World Bank Economic Review*, 2, 1:123-138.

Solow, R., 1956, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics*, 70: 65-94.

Summers, L., 1981, "Capital Taxation and Accumulation in a Life-Cycle Growth Model," *American Economic Review*, 71.

Summers, R. and A. Heston, 1991, The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988, *The Quarterly Journal of Economics*, vol CVI, 2:327-368.

Tanzi, V., "Quantitative Characteristics of the Tax Systems of Developing Countries," in Newbery, D. and N. Stern, *The Theory of Taxation for Developing Countries*, Oxford University Press, 1987.

Vaillancourt, F. *The Administrative and Compliance Costs of Personal Income Taxes and Payroll Taxes, Canada, 1986*, Canadian Tax Foundation, 1989.

Wang, P. and C. Yip, "Alternative Approaches to Money and Growth," mimeo, The Pennsylvania State University, 1991.

Watson, M., 1992, A Note on Estimating Deterministic Trends in the Presence of Serially Correlated Errors, working paper, Northwestern University.

White, H., 1980, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica*, 48: 817-838.

Yuen, C., 1990, "Taxation of Human Capital," Mimeo, University of Chicago.