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A Comparative Analysis of the Structure of Tax Systems in Industrial Countries

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Abstract

A methodology for computing effective average tax rates on factor incomes and consumption using OECD data from national accounts and revenue statistics is described and applied to construct time series of tax rates for the group of seven largest industrialized countries. These tax rates are compared with estimates of effective marginal tax rates obtained in other studies. The stylized facts that distinguish tax systems across countries are documented, and the co-movements between the tax rates and savings, investment, net exports, unemployment, and hours worked are also examined. The results of this analysis illustrate some of the potential implications of tax policies currently under consideration and suggest that the proposed tax rates are useful approximations to those faced by representative agents in dynamic macroeconomic models.

JEL Classification Numbers:
F41, H20

1/ International Monetary Fund, Tel-Aviv University, and University of California-Santa Barbara respectively. Work on this project started while Assaf Razin and Linda Tesar were visiting scholars at the Research Department of the International Monetary Fund. We gratefully acknowledge comments and suggestions by David Coe, Robert Ford, Robert Hagemann, Carmen Reinhart, and Peter Wickham, as well as the research assistance provided by Kote Nikoi.

Contents

Summary

This paper proposes a method for computing effective average rates of taxation on consumption and factor incomes based on data from revenue statistics and national accounts. The method estimates the wedges that distort optimal plans in a representative agent framework by computing percentage differences in measures of aggregate post- and pretax incomes and prices. It is used to compute time series of tax rates for the group of seven largest industrialized countries covering the period 1965-88. The paper then compares these tax rates with existing estimates of effective marginal tax rates and examines the relationship between the tax rates and savings, investment, net exports, hours worked, and unemployment. This analysis highlights the features that distinguish the stance of tax policy among industrial countries and suggests some potential implications of tax-harmonization policies.

The estimates of effective average tax rates show that labor income, capital income, and consumption taxes have fluctuated noticeably in response to changes in statutory taxes and policies regarding credits and exemptions. Capital and consumption taxes do not exhibit a marked trend. The tax on labor income, on the other hand, has increased over time in all of the countries studied. Taxes on consumption and labor income tend to be higher in European countries relative to Japan and the United States, while taxes on capital income in the United States have been higher than in other countries--except the United Kingdom and, in recent years, Japan. Despite significant differences in tax systems, tax rates have tended to converge for groups of countries--particularly in the case of consumption taxes in European countries (except France), labor income taxes in North America, Japan, and the United Kingdom, and capital income taxes in France, Germany, and Italy, and in Canada and the United States.

The statistical analysis relating the tax rates to macroeconomic variables indicates that capital income tax rates are negatively related to savings rates, and consumption and labor income tax rates are negatively correlated with the number of hours worked, as predicted by neoclassical equilibrium models. Moreover, the level and trend of the rate of unemployment are positively correlated with the tax on labor income, as predicted by models of equilibrium unemployment or the "natural rate." These relationships are stronger in panel tests that combine time-series and cross-sectional information, but they remain strong even for time series of several individual countries. These empirical regularities are also documented using detrended and non-detrended data. The relationships between macroeconomic variables and tax rates are generally stronger at low frequencies relative to business cycle frequencies.

I. Introduction

The precise measurement of the tax rates that affect economic decisions at the aggregate level is critical in the design of macroeconomic models intended to simulate the effects of fiscal policies. The extensive analytical work on the subject produced during the last decade, as in Buiter (1981), Razin and Svensson (1983), Aschauer and Greenwood (1985), Pissarides (1985), Frenkel and Razin (1986), and Baxter and King (1992), 1/ emphasized the importance of modelling explicitly the structure of incentives and constraints under which households and firms formulate optimal plans in order to produce reliable assessments of the effects of policies—particularly in an environment of increasing international economic integration (see Frenkel, Razin, and Sadka (1991)). Hence, applications of these models aimed at quantifying the effects of policies require that, in addition to specifying explicit representations of the structure of preferences and technology, researchers adopt a realistic description of the rates of taxation prevailing in different countries prior to experimenting with policy changes.

Unfortunately, measuring the relevant tax rates has proven to be a difficult task, and this in turn has contributed to hamper the development of quantitative applications of equilibrium models as a policy-making tool. 2/ Simulation exercises of fiscal policy changes like that undertaken by Greenwood and Huffman (1991) have illustrated the potential usefulness of these models in the evaluation of policies. However, without a realistic characterization of the key elements of the tax system, it is difficult to infer the implications of model simulations for the design of actual policies. Moreover, an attempt to construct a realistic picture of the structure of tax systems in industrial countries is of particular interest given the convergence of fiscal policies envisaged for the European Community in the Maastricht Agreement and in the agreements to harmonize indirect taxes, and also in light of recent proposals of deficit-reduction plans for the United States and Japan—some of which emphasize the use of indirect taxation.

There has been an extensive literature on the measurement of effective *marginal* tax rates on labor and capital income for the United States (see Auerbach (1987), Barro and Sahasakul (1986), Joines (1981), and Seater (1985)) and for other countries (King and Fullerton (1984), McKee, Visser,

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1/ See Frenkel and Razin (1987) for a comprehensive review of this literature.

2/ The development of empirical applications of these models has also been hampered by the limitations of standard econometric techniques to estimate and simulate non-linear stochastic equilibrium models, most of which lack closed-form solutions. The use of recursive numerical solution methods, a key contribution of the real business cycle research program, has provided researchers with the means to overcome this limitation. Mendoza and Tesar (1992) show how recursive solution methods and the tax rates reported in this paper can be combined to provide quantitative assessments of the impact of fiscal consolidation and coordination among industrial countries.

and Saunders (1986) and OECD (1991b)). These thorough studies construct estimates of marginal tax rates by combining information on statutory tax rates, tax returns, and tax codes with data on income distribution, household surveys, and projections of real present values for investment projects in specific industries. However, as Frenkel, Razin, and Sadka (1991) argue, the complexity of tax credits and tax exemptions that exist in most countries, as well as the numerous equivalences that link broad categories of taxes, make the construction of effective marginal tax rates useful for macroeconomic modelling at an international scale extremely difficult. It is also difficult to show that marginal tax rates that apply to particular individuals in a household survey, or a specific aggregation of incomes based on tax-bracket weights, are equivalent to the aggregate tax rates that affect macroeconomic variables as measured in conventional national accounts systems. Moreover, detailed time-series and international cross-section applications of methods for computing effective marginal tax rates are seriously limited by data availability.

Lucas (1990) and (1991) and Razin and Sadka (1993) have opted for an approach that produces effective *average* tax rates, for the taxes that generate the majority of the government's tax revenue, based on data on actual tax payments and national accounts. Their empirical analysis suggests that these tax rates are useful approximations to the taxes that distort decisions by representative agents in dynamic macroeconomic models. Their method focuses on the information that national accounts data provide regarding post- and pre-tax prices and incomes, combined with figures that aggregate tax revenues by allocating them to taxes on consumption and factor incomes. This method is less rigorous in the treatment of the tax laws, but it produces measures of the tax rates that are consistent with the representative agent assumption and, by looking at the aggregate data, it also takes into account the effective, overall tax burden resulting from each of the major tax categories (i.e. taxes on capital and labor income and taxes on consumption). In addition, this method is easier to implement in multi-country research projects because it exploits the international consistency of available data sources on national accounts and revenue statistics.

This paper describes an application of this method to compute time series of the effective average tax rates on consumption, capital income, and labor income for the group of seven largest industrialized countries using information publicly available from the OECD. We compare these tax rates with some of the available estimates of effective marginal tax rates and find that, despite differences, the tax rates reported here are within the ranges of marginal tax rate estimates and display very similar trends.

The paper also shows that our estimates of the tax rates are generally consistent with some key predictions of equilibrium models. In particular, we find that in the majority of countries, the savings rate is inversely related to the tax rate on capital income, the average number of hours worked is negatively correlated with the sum of the labor and consumption

taxes, and the rate of unemployment is positively correlated with the labor income tax. The first two results are consistent with the intertemporal equilibrium model of savings in an open economy, as explained in Frenkel, Razin and Sadka (1991), while the second is consistent with models of equilibrium unemployment, or the "natural rate," as in Pissarides (1985) and Adams and Coe (1990). The investment rate is also inversely related with the capital income tax, reflecting the well-known positive correlation between savings and investment, and suggesting that the rates of taxation affecting the returns on foreign and domestic capital tend not to offset each other.

Comparing the data across countries, we find that in countries where tax rates on capital income are above average, savings and investment rates tend to be below average, while in countries where labor income taxes are relatively high, the rate of unemployment tends to be higher and the number of hours worked tends to be lower. The international cross-section and time-series information is combined in panel data tests to formalize the evidence obtained from the inspection of correlation coefficients. Finally, the cross-country analysis highlights important differences in the distribution of the tax burden on consumption, labor income, and capital income between North America, Japan, and Europe which are suggestive of the magnitude of adjustment that policies of tax harmonization may require. The analysis indicates that consumption taxes in the United States are significantly lower than in Canada and the European Community, but it also suggests that increasing the U.S. consumption tax could result in a higher natural rate of unemployment and a reduction in the number of hours worked.

The paper is organized as follows. Section II describes the methodology and the sources used to compute effective average tax rates. Section III compares the effective average tax rates with estimates of effective marginal tax rates obtained in other studies. Section IV examines some of the empirical regularities that characterize the tax rates within each country and across countries, and compares them with basic implications derived from theory. This section includes an econometric analysis based on panel data techniques. The last section draws some general conclusions.

II. A Methodology for Computing Effective Average Tax Rates

While the concept of the marginal tax rate that affects the decisions of economic agents is very simple in theory, and relatively easy to quantify at a microeconomic level, computing effective marginal tax rates that apply at a national or international level is quite difficult. Within one country, computing these tax rates is problematic because tax revenue data and the tax system itself do not conform to the aggregate concepts of a macroeconomic model, because of the many exemptions and credits that make it difficult to extrapolate the information from the statutory tax rates written in the law, because of the equivalent effects that may result from different types of taxes, and because of the need to have available data on

the distribution of income consistent with systems of income tax and social security contributions. At an international level, the situation is complicated further by differences in the structure of the tax systems and the limitations of the information available on tax revenues and income distribution. Following Frenkel, Razin, and Sadka (1991) and Razin and Sadka (1993), we adopt the view that a useful approach is to look at effective average tax rates based on actual tax payments and national accounts.

This section of the paper describes our method for computing effective average rates of taxation on consumption and the income derived from capital and labor services for the group of seven largest industrialized countries. Using data from two publications by the Organization for Economic Co-operation and Development—Revenue Statistics of OECD Member Countries, OECD (1990) and National Accounts: Volume II, Detailed Tables, OECD (1991a)—we compute time series of the effective average tax rates for each country covering the period 1965-1988. The method we use is the same one that Razin and Sadka (1993) used to examine the structure of taxation in Israel, 1/ which was based on guidelines suggested by Lucas (1990) and (1991).

Razin and Sadka (1993) undertake a quantitative analysis of static and dynamic inefficiencies of taxation using a general equilibrium model of an economy inhabited by representative agents. Firms produce an aggregate consumption good using capital and labor services provided by households, and government levies ad-valorem taxes on consumption, capital income, and labor income. Ad-valorem tax rates are then derived as the ratio of *specific* tax rates (i.e. the difference between household and producer prices of each) to the producer prices. Calibration of the model using Israeli national accounts data on pre- and post-tax income and prices produces aggregate effective tax rates that in fact correspond to realized average tax rates. Thus, the effective average tax rates aggregate the information on statutory taxes, credits, and exemptions implicit in national accounts in a manner that maintains consistency with the representative agent framework.

1. Description of the data:

The data used to compute the tax rates and the sources from which they were obtained are described next. The four-digit codes listed below identify different measures of tax revenue and correspond to the codes used in the OECD's Revenue Statistics. This publication is extremely useful because it collects information on tax revenues from country sources and organizes it under a uniform format at the general government level and on a cash basis. Abbreviations in capitalized letters correspond to variables

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1/ These authors start their analysis by examining the details of the Israeli tax laws, including credits and exemptions, and the effects of the inflation tax on measures of effective marginal tax rates on capital income similar to those of King and Fullerton (1984) and Auerbach (1987).

obtained from the OECD's National Accounts: Volume II, Detailed Tables. This publication also takes information from country sources and attempts to organize it under a common format. Of particular importance for the computation of tax rates is the data at the disaggregated level that it provides on the detailed accounts for households, corporate enterprises, and government. The data from both sources covers the period 1965–1988. The key to the variables is as follows:

a. Revenue statistics data:

1100 Taxes on income, profits, and capital gains of individuals
1200 Taxes on income, profits, and capital gains of corporations
2000 Total social security contributions
2200 Employer's contribution to social security
3000 Taxes on payroll and workforce
4100 Recurrent taxes on immovable property
4400 Taxes on financial and capital transactions
5110 General taxes on goods and services
5121 Excise taxes

b. National accounts data:

C = Private final consumption expenditure
G = Government final consumption expenditure
GW = Compensation of employees paid by producers of government services
OSPUE = Operating surplus of private unincorporated enterprises
PEI = Household's property and entrepreneurial income
W = Wages and salaries
OS = Total operating surplus of the economy.

2. Effective average consumption tax rate:

In a simple general equilibrium model of fiscal policy, where representative households purchase an aggregate consumption good and pay an ad-valorem tax on their purchases, the consumption tax rate should correspond to the percentage difference between the post-tax price they pay and the pre-tax price at which firms supply the good. Thus, if we use the data collected from the OECD sources, the effective average tax rate on sales of consumption goods (t_c) can be computed as follows:

$$t_c = [(5110+5121)/(C+G-GW-5110-5121)]*100.$$

The numerator of this expression is the revenue from indirect taxation (general taxes on goods and services plus excise taxes), which is equal, by definition, to the difference between the nominal value of aggregate consumption at pre-tax and post-tax prices. The denominator is the base of the tax, which is the pre-tax value of consumption—measured as post-tax consumption expenditures minus the revenue from indirect taxation. The

formula takes advantage of the fact that nominal consumption expenditures in national accounts are at post-tax prices. Government consumption of goods must be included in the denominator because Revenue Statistics reports data on indirect tax revenue that includes taxes paid by government. However, this only applies to purchases of goods and non-factor services, and hence the compensation of government employees must be deducted from G. This formula is identical to the one used by McKee, Visser, and Saunders (1986) in their computations of the consumption tax that they incorporated to their calculations of effective marginal tax rates on labor income for OECD countries.

3. Effective average labor income tax rate:

The effective average tax on labor income corresponds to the percentage difference between post- and pre-tax labor income. In practice, however, computing this average tax rate is difficult because of the manner in which data on income taxes and other taxes based on labor income are reported. One common problem, which also affects most computations of effective marginal labor income tax rates (as in McKee, Visser and Saunders (1986) and Barro and Sahasakul (1986)) is that tax revenue sources typically do not provide a breakdown of individual income tax revenue in terms of labor and capital income. We address this problem by assuming that all sources of the households' income are taxed at the same rate—an assumption which according to 1991 tax laws in OECD member countries (see OECD (1991b)) is a good approximation. Another issue of concern is the fact that, in addition to the individual income tax on wages, there are other important taxes based on labor income such as social security contributions and payroll taxes. These are taken into account in the computations that follow.

We begin by computing the households' average tax rate (t_h) on total income as:

$$t_h = [1100/(OSPUE+PEI+W)]*100.$$

Thus, the representative agent's income tax rate is the ratio of individual income tax revenue—which represents the difference between post-tax and pre-tax individual income—to pre-tax household income. The latter is defined as the sum of wage and non-wage individual income (i.e. the sum of wages and salaries, property and entrepreneurial income, and the operating surplus of private unincorporated enterprises).

Then we estimate the revenue from the income tax on wages and salaries as t_h*W and we compute the effective average tax rate on labor income (t_l) as:

$$t_l = [(t_h*W+2000+3000)/(W+2200)]*100.$$

In addition to the tax on wages and salaries, this calculation incorporates all social security contributions and payroll taxes as part of the revenue

derived from labor income taxes, and it also makes a correction to expand the tax base to include the employers' contribution to social security—since households are not taxed on the portion of compensation to employees that represents social security contributions by firms.

4. Effective average capital income tax rate:

Continuing under the assumption that all sources of the households' income are taxed uniformly, we estimate first the revenue from the capital income tax on individuals as t_h*(OSPUE+PEI), and then we define the effective average capital income tax rate (t_k) as:

$$t_k = [(t_h*(OSPUE+PEI)+1200+4100+4400)/OS]*100.$$

This formula represents the difference between post-tax and pre-tax capital income divided over pre-tax capital income. The difference between post- and pre-tax capital income includes, in addition to the households' payments of capital income taxes, the payments of capital income taxes made by corporations, 1/ all recurrent taxes on immovable property paid by households and others, and the revenue from specific taxes on financial and capital transactions. The pre-tax capital income which serves as the base of the tax is the operating surplus of the economy as a whole (gross output at producers' values less the sum of intermediate consumption, compensation of employees—which is wages and salaries plus employers' contributions to social security—, consumption of fixed capital, and indirect taxes reduced by subsidies).

Tables 1-4 list the time series of the effective average tax rates on consumption, labor income, capital income, and corporate capital income for each of the seven largest industrialized countries. These time series are plotted in Figures 1-4. In the remainder of the paper we compare these tax rates with existing estimates of effective marginal tax rates, and we examine some of their basic stylized facts.

III. A Comparison with Previous Work

The analytical framework from which the method for computing effective average tax rates was derived indicates that these tax rates are an accurate characterization of the wedge between pre-tax and post-tax prices in a representative agent, equilibrium model. Nevertheless, the method we presented does not consider explicitly the statutory tax rates and the peculiarities of the tax laws of each country, nor does it incorporate information on the income distribution according to income tax brackets and the schedule of social security taxes. These are issues that are examined

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1/ The average income tax rate on corporate capital can be computed in a similar manner by dividing the income tax bill of all corporate enterprises over the operating surplus of the corporate sector.

thoroughly in the existing literature on the computation of effective marginal tax rates. This section provides a brief review of some of this literature and compares its results with those obtained in this study.

Consider first some of the studies that have focused on the computation of marginal labor income tax rates for the United States, as in Joines (1981), Seater (1985), and Barro and Sahasakul (1986). 1/ These studies compute effective marginal tax rates by calculating weighted averages of tax rates, or tax bills, per tax bracket, using as weights the shares of income on total income pertaining to each tax bracket. They take into account both income tax returns and social security contributions. Seater defines each tax bracket's marginal tax rate as the ratio of the difference in the tax bill of that bracket minus the tax bill of the previous bracket divided over the difference in income earned by individuals in the same two tax brackets. Joines' measure is similar but it adjusts for the number of tax returns in each bracket and it incorporates property, sales, and other proportional taxes. In contrast, Barro and Sahasakul compute their effective marginal tax rates by taking a weighted average of the statutory tax rates listed in income tax schedules. All three authors face the problem of individual income tax revenue data not providing detail on the revenue derived from labor income and capital income separately. Seater and Barro and Sahasakul set aside this problem by focusing on tax rates for individuals, without distinguishing between capital and labor income. While Joines takes a similar approach to the one adopted here, by assuming that personal income tax rates apply uniformly to capital and labor income.

Figure 5 plots the available time series for the effective marginal tax rates on labor or individual income from the studies mentioned above, together with the effective average tax rate estimates reported in Section II. The chart illustrates clearly that despite methodological differences, which result in noticeable differences in the level of the tax rates, the general trend of the four series listed is very similar. Nevertheless, it is important to try to account for the factors that explain the differences in levels because theory predicts that the level of the tax rates has important implications on economic behavior. The Barro-Sahasakul rates are the highest because, by focusing on statutory tax rates, they abstract from the information on tax credits and exemptions that estimates based on actual tax returns can capture. The tax rates that Seater estimated using actual tax returns are the lowest, but considering Joines' adjustments to take into account the number of returns per tax bracket and taxes that tend to be proportional to income--such as consumption taxes--the outcome is a series on labor income tax rates that is not very different from the effective average tax rates presented here. If the effective average consumption tax

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1/ For earlier studies of this issue see Seater (1982), Barro and Sahasakul (1983), and Wright (1969).

Figure 1. Consumption Sales Tax 1965 to 1988

(In Percent)

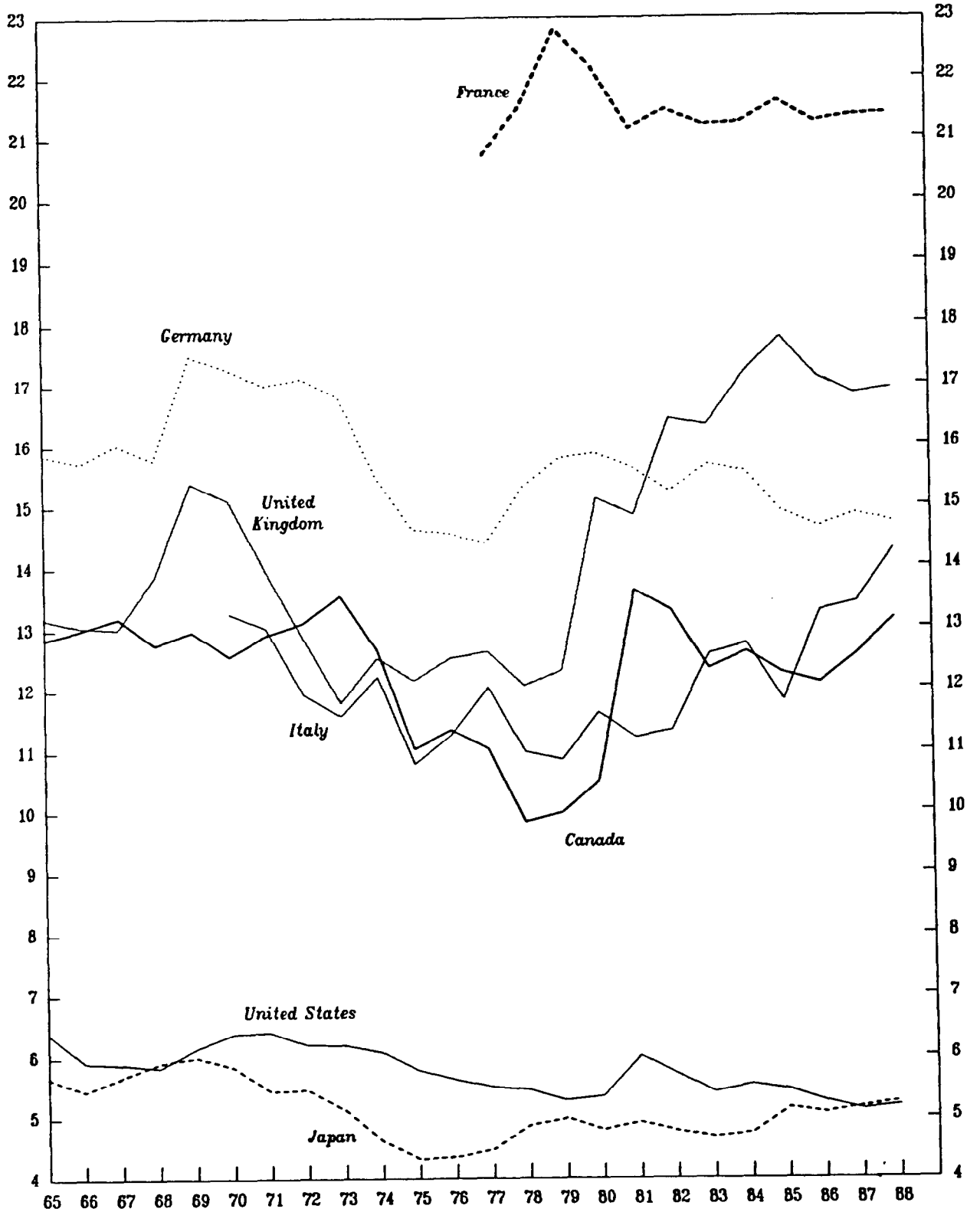


Figure 2. Labor Income Tax
1965 to 1988

(In Percent)

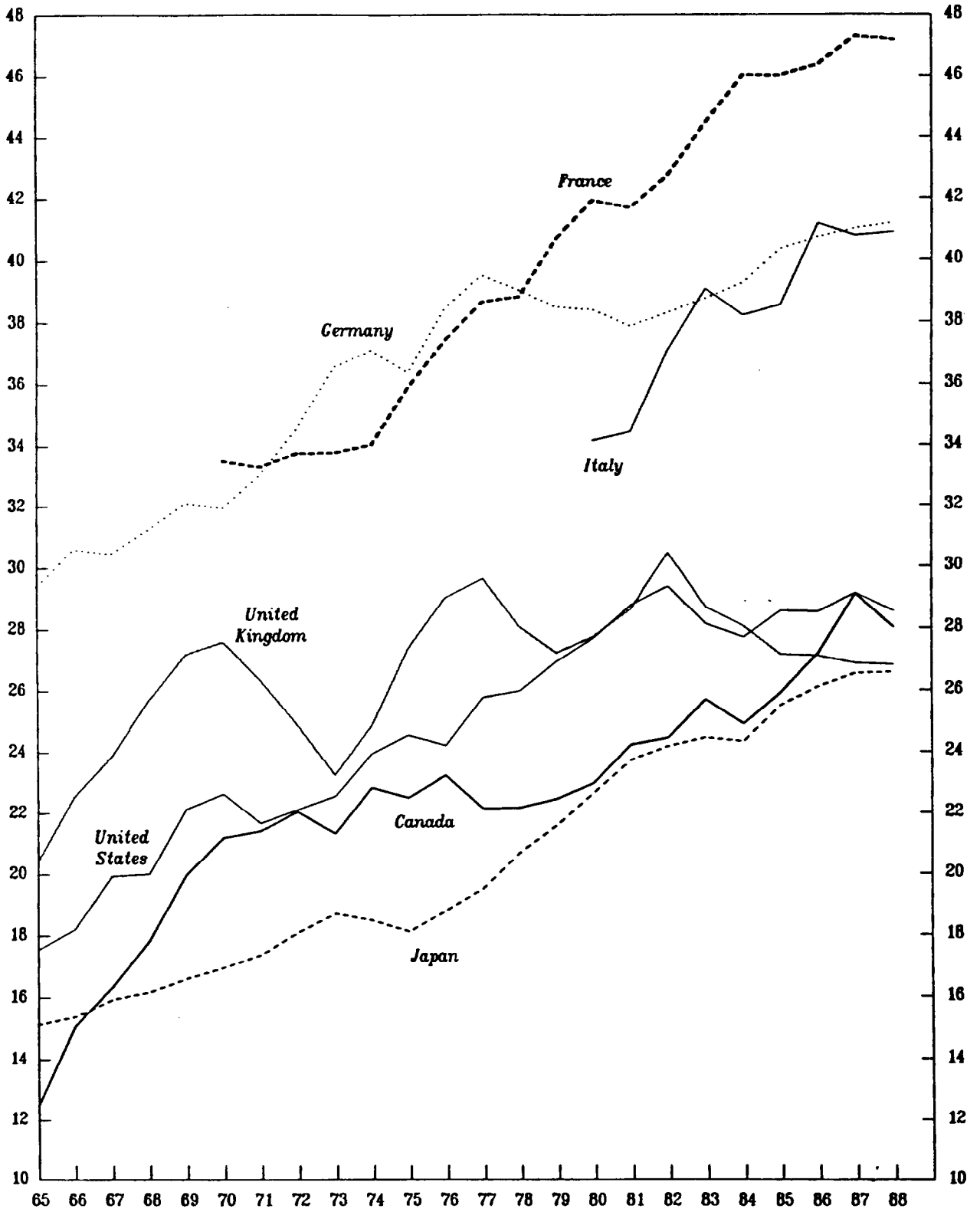


Figure 3. Capital Income Tax. 1965 to 1988

(In Percent)

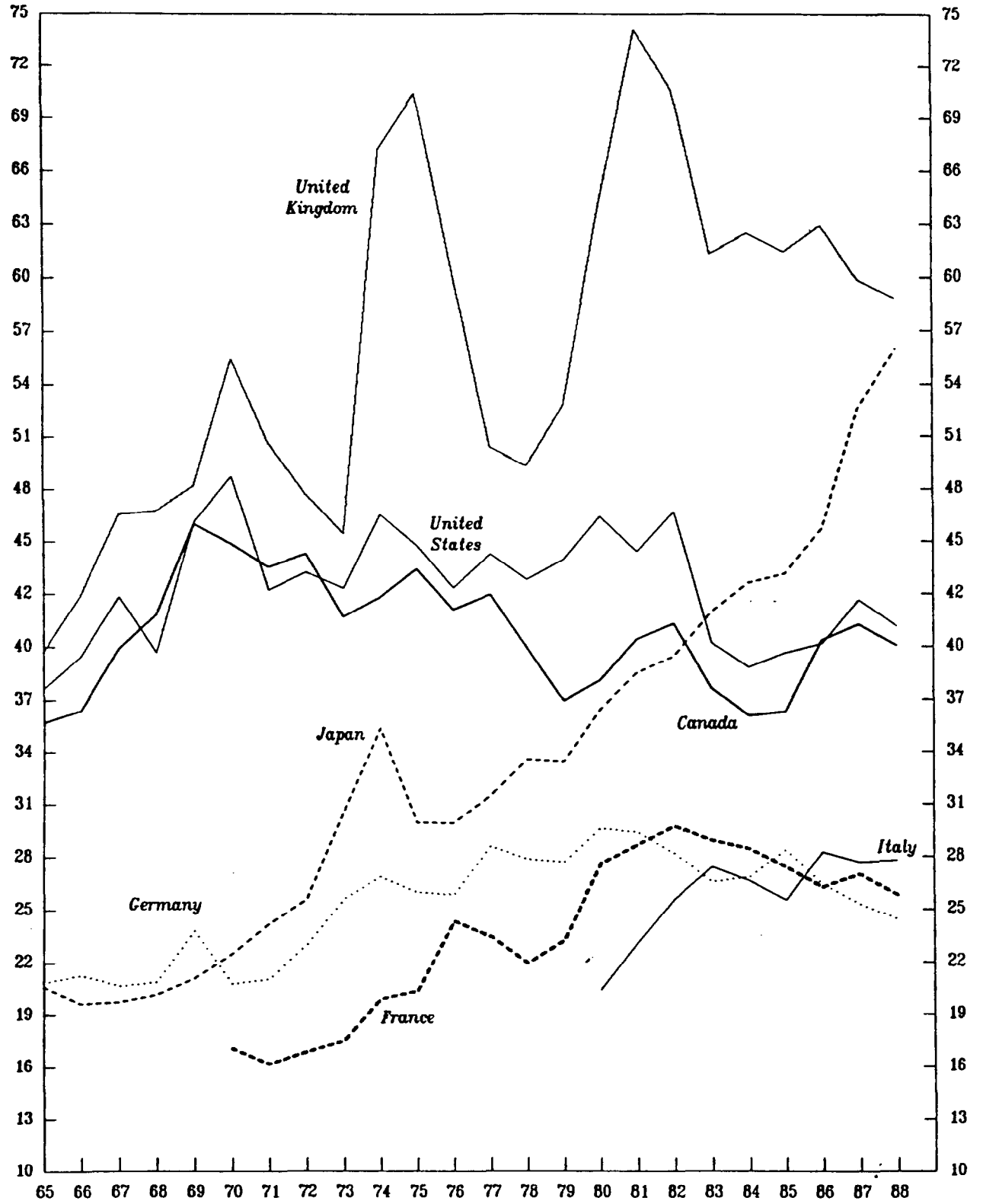


Figure 4. Corporate Capital Income Tax. 1965 to 1988

(In Percent)

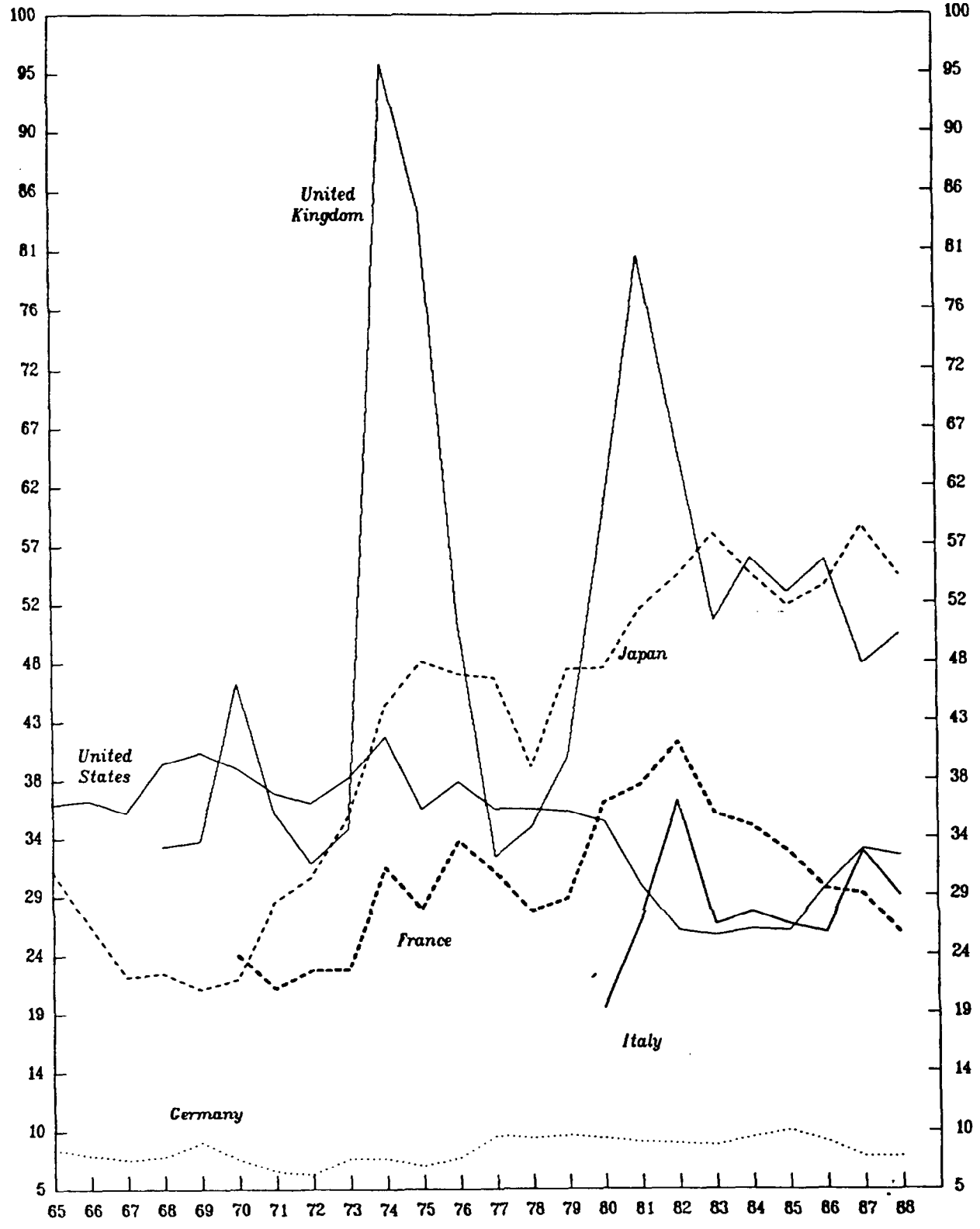
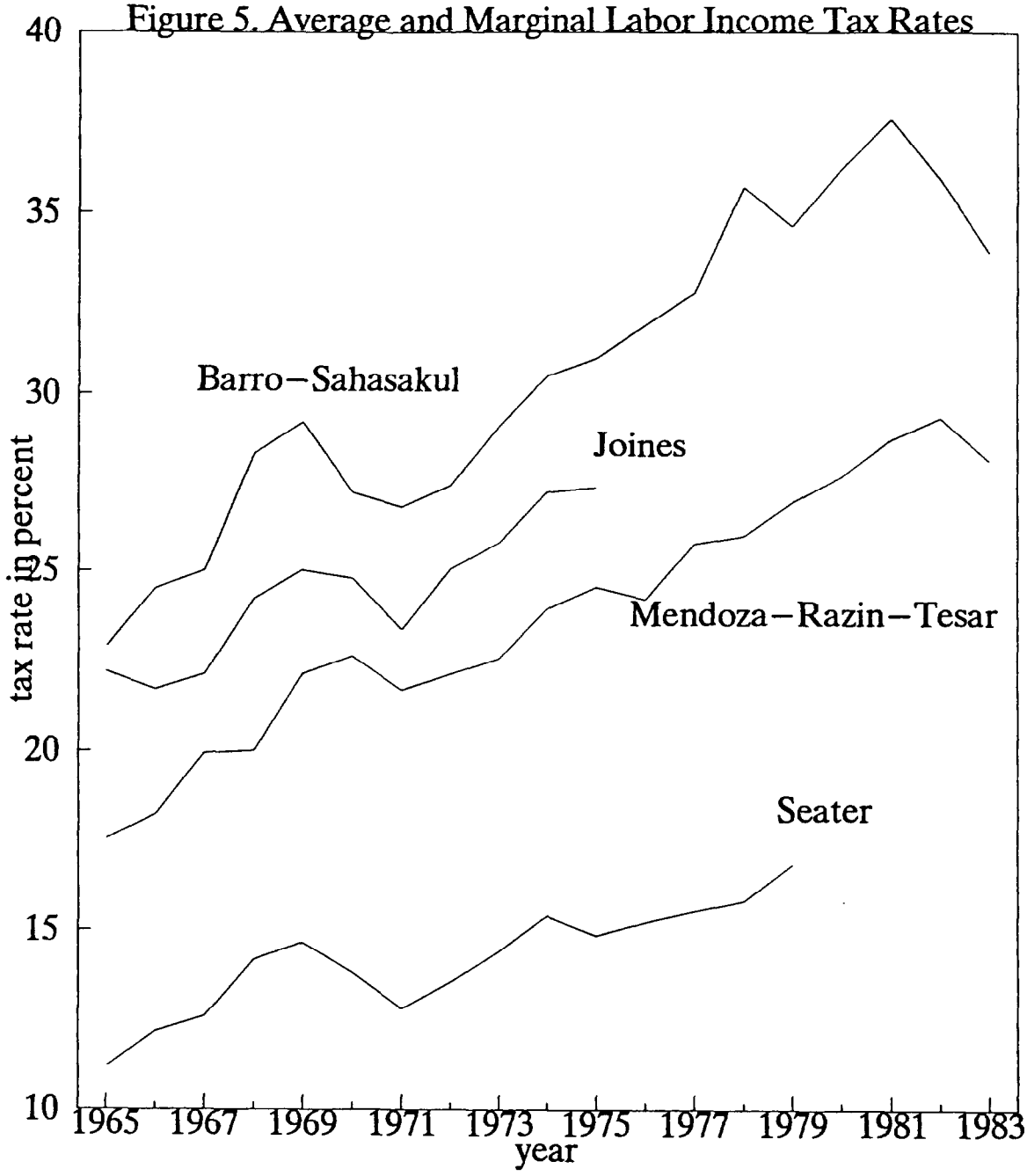


Figure 5. Average and Marginal Labor Income Tax Rates



is added to the effective average labor income tax, the difference with Joines' marginal labor income tax is negligible. 1/

We focus now on international studies of effective marginal tax rates. In particular the study on capital and labor income taxes in OECD countries by McKee, Visser, and Saunders (1986), and the studies on effective tax rates on marginal investments by King and Fullerton (1984) and OECD (1991b). The tax rates on labor income constructed by McKee et. al. differ from those discussed above in that they do not represent weighted averages of tax-bracket data. Instead, their calculations are based on statutory taxes, tax returns, and post- and pre-tax labor income that apply at the level of the "Average Production Worker" (APW) as a reference for international comparisons. 2/ Their estimates incorporate payroll taxes, social security contributions, income taxes, and consumption taxes, assuming that individuals do not collect capital income—so that statutory taxes on individual income and individual income tax returns can be treated as corresponding to labor income taxes. Two sets of tax rates are produced, corresponding to APWs that are single workers and APWs that are single-earner married couples with children, for the years 1979, 1981, and 1983. The limitations of the sample are due to restrictions imposed by data availability. As Table 5 shows, on a country-by-country basis, changes in the labor income tax rates computed by McKee et. al. coincide with the changes in the effective average tax rates computed here. Nevertheless, these authors' estimates are generally higher than those computed here. This bias reflects in part the addition of individual capital income tax as part of the labor income tax, and is also an indication of the relative position of the hypothetical APW in each country's tax schedule and income distribution.

The international studies on capital income taxation by McKee et. al. (1986) and OECD (1991b) are based on a methodology originally developed in the work of King and Fullerton (1984). This method computes rates of taxation on marginal investments as the percentage difference between post- and pre-tax net rates of return on specific investment projects. The pre-tax real rate of return is defined as the value of the marginal rate of return that equates the expected discounted present value of the future

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1/ Joines (1981) also constructed estimates of the effective marginal tax rate on capital income by computing a weighted average of proportional and non-proportional capital income taxes. The non-proportional tax is assumed to be identical to the federal personal income tax, and the proportional taxes include sales taxes, property taxes, corporate income taxes, and state and local income taxes. Joines' estimates are slightly higher than those reported in the paper for the effective average tax rate on capital income, but the two series display similar trends. The difference between the two estimates is minimal if the average sales tax is added to the average capital income tax.

2/ The APW income is the average of earnings of production workers in the manufacturing sector.

stream of after-tax profits of the project with its cost, net of grants and allowances, and after deducting the rate of depreciation. The procedure requires, therefore, that researchers obtain information on the statutory taxes on corporate and individual capital income according to ownership institutions, industries, and form of income (i.e. interest, dividends, or retained earnings), as well as information on application of taxes, credits, and exemptions according to form of financing and accounting of depreciation. Moreover, the computation of real internal rates of return also requires assumptions regarding the expected path of the rate of inflation and the market discount factor.

The tax rates computed in the three studies mentioned above are illustrative of the strengths and weaknesses of the King-Fullerton approach. The tax rates differ very significantly depending on the sector to which investment is going, on whether, within each sector, it is oriented towards equipment, structures or inventories, on whether it is financed by debt, new share issues, or retained earnings, on whether it is undertaken by firms owned by households subject to personal income taxes or by tax-exempt institutions, and on the assumed inflation and market discount rates. For instance, McKee et. al. show that for the United States in 1983, the tax rate on investments in manufacturing, assuming inflation fixed at 8.3 percent, varies from -137.8 percent for equipment investments by tax-exempt institutions incurring in debt to 97.1 percent for investments in structures financed by household-owned firms issuing new shares.

While this methodology provides accurate measures of the effective marginal tax on specific investments, which can be compared across industries and across countries, it is nonetheless difficult to introduce in a macroeconomic model to produce the relevant tax rate for explaining aggregate investment and saving decisions. Moreover, the assumptions of perfect-foresight regarding the future paths of profits and prices seem difficult to integrate with the uncertain environment that modern macroeconomic models emphasize.

IV. Stylized Facts of Effective Average Tax Rates

In this section we examine the empirical regularities that characterize the effective average tax rates and their co-movements with other key macroeconomic aggregates. This analysis serves two purposes. First, it provides us with some formal evidence on the empirical regularities that distinguish the tax systems across large industrial countries. Second, it gives us some insight into the potential empirical relevance of effective average tax rates for macroeconomic modelling. The second goal is accomplished by contrasting the co-movements we find between our estimates of the tax rates and data on macroeconomic variables with basic implications derived from theory. However, the results of this analysis must be interpreted carefully because they are only intended to establish whether effective average tax rates "make sense", in the sense that they do not

produce empirical puzzles, without providing substantial evidence for or against any particular model.

There are three basic theoretical implications regarding the connection between taxes and macroeconomic variables that we examine here. The first two follow from intertemporal equilibrium models of the open economy. In these models, as Frenkel, Razin, and Sadka (1991) explain, the capital income tax distorts savings decisions by taxing the benefits obtained from postponing consumption. An increase in the rate of the capital income tax lowers the intertemporal relative price of consumption, inducing agents to increase current consumption and reduce savings. In contrast, investment should not be significantly affected by capital income taxation to the extent that financial capital is mobile across countries, physical capital is not costly to adjust, and the returns on domestic and foreign investments are taxed uniformly. If there are capital-adjustment costs, capital income taxes affect investment depending on whether it is equity- or debt-financed. 1/ Hence, we examine whether the capital income tax rate and the savings rate are negatively correlated, and we also study the co-movement between investment and the capital income tax. The second implication of the neoclassical framework that we examine is that taxes on consumption and labor reduce the price of leisure time relative to consumption. As these two tax rates rise, households substitute consumption for leisure and devote less time to work. Thus, we study whether the sum of the labor and consumption tax rates is negatively correlated with the number of hours worked per worker. 2/ Finally, we also examine a prediction of equilibrium models of unemployment as that of Pissarides (1985), which has also been examined in the empirical literature on the natural rate of unemployment (see, for example, Adams and Coe (1990)). In Pissarides' search framework, given tax-free unemployment compensation, firms cannot pass the effect of an increase in the rate of labor income tax entirely to workers, and hence wage costs to firms increase with the tax and result in a decline in profits and vacancies and higher equilibrium unemployment. We examine, then, whether the rate of unemployment is positively related to the labor income tax, particularly in the absence of cyclical effects.

Tables 1-4 and Figures 1-4 illustrate some important stylized facts of taxation in industrial countries. First, effective average tax rates have

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1/ In general, assuming taxes are constant over time, it is only in the case that firms retain profits and issue equity that investment would be independent of the tax structure (see Frenkel, Razin, and Sadka (1991), Chapter 5).

2/ Note that the two co-movements identified in this paragraph emphasize only substitution effects resulting from a specific tax adjustment. The equilibrium co-movements observed in the data, however, reflect the outcome of income and substitution effects that result not only from changes in one tax rate, but also from other exogenous variables—such as other tax changes, productivity disturbances or terms-of-trade shocks. For a formal analysis of this issue see Mendoza and Tesar (1992).

fluctuated markedly since 1965 mainly in response to both long-term fiscal reforms and short-term policy changes in statutory taxes, tax credits, and exemptions, and also to some extent in response to cyclical effects affecting the data on tax revenues and the measures of tax bases described in Section II. 1/ While tax rates on consumption and capital income appear to be stationary (except for the tax rate on capital income in Japan), the effective average tax rate on labor income has followed an increasing trend in all countries. Second, cross-country differences in tax rates, particularly labor income tax rates, have narrowed considerably in recent years relative to the late 1960s. Nevertheless, as of 1988 one can still identify clear differences in the various tax systems, and in general it is observed that countries that tax more (less) consumption and labor income tend to tax less (more) capital income. The rate of taxation on consumption is significantly lower in Japan and the United States than in the rest of the countries examined. The tax rates on labor income can be divided into three groups—four countries with a rate between 26 and 28 percent (Canada, Japan, the United Kingdom, and the United States), two with a rate of about 41 percent (Germany and Italy), and one with a rate of nearly 47 percent (France). Similarly, taxes on capital income can also be broken down in three groups. The capital income tax rate is significantly higher, at about 57 percent, in the United Kingdom and Japan than in the other countries. 2/ In Canada and the United States capital income is taxed at about 40 percent, while in France, Germany, and Italy, that tax rate is around 25-28 percent. A comparison of Figures 3-4 suggests also that the mix between corporate and individual capital income taxes has shifted over time in most countries.

Tables 6-7 report the arithmetic means of the effective average tax rates in each country and their co-movement with savings, investment, net exports, unemployment, trend unemployment—as a proxy for the natural rate of unemployment—and hours worked. 3/ These statistics are only intended to provide a general idea of how taxes and other macroeconomic variables

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1/ Fluctuations in the corporate income tax rate of the United Kingdom are particularly notorious. The sharp increases following the oil-price shocks reflect increases in tax revenue from the petroleum revenue tax and the supplementary petroleum duty (see OECD (1990), p. 136), as well as declines in the aggregate operating surplus of corporations due to the recession induced by those shocks. Nevertheless, the corporate income tax during the period 1973-1982 was centered around 52 percent, which was in line with the statutory General Corporate Tax prevailing at that time.

2/ The striking pattern of the average capital income tax rate in Japan, which unlike in the other countries has increased in a sustained manner since 1965, is an interesting fact to examine by itself in light of the impressive growth performance of the country over the same period.

3/ Data on national accounts aggregates was obtained from OECD (1991a) and data on hours worked, which corresponds to an index of hours worked per employee in the manufacturing sector, was obtained from Bureau of Labor Statistics (1992).

differ across countries on average, and how they move within each country over time; they must be interpreted with caution because some of the series, in particular the labor income tax rates, do not appear to be stationary in the sample under study. An examination of the co-movement of the tax rates and macroeconomic variables at business cycle frequencies, using filters to separate trend and cyclical components, is undertaken later in this section.

With regard to time-series co-movements within each country, Table 6 shows that the tax rate on capital income is generally negatively correlated with savings and investment rates, while the correlation between the capital income tax and the net exports-output ratio is positive or negative, depending on the size of the correlations of the tax with investment and savings. Table 7 indicates that the tax rate on labor income moves closely with actual and trend unemployment rates, and hours worked are negatively correlated with the sum of labor and consumption tax rates in all countries except Italy. The time-series correlations between capital income tax and savings, between labor-plus-consumption tax and hours worked, and between labor income tax and unemployment are in line with the theoretical predictions mentioned earlier. The observed negative co-movement between investment and the capital income tax rate is more difficult to interpret. It reflects in part the well-known positive correlation between savings and investment (see Obstfeld (1986)), but it may also be an indication of the degree to which rates of taxation on domestic corporate income and foreign capital income differ, or, assuming capital is costly to adjust, the extent to which the structures of taxation and investment financing vary across countries.

Cross-country comparisons of the mean tax rates in Tables 6 and 7 confirm most of the differences in the structure of the tax systems identified earlier in Figures 1-4. Cross-country comparisons also suggest that higher savings and investment rates tend to be associated with lower capital income rates, higher rates of taxation on labor income tend to coexist with higher unemployment rates, and higher consumption and labor income taxes coincide with less hours worked—with the notable exception of Germany.

Tables 8-9 list cyclical co-movements between the tax rates, net exports, savings, investment, hours worked, and unemployment. Cyclical components for the correlations in Table 8 have been obtained using the Hodrick-Prescott filter with the smoothing parameter set at 100, while the correlations in Table 9 correspond to first-differenced data. These cyclical correlations are qualitatively similar to the correlations obtained from the original data, but quantitatively they are much weaker. Using the Hodrick-Prescott filter, savings and investment rates, as well as the ratio of net exports to output, are weakly negatively correlated, or uncorrelated, with the capital income tax rate in most countries. Unemployment rates are weakly positively correlated with the labor income tax in three countries (Italy, the United Kingdom, and the United States), while the other countries—except Japan—display almost no cyclical correlation between the

two variables. Hours worked are significantly negatively correlated with the consumption-labor tax in the United States and Canada, almost uncorrelated in the United Kingdom, Italy, and France, and positively correlated in Germany and Japan. Table 9 reports similar results using first-differenced data, although the magnitude of some correlation coefficients is noticeably different. Overall, these cyclical co-movement indicators suggest that, while there are no obvious anomalies in the co-movement of tax rates and macroeconomic aggregates during business cycles, the link between the two sets of variables seems stronger at frequencies lower than business cycle frequencies. This is a reasonable result in view of the fact that changes in tax policy need approval of legislative bodies in most countries, and hence tax rates are not likely to fluctuate significantly at business cycle frequencies.

The stylized facts documented above provide some crude evidence on the extent to which effective average tax rates help explain the behavior of savings, investment, unemployment, hours worked, and the balance of trade. We try to formalize this evidence by applying panel data econometric techniques that combine the time-series and cross-sectional information on tax rates and macroeconomic variables. The data is pooled by stacking the time series of each of the seven countries in the sample, and then we estimate basic pooled (total), between means, fixed effects, random effects, and country independent models. The regressions for which each model is estimated are: a) the savings rate on the capital income tax rate; b) the investment rate on the capital income tax rate; c) the ratio of net exports to output on the capital income tax rate; d) the rate of unemployment on the labor income tax rate; and e) the index of hours worked on the sum of the labor income tax and the consumption tax. The models were also estimated using a time trend to account for the problem of non-stationarity in some of the variables involved--particularly in the case of the labor income tax rates. The basic statistics describing the results of these tests are presented in Tables 10a-11e. Table 12 reports additional information combining cross-sectional and time-series data by computing co-movements of some of the time series in terms of deviations from the group-of-seven mean in each year.

The results of the panel tests indicate that there is statistically significant evidence of a negative relationship between the savings rate, or the investment rate, and the capital income tax rate, and between hours worked and the consumption-labor tax, as well as a positive link between unemployment and the labor income tax. These effects are estimated with more precision in the total regressions involving the time series of the seven countries, while regressions based on country means generally produce slope coefficients that are not significantly different from zero. Both fixed effects (common slope coefficients, fixed intercepts) and random effects (common slopes, random intercepts) models generally produce statistically significant coefficients with the expected signs when the time trend is ignored, but in the regressions with time trends the standard errors are too large to reject the hypothesis that the slope coefficients

are not zero. Thus, the panel tests also support the view that the link between macroeconomic variables and tax rates is stronger at low frequencies. Moreover, given the differences in tax structures discussed above, it is not surprising that most of the hypothesis tests that evaluate whether the slope coefficients, the intercepts, or all parameter estimates are equal across countries produce negative results. Hence, while the pooled data indicate that increases in the capital tax rate have adverse effects on savings and investment, increases in the consumption or labor income tax reduce hours worked, and increases in the labor income tax result in an increase in unemployment, the magnitude of these effects seems to differ across countries.

The results of the independent model regressions reported in Table 10a-11e give support to the argument that the effects of changes in taxes on macroeconomic variables differ significantly across countries. Note that in each of these regressions, the slope coefficients are statistically different from zero only when the sign of the coefficient is as predicted by theory—except in the cases of Italy in Table 10e and Japan in Table 11e. Thus, effective average tax rates produce statistically significant co-movements with savings, hours worked, and unemployment that are consistent with basic theoretical principles. Moreover, in some countries the tax rates alone are sufficient to explain a large fraction of the observed movements in savings, hours worked, and unemployment. This is particularly the case of the capital income tax rate as an explanatory variable of savings in France, Germany, and Italy, the labor income tax as an explanatory variable of unemployment in the United Kingdom and the United States, and the sum of the labor and consumption taxes as an explanatory variable of hours worked in the United States.

The results of the independent regressions for the United States are particularly interesting to examine in view of the current discussion on the possibility of increasing tax rates on consumption or labor income in order to reduce the fiscal deficit. The international comparison of tax rates discussed earlier in this section indicated that consumption and labor taxes are significantly lower in the United States than in the rest of the large industrial countries (except Japan), so that potential tax increases would tend to harmonize the U.S. tax rates with those of other countries. The econometric analysis provides some insight into some of the implications that would follow from these tax increases. In particular, we find that an increase of 1 percentage point in the labor income tax may result in an increase in the unemployment rate of about 1/3 of a percentage point (see Table 10d), and that an increase of 1 percentage point in either consumption or labor income taxes may induce a reduction in the index of hours worked of between 1/2 to 1 1/2 points (see Tables 10e and 11e). All the coefficient estimates that link the tax rates to unemployment and hours worked in the regressions for the United States are statistically significant, the explanatory power of the regressions ranges from 53 to 83 percent, and the Durbin-Watson statistics reject the hypothesis of first-order serial autocorrelation of the residuals when the time trend is included. It must

be noted, however, that these results are not an indication of the welfare effects of the tax increases examined, but merely a rough estimate of their partial effects on some of the elements that affect the behavior of labor markets.

The clear relationship between the tax rates and savings, hours worked, and unemployment, and the fact that the relationship seems stronger at lower frequencies is clearly illustrated in Figures 6-8 for the case of Germany. Figure 6 shows how, over the period 1965-1988, the savings and investment rates in Germany fell in conjunction with an increase in the capital income tax rate. On a yearly basis, however, there are episodes during which the capital income tax increased and savings also increased. Figure 7 illustrates a similar point for the rate of unemployment and the labor income tax and Figure 8 for the index of hours worked and the sum of the labor and consumption tax rates.

To conclude, Table 13 reports some of the cyclical properties of tax revenues based on Hodrick-Prescott filtered data. We observe that the revenue of all three taxes is more variable than output in each country, and that capital income tax revenue tends to fluctuate more than the revenue from labor income tax and the consumption tax. Revenues are generally procyclical and uncorrelated, or weakly negatively correlated, with net exports. These results suggest that, while our measures of effective average tax rates may be affected by cyclical noise, as explained before, the fact that tax revenues and tax bases tend to move together over the business cycle contributes to minimize that noise.

V. Conclusions

This paper presented a method for computing effective average rates of taxation on consumption and the income derived from capital and labor based on aggregate data from revenue statistics and national income accounts. Following recent work by Lucas (1990) and (1991) and Razin and Sadka (1993), we constructed estimates of the tax rates that represent the wedges distorting optimal plans in a representative agent framework by calculating percentage differences in measures of aggregate post- and pre-tax incomes and prices. The method was used to compute time series of the three tax rates for the group of seven largest industrialized countries covering the period 1965-1988. The potential applicability of the resulting tax rates in the design of macroeconomic models of fiscal policy was examined by contrasting the results of this study with existing estimates of effective marginal tax rates, as well as by exploring the relationship between the tax rates and savings, investment, net exports, hours worked, and unemployment.

The comparison between the effective average tax rates computed here and available estimates of effective marginal tax rates showed that, while the levels of the taxes differ, the trends are very similar. Moreover, average tax rates are within the range of existing estimates of marginal tax

Figure 6. Germany: Savings, Investment and Capital Income Tax.

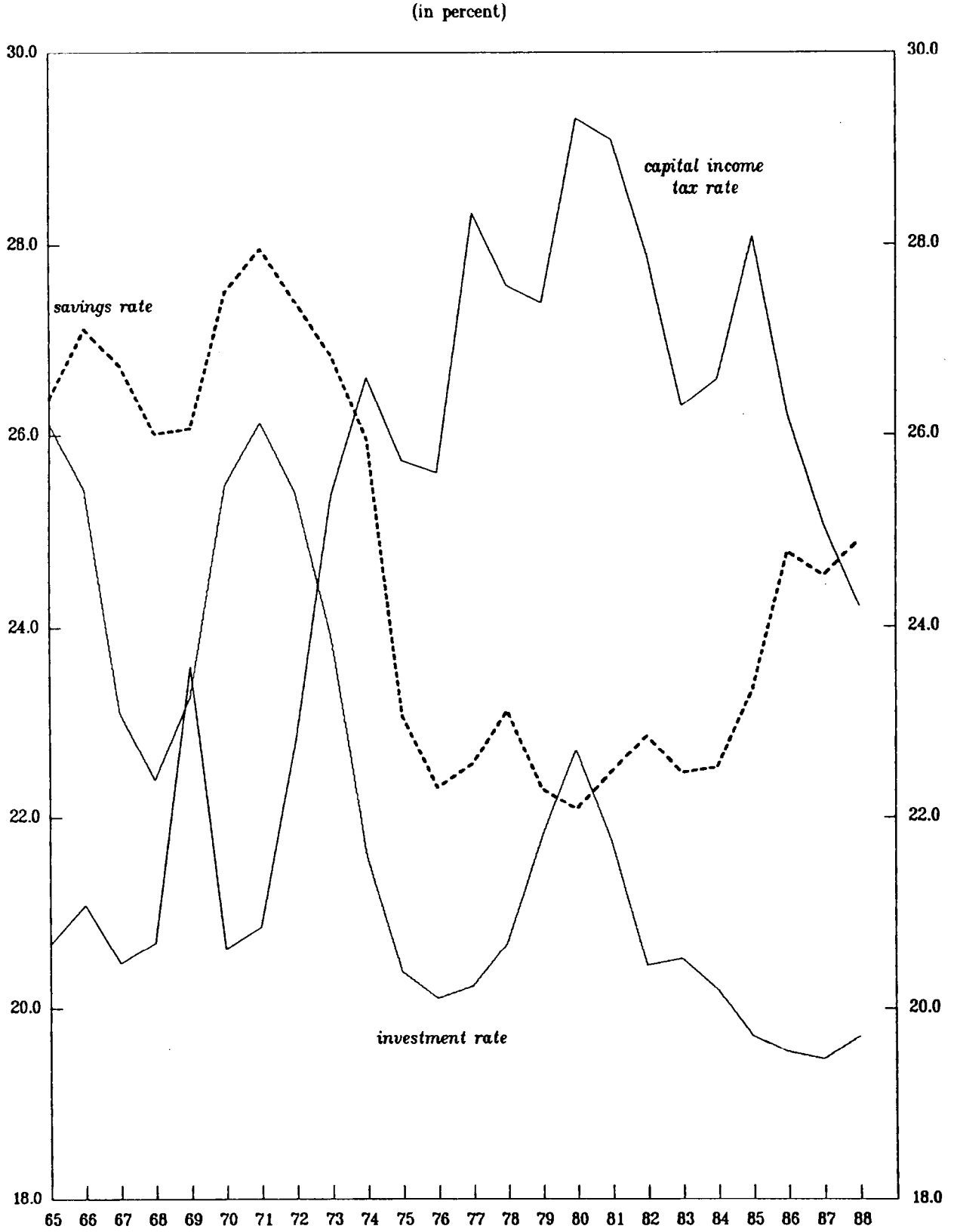


Figure 7. GERMANY: Unemployment and Labor Income Tax.

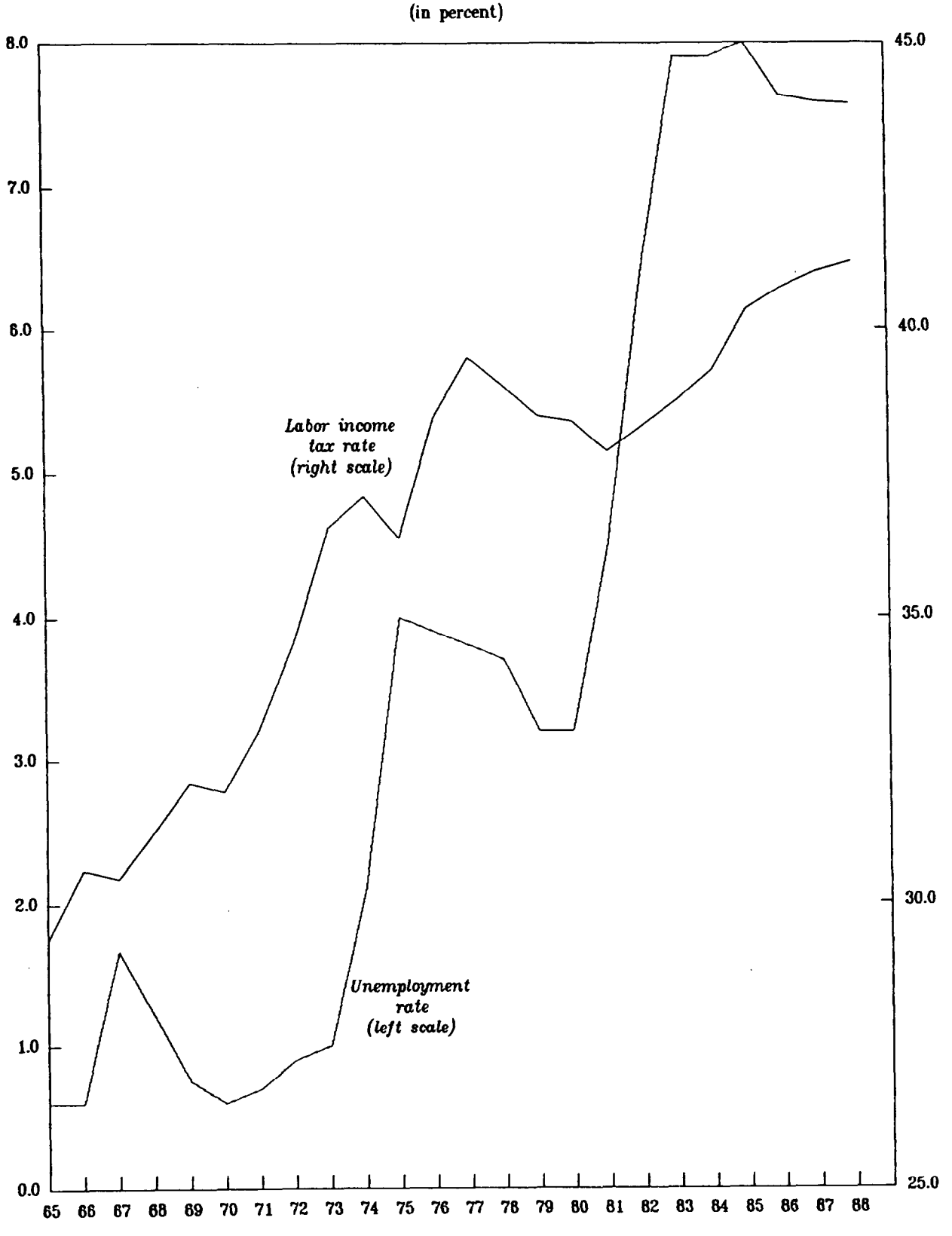
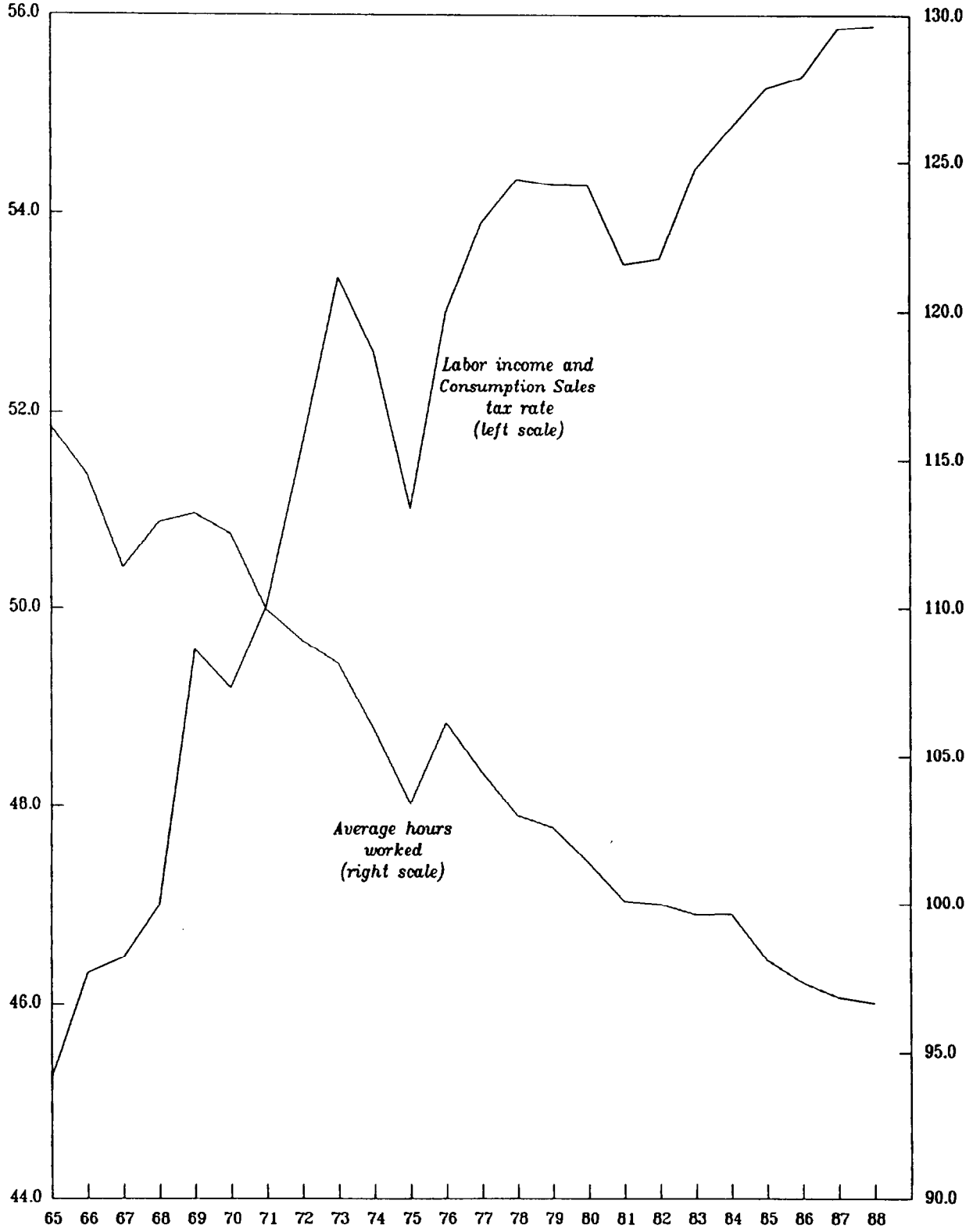


Figure 8. GERMANY: Average hours worked and Consumption-Labor Income Tax Rate 1/



1/ Average hours worked is an index number, the tax rate is in percent.

rates, and a large fraction of the difference between the two can be attributed to the treatment of tax credits and exemptions and the treatment of consumption taxes. The differences between the two sets of estimates are minimal when the effective average labor income tax is adjusted to incorporate sales taxes, and the resulting effective tax is compared with estimates of marginal tax rates based on tax returns data.

The empirical analysis undertaken in the paper illustrates important trends and differences in the structure of the tax systems among industrial countries. While labor, capital, and consumption taxes have fluctuated noticeably in response to changes in statutory tax schedules and policies regarding credits and exemptions, capital and consumption taxes do not exhibit a noticeable trend in general, while the rate of taxation on labor income has increased over time in all of the countries studied. The rates of indirect taxation and labor income tax tend to be higher in European countries relative to Japan and the United States, while the effective average tax rates on capital income in the United States have been higher than in other large industrial countries—except the United Kingdom, and in recent years Japan. Notwithstanding significant differences in tax systems, tax rates have tended to converge for groups of countries in the sample over the last 20 years—particularly in the case of consumption taxes in European countries (except France), labor income taxes in North America, Japan, and the United Kingdom, and capital income taxes in Germany, Italy, and France and in the United States and Canada.

The statistical analysis relating effective average tax rates to macroeconomic variables provided evidence suggesting that these measures of tax rates may be useful for macroeconomic modelling. In particular, the effective average tax rates on capital income are negatively related to savings rates, and the consumption and labor income tax rates are negatively correlated with the number of hours worked, as predicted by neoclassical equilibrium models. Moreover, the level and trend of the rates of unemployment are positively correlated with the tax on labor income, as predicted by models of equilibrium unemployment or the "natural rate." These relationships are stronger in panel data tests that combine time series and cross sectional information, but they remain strong even for time series of several individual countries. These empirical regularities were also documented using detrended and non-detrended data. The relationships between macroeconomic variables and the tax rates were found to be generally stronger at low frequencies relative to business cycle frequencies.

Table 1. Consumption Tax Rates

(In percent)

Year	United States	United Kingdom	France	Germany	Italy	Canada	Japan
1965	6.4	13.2		15.9		12.8	5.7
1966	5.9	13.0		15.7		13.0	5.5
1967	5.9	13.0		16.0		13.2	5.7
1968	5.8	13.9		15.8		12.7	5.9
1969	6.2	15.4		17.5		13.0	6.0
1970	6.4	15.1		17.3	13.3	12.6	5.8
1971	6.4	14.0		17.0	13.0	12.9	5.5
1972	6.2	12.9		17.1	11.9	13.1	5.5
1973	6.2	11.8		16.8	11.6	13.5	5.1
1974	6.1	12.5		15.5	12.2	12.7	4.6
1975	5.8	12.1		14.6	10.8	11.0	4.3
1976	5.6	12.5		14.5	11.3	11.4	4.3
1977	5.5	12.6	20.7	14.4	12.0	11.0	4.5
1978	5.5	12.0	21.5	15.3	11.0	9.8	4.9
1979	5.3	12.3	22.8	15.8	10.9	10.0	5.0
1980	5.4	15.1	22.2	15.9	11.6	10.5	4.8
1981	6.0	14.8	21.2	15.6	11.2	13.6	4.9
1982	5.7	16.4	21.5	15.2	11.3	13.3	4.8
1983	5.4	16.3	21.2	15.7	12.6	12.3	4.7
1984	5.5	17.2	21.2	15.6	12.7	12.6	4.7
1985	5.5	17.8	21.6	14.9	11.8	12.2	5.2
1986	5.3	17.1	21.3	14.6	13.3	12.1	5.1
1987	5.1	16.8	21.3	14.9	13.4	12.6	5.2
1988	5.2	16.9	21.4	14.7	14.3	13.1	5.3

Source: Authors' estimates produced as described in the text.

Table 2. Labor Income Tax Rates

(In percent)

Year	United States	United Kingdom	France	German	Italy	Canada	Japan
1965	17.5	20.4		29.4		12.5	15.1
1966	18.2	22.5		30.6		15.1	15.4
1967	19.9	23.8		30.5		16.3	15.9
1968	20.0	25.7		31.2		17.8	16.2
1969	22.1	27.2		32.1		20.0	16.6
1970	22.6	27.6	33.5	31.9		21.2	17.0
1971	21.7	26.4	33.3	33.0		21.4	17.4
1972	22.1	24.9	33.8	34.5		22.0	18.1
1973	22.6	23.3	33.8	36.6		21.3	18.7
1974	23.9	24.8	34.0	37.1		22.8	18.5
1975	24.5	27.4	35.9	36.4		22.5	18.1
1976	24.2	29.0	37.4	38.5		23.2	18.8
1977	25.8	29.6	38.7	39.5		22.1	19.5
1978	26.0	28.0	38.8	39.0		22.1	20.7
1979	26.9	27.2	40.7	38.5		22.4	21.6
1980	27.7	27.7	41.9	38.4	34.2	23.0	22.6
1981	28.7	28.6	41.7	37.9	34.5	24.2	23.7
1982	29.3	30.4	42.7	38.3	37.1	24.4	24.2
1983	28.1	28.7	44.5	38.8	39.1	25.7	24.5
1984	27.7	28.1	46.0	39.3	38.2	24.9	24.3
1985	28.5	27.1	46.0	40.3	38.5	25.9	25.5
1986	28.5	27.1	46.4	40.7	41.2	27.2	26.1
1987	29.1	26.9	47.3	41.0	40.8	29.1	26.5
1988	28.5	26.8	47.2	41.2	40.9	28.0	26.6

Source: Authors' estimates produced as described in the text.

Table 3. Capital Income Tax Rates

(In percent)

	United States	United Kingdom	France	Germany	Italy	Canada	Japan
1965	37.2	39.3		20.7		35.3	20.4
1966	39.0	42.4		21.1		36.0	19.5
1967	42.3	47.0		20.5		39.4	19.6
1968	39.2	47.2		20.7		41.3	20.0
1969	46.6	48.6		23.6		46.4	20.9
1970	49.2	55.8	17.0	20.6		45.3	22.3
1971	42.7	51.1	16.1	20.9		44.0	24.0
1972	43.7	48.1	16.8	22.8		44.7	25.3
1973	42.8	45.9	17.4	25.4		41.2	30.2
1974	47.0	67.3	19.8	26.6		42.3	34.9
1975	45.2	70.5	20.2	25.7		43.9	29.6
1976	42.8	60.5	24.1	25.6		41.6	29.6
1977	44.7	50.8	23.3	28.3		42.5	31.2
1978	43.3	49.7	21.8	27.6		39.5	33.2
1979	44.4	53.1	23.1	27.4		36.5	33.1
1980	46.9	64.2	27.3	29.3	20.3	37.6	36.0
1981	44.9	74.2	28.4	29.1	22.9	39.9	38.1
1982	47.1	70.7	29.4	27.9	25.4	40.8	39.0
1983	39.8	61.5	28.6	26.3	27.2	37.2	41.5
1984	38.4	62.7	28.2	26.6	26.4	35.6	43.1
1985	39.2	61.6	27.2	28.1	25.3	35.9	43.6
1986	39.7	63.1	26.0	26.2	28.0	39.9	46.2
1987	42.2	60.1	26.8	25.1	27.4	40.8	53.0
1988	40.7	59.0	25.6	24.2	27.5	39.6	56.3

Source: Authors' estimates produced as described in the text.

Table 4. Corporate Capital Income Tax Rates

(In percent)

	United States	United Kingdom	France	Germany	Italy	Japan
1965	36.3			8.3		30.8
1966	36.6			7.8		26.4
1967	35.6			7.4		22.2
1968	39.7	32.8		7.7		22.5
1969	40.6	33.3		8.9		21.2
1970	39.3	46.1	24.0	7.5		22.0
1971	37.3	35.6	21.3	6.5		28.3
1972	36.4	31.4	22.8	6.2		30.3
1973	38.5	34.3	22.8	7.5		35.3
1974	41.8	96.0	31.1	7.5		44.2
1975	35.9	84.3	27.7	6.9		47.8
1976	38.2	51.0	33.3	7.6		46.8
1977	35.9	31.9	30.6	9.4		46.5
1978	35.9	34.4	27.5	9.2		39.3
1979	35.7	40.1	28.5	9.4		47.1
1980	34.9	59.4	36.4	9.1	19.7	47.2
1981	29.6	80.5	37.9	8.9	26.8	52.0
1982	26.0	65.6	41.4	8.7	36.6	54.6
1983	25.6	51.1	35.6	8.6	26.5	58.1
1984	26.1	56.1	34.5	9.2	27.5	54.9
1985	25.9	53.3	32.4	9.8	26.5	52.3
1986	29.5	56.0	29.3	8.9	25.8	53.9
1987	32.6	47.6	28.9	7.7	32.4	58.7
1988	32.0	50.0	25.7	7.7	28.7	54.8

Source: Authors' estimates produced as the ratio of corporate income tax revenue (from OECD (1990)) to the operating surplus of corporations (from OECD (1991a)).

Table 5. Comparison of Average Tax Rates on Labor Income

	Mendoza - Razin - Tesar 1/			McKee - Visser - Saunders					
				Single Worker APW			Married Couple APW		
Country	1979	1981	1983	1979	1981	1983	1979	1981	1983
Canada	32.4	37.8	38.0	43.3	45.1	42.7	41.1	43.0	42.7
France	63.5	62.9	65.7	66.9	66.7	68.8	57.5	57.2	59.7
Germany	54.3	53.5	54.5	61.1	60.5	60.4	56.8	56.4	57.0
Italy	45.4	45.7	51.7	56.3	59.5	62.7	56.3	59.5	62.7
Japan	26.6	28.6	29.2	40.5	43.9	43.7	35.9	39.4	39.9
United Kingdom	39.5	43.2	45.0	51.5	53.4	54.5	51.5	53.4	54.5
United States	32.2	34.7	33.5	47.1	52.9	48.6	40.2	45.2	42.6

1/ Including effective average sales tax.

Table 6. Savings, Investment, Net Exports, and Capital Income Tax Rates

Country	Savings/GDP ratio		Investment/GDP ratio		Net Exports/GDP ratio		Capital Tax Rate
	Mean	Corr.(tk) 1/	Mean	Corr.(tk) 1/	Mean	Corr.(tk)	Mean
United States	0.17	0.32	0.18	0.11	-0.01	0.34	0.43
United Kingdom	0.18	-0.23	0.18	-0.37	--	0.09	0.56
Germany	0.25	-0.85	0.22	-0.69	0.03	-0.11	0.25
Italy	0.21	-0.43	0.21	-0.93	--	0.95	0.26
France	0.23	-0.95	0.22	-0.81	0.01	-0.53	0.24
Japan	0.33	-0.45	0.31	-0.58	0.02	0.36	0.33
Canada	0.24	-0.12	0.22	0.11	0.02	-0.24	0.40

Note: Data for the period 1965-1988, except for Italy (1980-1988) and France (1970-1988).
1/ Contemporaneous correlation with the capital income tax rate.

Table 7. Unemployment, Hours Worked, Consumption Tax and Labor Income Tax

Country	Unemployment rate		Trend unemployment 2/		Hours 4/		Consumption Tax	Labor Income Tax
	Mean	Corr. (tl)1/	Mean	Corr. (tl)3/	Mean	Corr. (tc+tl)5/	Mean	Mean
United States	6.20	0.74	6.30	0.93	104.7	-0.76	5.77	24.77
United Kingdom	5.26	0.56	5.03	0.60	104.8	-0.71	14.37	26.63
Germany	3.73	0.83	3.65	0.90	105.1	-0.92	15.68	36.45
Italy	10.09	0.95	9.97	0.95	101.3	0.66	12.47	38.27
France	8.07	0.98	7.83	0.99	102.2	-0.86	21.49	43.49
Japan	1.90	0.94	1.86	0.97	102.6	-0.49	5.12	20.47
Canada	7.18	0.80	7.14	0.91	104.0	-0.73	12.30	22.30

Note: Data for the period 1965-1988, except for Italy (1980-1988) and France (1977-1988).
1/ Correlation between the unemployment rate and the labor income tax rate.
2/ Trend defined as the trend component of data filtered using the Hodrick-Prescott filter with the smoothing parameter set at 100.
3/ Correlation between trend unemployment and the labor income tax rate.
4/ Average annual hours in manufacturing (Index, 1982=100).
5/ Correlation between hours and the sum of the labor income and consumption tax rates.

Table 8. Cyclical Correlations of Savings, Investment, Net Exports, Hours Worked and Unemployment with Effective Average Tax Rates. 1/
(based on Hodrick-Prescott Filter)

Country	Savings-Capital Tax	Investment-Capital Tax	Net Export-Capital Tax	Hours Worked-Labor Consumption-Tax	Unemployment-Labor tax
United States	0.09	-0.19	0.37	-0.74	0.11
United Kingdom	-0.19	-0.01	-0.13	-0.01	0.32
Germany	-0.30	-0.19	-0.04	0.45	0.01
Italy	0.55	-0.60	0.64	0.05	0.15
France	-0.80	0.03	-0.73	-0.01	0.07
Japan	0.05	0.36	-0.39	0.67	-0.46
Canada	-0.17	-0.07	-0.08	-0.27	-0.02

1/ Savings, Investment, and Net Exports as a share of GDP. Savings equals GDP minus private and public consumption. All data are detrented using the Hodrik-Prescott filter with the smoothing parameter set at 100. Hours worked are logged prior to detrending. Data cover the period 1965-88, except for Italy (1980-88) and for France (1970-88 for Savings, Investment, and Capital Tax Rate, and 1977-88 for Unemployment, Hours worked and Labor and Consumption tax rates).

Table 9. Cyclical Correlations of Savings, Investment, Net Exports, Hours Worked and Unemployment with Effective Average Tax Rates 1/
(based on first differenced Data)

Country	Savings-Capital Tax	Investment-Capital Tax	Net Export-Capital Tax	Hours Worked-Labor Consumption Tax	Unemployment-Labor Tax
United States	-0.12	-0.24	0.17	-0.62	0.16
United Kingdom	-0.10	0.05	-0.10	-0.14	0.34
Germany	-0.18	-0.17	0.02	0.47	-0.30
Italy	0.71	-0.71	0.85	0.25	0.63
France	-0.81	0.26	-0.79	-0.03	0.28
Japan	0.09	0.33	-0.28	0.48	-0.22
Canada	-0.23	0.08	-0.27	-0.21	-0.07

1/ Savings, Investment, and Net Exports as a share of GDP. Savings equals GDP minus private and public consumption. All data are detrented by first differencing. Hours worked are logged prior to detrending. Data cover the period 1965-88, except for Italy (1980-88) and for France (1970-88 for Savings, Investment, and Capital Tax Rate, and 1977-88 for Unemployment, Hours worked and Labor and Consumption tax rates).

Table 10a. Panel Data Tests: Regression of Savings Rate on Capital Income Tax Rate (time trend excluded) 1/

Model	Intercept	Slope	F Test Against		Hausman Test	R^2	SSR
			Total	Independent			
Total	0.301 (25.670)*	-0.192 (-6.345)*	--	129.52* **12,134**	--	0.211	0.325
Means	0.292 (4.613)*	-0.180 (-1.048)	--	--	--	0.016	0.013
Fixed Effects	..	-0.102 (-4.619)*	169.85* **6,140**	11.653* **6,134**	--	0.089	0.039
Random Effects	0.265 (14.159)*	-0.103 (-4.634)*	--	--	0.0 **1**	0.101	0.041
Independent							
United States	0.101 (2.183)	0.170 (1.578)	--	--	--	0.061	0.006
United Kingdom	0.200 (12.097)*	-0.032 (-1.121)	--	--	--	0.011	0.004
France	0.344 (35.100)*	-0.503 (-12.283)*	--	--	--	0.893	0.001
Germany	0.393 (19.910)*	-0.585 (-7.468)*	--	--	--	0.704	0.003
Italy	0.240 (10.29)*	0.116 (-1.276)	--	--	--	0.073	0.003
Canada	0.252 (8.532)*	-0.040 (-0.549)	--	--	--	0.013	0.003
Japan	0.359 (26.240)*	-0.094 (-2.379)*	--	--	--	0.168	0.009

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 10b. Panel Data Tests: Regression of Investment Rate on Capital Income Tax Rate (time trend excluded) 1/

Model	Intercept	Slope	F Test Against		Hausman	$\bar{R}^2$	SSR
			Total	Independent			
Total	0.282 (26.810)*	-0.159 (-5.848)*	--	87.32* **12,134**	--	0.184	0.262
Means	0.274 (4.959)*	-0.142 (-0.957)	--	--	--	--	0.097
Fixed Effects	..	-0.126 (-5.708)*	131.57* **6,140**	7.339* **6,134**	--	0.148	0.040
Random Effects	0.268 (15.830)*	0.126 (-5.675)*	--	--	0.0 **1**	0.163	0.041
Independent							
United States	0.170 (6.858)*	0.031 (0.536)	--	--	--	--	0.002
United Kingdom	0.212 (13.787)*	-0.050 (-1.849)	--	--	--	0.095	0.003
France	0.316 (18.921)*	-0.393 (-5.629)*	--	--	--	0.630	0.003
Germany	0.353 (11.890)*	-0.528 (-4.480)*	--	--	--	0.453	0.006
Italy	0.374 (15.155)*	-0.622 (-6.483)*	--	--	--	0.837	0.007
Canada	0.203 (4.973)	0.054 (0.539)	--	--	--	--	0.005
Japan	0.360 (25.155)*	-0.140 (-3.379)*	--	--	--	0.312	0.010

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman Test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 10c. Panel Data Tests: Regression of Net Exports-Output Ratio on Capital Income Tax Rate (time trend excluded) 1/

Model	Intercept	Slope	F Test Against		Hausman Test	$\bar{R}^2$	SSR
			Total	Independent			
Total	0.019 (4.324)*	-0.033 (-2.974)*	--	8.692* **12,134**	--	0.051	0.044
Means	0.018 (1.221)	-0.037 (-0.900)	--	--	--	--	0.001
Fixed Effects	..	-0.024 (1.318)	13.982* **6,140**	2.502* **6,134**	--	--	0.027
Random Effects	0.002 (0.243)	0.011 (0.650)	--	--	3.240 **1**	--	0.029
Independent							
United States	-0.068 (-1.919)	0.139 (1.687)	--	--	--	0.074	0.004
United Kingdom	-0.011 (-0.497)	0.017 (0.430)	--	--	--	--	0.007
France	0.028 (2.671)*	-0.110 (-2.543)*	--	--	--	0.233	0.001
Germany	0.039 (1.456)	-0.057 (-0.524)	--	--	--	--	0.005
Italy	-0.133 (-8.304)*	0.506 (8.109)*	--	--	--	0.890	0.000
Canada	0.049 (1.466)	-0.095 (-1.137)	--	--	--	0.012	0.004
Japan	-0.001 (-0.159	0.046 (1.832)	--	--	--	0.092	0.004

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 10d. Panel Data Tests: Regression of Unemployment Rate on Labor Tax Rate (time trend excluded) 1/

Model	Intercept	Slope	F Test against Total	F Test against Independent	Hausman Test	$\bar{R}^2$	SSR
Total	0.756 (0.851)	0.160 (5.380)*	—	30.753* 12,134	—	0.160	1275.4
Means	1.870 (0.470)	0.132 (1.019)	—	—	—	0.010	33.6
Fixed effects	—	0.476 (12.440)*	29.231* 6,140	4.623* 6,134	—	0.501	410.1
Random effects	-7.479 (-5.032)*	0.445 (11.643)*	—	—	120.61* 1	0.474	448.9
Independent							
United States	-2.602 (-1.505)	0.355 (5.143)*	—	—	—	0.525	32.5
United Kingdom	-17.154 (-2.427)*	0.842 (3.184)*	—	—	—	0.284	195.0
France	-16.849 (-20.69)*	0.575 (28.577)*	—	—	—	0.978	3.3
Germany	-18.891 (-5.795)*	0.620 (6.974)*	—	—	—	0.674	56.8
Italy	-9.757 (-4.035)*	0.519 (8.223)*	—	—	—	0.893	1.6
Canada	-3.943 (-2.190)*	0.499 (6.268)*	—	—	—	0.625	49.6
Japan	-1.125 (-4.634)*	0.148 (12.654)*	—	—	—	0.874	1.0

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 10e. Panel Data Tests: Regression of Hours Worked on the sum of the Consumption and Labor Tax Rates (time trend excluded) 1/

Model	Intercept	Slope	F Test against Total	F Test against Independent	Hausman Test	$\bar{R}^2$	SSR
Total	106.2 (95.29)*	-0.059 (-2.218)*	--	19.661* **12,127**	--	0.027	2122.1
Means	104.9 (51.27)*	-0.032 (-0.692)	--	--	--	--	12.1
Fixed effects	--	-0.685 (-9.350)*	17.005* **6,133**	13.063* **6,127**	--	0.365	1200.9
Random effects	119.1 (42.86)*	-0.366 (-6.103)*	--	--	57.521* **1**	0.610	1568.8
Independent							
United States	119.7 (43.61)*	-0.492 (-5.512)*	--	--	--	0.560	46.2
United Kingdom	138.4 (19.50)*	-0.821 (-4.759)*	--	--	--	0.485	192.3
France	160.8 (14.79)*	-0.903 (-5.401)*	--	--	--	0.719	30.0
Germany	195.4 (23.58)*	-1.731 (-10.913)*	--	--	--	0.837	135.5
Italy	77.8 (7.66)*	0.463 (2.317)*	--	--	--	0.353	28.5
Canada	118.3 (41.32)*	-0.414 (-5.033)*	--	--	--	0.514	53.4
Japan	115.7 (23.17)*	-0.511 (-2.645)*	--	--	--	0.207	256.7

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 11a. Panel Data Tests: Regression of Savings Rate on Capital Income Tax Rate (time trend included) 1/

Model	Intercept	Slope	Trend	F Test Against		Hausman Test	$\bar{R}^2$	SSR
				Total	Independent			
Total	0.389 (8.890)*	-0.182 (-6.031)*	-0.001 (-2.084)	--	108.84* **18,127**	--	0.228	0.316
Means	1.030 (1.519)	-0.284 (-1.470)	-0.009 (-1.093)	--	--	--	0.053	0.010
Fixed Effects	..	-0.015 (-0.676)	-0.002 (-6.972)*	228.18* **6,139**	5.439* **12,127**	--	0.320	0.029
Random Effects	0.352 (15.653)*	-0.019 (-0.840)	-0.001 (-6.739)*	--	--	0.0 **2**	0.314	0.031
Independent							0.692	0.002
United States	0.262 (7.356)*	0.139 (2.237)	-0.002 (-6.783)*	--	--	--		
United Kingdom	0.244 (8.419)*	0.013 (0.355)	-0.001 (-1.805)	--	--	--	0.103	0.003
France	0.442 (16.269)*	-0.306 (-5.016)*	-0.002 (-3.749)*	--	--	--	0.939	0.001
Germany	0.404 (15.773)*	-0.527 (-4.643)*	0.000 (-0.780)	--	--	--	0.697	0.003
Italy	0.442 (8.034)*	0.177 (1.884)	-0.003 (-3.782)*	--	--	--	0.680	0.000
Canada	0.313 (7.162)*	-0.077 (-1.067)	-0.001 (-1.823)	--	--	--	0.067	0.002
Japan	0.527 (4.207)*	0.101 (0.677)	-0.003 (-1.352)	--	--	--	0.199	0.008

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 11b. Panel Data Tests: Regression of Investment Rate on Capital Income Tax Rate (time trend included) 1/

Model	Intercept	Slope	Trend	F Test Against		Hausman Test	$\bar{R}^2$	SSR
				Total	Independent			
Total	0.375 (9.603)*	-0.149 (-5.510)*	-0.001 (-2.466)*	--	72.82* **18,127**	--	0.211	0.252
Means	0.752 (1.193)	-0.211 (-1.173)	-0.006 (-0.762)	--	--	--	--	0.009
Fixed Effects	..	-0.041 (-1.773)	-0.001 (-6.834)*	174.04* **6,139**	3.491* **12,127**	--	0.358	0.029
Random Effects	0.354 (16.857)*	-0.044 (-1.910)	-0.001 (-6.640)*	--	--	**0.0 2**	0.357	0.031
Independent								
United States	0.195 (5.937)*	0.026 (0.452)	0.000 (-1.161)	--	--	--	--	0.002
United Kingdom	0.261 (10.087)*	0.002 (0.056)	-0.001 (-2.278)*	--	--	--	0.240	0.003
France	0.506 (12.589)*	-0.012 (-0.135)	-0.004 (-4.890)*	--	--	--	0.843	0.001
Germany	0.423 (13.903)*	-0.173 (-1.282)	-0.002 (-3.676)*	--	--	--	0.652	0.004
Italy	0.585 (9.890)*	-0.314 (-3.113)*	-0.003 (-3.687)*	--	--	--	0.942	0.000
Canada	0.325 (5.922)*	-0.020 (-0.218)	-0.001 (-2.904)*	--	--	--	0.229	0.004
Japan	0.532 (4.044)*	0.059 (0.378)	-0.003 (-1.313)	--	--	--	0.334	0.009

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 11c. Panel Data Tests: Regression of Net Exports-Output Ratio on Capital Income Tax Rate (time trend included) 1/

Model	Intercept	Slope	Trend	F Test Against		Hausman Test	$\bar{R}^2$	SSR
				Total	Independent			
Total	0.014 (0.837)	-0.034 (-2.978)*	0.000 (0.316)	--	9.082* **18,127**	--	0.048	0.044
Means	0.279 (2.151)	-0.074 (-1.992)	-0.003 (-2.012)	--	--	--	0.360	0.001
Fixed Effects	..	0.025 (1.146)	-0.000 (-0.083)	13.859* **6,139**	4.562* **12,127**	--	--	0.027
Random Effects	-0.001 (-0.090)	0.882 (0.464)	0.000 (0.243)	--	--	2.169 **2**	--	0.029
Independent								
United States	0.067 (3.324)*	0.113 (3.221)*	-0.002 (-10.107)*	--	--	--	0.834	0.001
United Kingdom	-0.017 (-0.393)	0.011 (0.205)	0.000 (0.153)	--	--	--	--	0.007
France	-0.064 (-2.052)	-0.293 (-4.200)*	0.002 (3.051)*	--	--	--	0.484	0.001
Germany	-0.019 (-0.649)	-0.354 (-2.716)*	0.001 (3.183)*	--	--	--	0.270	0.003
Italy	-0.143 (-2.057)	0.492 (4.147)*	0.000 (0.142)	--	--	--	0.872	0.001
Canada	-0.012 (-0.232)	-0.057 (-0.685)	0.001 (1.572)	--	--	--	0.074	0.003
Japan	-0.005 (-0.056)	0.042 (0.425)	0.000 (0.040)	--	--	--	0.049	0.004

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 11d. Panel Data Tests: Regression of Unemployment Rate on Labor Tax Rate (time trend excluded) 1/

Model	Intercept	Slope	Trend	F Test against Total	F Test against Independent	Hausman Test	$\bar{R}^2$	SSR
Total	-19.581 (-8.758)*	0.021 (0.746)*	0.315 (9.573)*	—	31.793* **18,127**	—	0.481	781.4
Means	-52.044 (-1.870)	-0.035 (-0.263)	0.756 (1.950)	—	—	—	0.362	17.2
Fixed effects	—	0.010 (0.143)	0.294 (7.396)*	38.345* **6,139**	11.363* **12,127**	—	0.639	294.3
Random effects	-17.412 (-10.188)*	0.023 (0.395)	0.288 (8.178)*	—	—	0.119 **2**	0.657	309.9
Independent								
United States	-1.538 (0.356)	0.606 (2.427)*	-0.135 (-1.045)	—	—	—	0.527	30.9
United Kingdom	-29.021 (-7.052)*	-0.001 (-0.008)	0.449 (7.440)*	—	—	—	0.794	53.6
France	-19.922 (-4.514)*	0.482 (3.638)*	0.086 (0.709)*	—	—	—	0.978	3.2
Germany	-25.246 (-11.127)*	-0.313 (-1.916)	0.528 (6.061)*	—	—	—	0.876	20.7
Italy	-28.576 (-8.369)*	0.130 (1.798)	0.401 (5.776)*	—	—	—	0.981	0.2
Canada	-16.804 (-4.053)*	-0.046 (-0.260)	0.327 (3.324)*	—	—	—	0.742	32.5
Japan	-4.145 (-3.071)*	0.011 (0.174)	0.076 (2.269)*	—	—	—	0.894	0.8

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 11e. Panel Data Tests: Regression of Hours Worked on the sum of the Consumption and Labor Tax Rates (time trend included) 1/

Model	Intercept	Slope	Trend	F Test against Total	F Test against Independent	Hausman Test	$\bar{R}^2$	SSR
Total	138.3 (56.62)*	0.058 (2.986)*	-0.475 (-13.763)*	—	18.053* **18,120**	—	0.587	894.4
Means	143.7 (16.42)*	0.059 (2.014)*	-0.544 (-4.458)*	—	—	—	0.771	2.0
Fixed effects	—	0.180 (1.381)	-0.522 (-7.555)*	1.453 **6,132**	24.782* **12,120**	—	0.553	838.9
Random effects	138.3 (55.3)*	0.057 (2.799)*	-0.474 (-13.389)*	—	—	3.995 **2**	0.546	890.2
Independent								
United States	111.8 (51.09)*	-1.469 (-8.372)*	0.493 (5.875)*	—	—	—	0.826	17.5
United Kingdom	145.6 (31.82)*	-0.043 (-0.258)*	-0.510 (-5.990)*	—	—	—	0.800	71.1
France	166.8 (13.93)*	-0.282 (-0.490)	-0.561 (-1.125)	—	—	—	0.726	26.3
Germany	172.8 (36.96)*	-0.120 (-0.604)	-0.803 (-8.810)*	—	—	—	0.964	28.9
Italy	39.8 (1.03)	-0.120 (-0.200)	0.806 (1.022)	—	—	—	0.357	24.3
Canada	125.0 (46.61)*	0.047 (0.374)	-0.296 (-4.199)*	—	—	—	0.723	29.0
Japan	161.9 (31.94)*	2.403 (7.971)*	-1.580 (-10.045)*	—	—	—	0.857	44.22

1/ Numbers in parentheses are t-statistics. Numbers in bold are degrees of freedom for numerator and denominator of F-tests or for the Hausman test of the Fixed v. Random Effects models. An asterisk denotes statistical significance at the 5 percent level.

Table 12 . Co-Movement between Macroeconomic Variables and Tax Rates (based on deviations from cross-sectional means)

Country	Savings-Capital Tax	Investment-Capital Tax	Net Exports-Capital Tax
United States	0.233	-0.619	0.664
United Kingdom	0.383	0.047	0.259
Germany	-0.514	0.053	-0.547
Italy	0.508	-0.604	0.874
France	-0.630	-0.208	-0.458
Japan	0.092	-0.319	0.591
Canada	-0.810	-0.550	-0.417

Table 13. Variability and Co-Movement of Tax Revenues in Industrial Countries 1/

Country	Sales Tax Revenue			Labor Income Tax Revenue			Capital Income Tax Revenue			Output
	Standard Dev.	Output Corr.	Trade balance Corr.	Standard Dev.	Output Corr.	Trade balance Corr.	Standard Dev.	Output Corr.	Trade balance Corr.	Standard Dev.
United States	3.04	0.11	-0.06	3.74	0.35	-0.07	5.83	0.74	-0.19	2.30
United Kingdom	4.86	-0.38	0.35	4.71	-0.24	0.18	4.71	-0.38	-0.12	2.03
Germany	4.49	0.75	-0.57	4.53	0.84	-0.11	5.92	0.51	-0.02	3.08
France	2.66	0.59	-0.08	2.54	0.17	-0.06	3.94	0.37	-0.60	1.93
Italy	4.09	0.54	-0.01	2.45	0.13	0.36	3.97	-0.34	0.60	2.33
Japan	6.49	0.81	0.04	3.52	0.75	-0.16	9.09	0.83	-0.28	3.98
Canada	5.71	0.08	0.09	5.22	0.12	-0.23	4.95	0.69	-0.68	2.85

1/ Data are annual observations for the period 1965-1988 (except 1970-1988 for France and 1980-1988 for Italy), expressed in per-capita terms, logged, and detrended using the Hodrick-Prescott filter with the smoothing parameter set at 100. Measures of tax revenue were computed using revenue figures from OECD (1990). Output and revenue figures were deflated using the private consumption deflator. The detrended trade balance is equal to the detrended ratio of net exports to output.

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