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EFFECTIVE TAX RATES IN MACROECONOMICS: CROSS-COUNTRY ESTIMATES OF TAX RATES ON FACTOR INCOMES AND CONSUMPTION

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ABSTRACT

This paper proposes a method for computing tax rates using national accounts and revenue statistics. Using this method we construct time-series of tax rates for large industrial countries. The method identifies the revenue raised by different taxes at the general government level and defines aggregate measures of the corresponding tax bases. This method yields estimates of effective tax rates on factor incomes and consumption consistent with the tax distortions faced by a representative agent in a general equilibrium framework. These tax rates compare favorably with existing estimates of marginal tax rates, and highlight important international differences in tax policy.

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1. Introduction

Public finance and macroeconomic analysis of fiscal policies emphasize the theoretical importance of distortionary taxation as a determinant of economic decision-making. However, despite the general acknowledgement that taxes are powerful policy instruments, the assessment of macroeconomic implications of alternative tax policies has traditionally been hampered by serious limitations in the measurement of relevant aggregate tax rates. For instance, tax rates on factor incomes are a key element of the set of incentives and constraints affecting economic decisions in the intertemporal framework often used in modern fiscal policy analysis.1/ Although there have been significant advances in the development of quantitative methods for studying complex intertemporal models, empirical studies in this area are still lacking reliable measures of actual aggregate tax rates on factor incomes and consumption. These tax rates are necessary both to develop quantitative applications of the theory and to help transform the theory into a policymaking tool. Thus, in this context, it seems that the rewards for making progress in the measurement of aggregate tax rates could be considerable.

The benefits of constructing tax rate estimates useful for macroeconomic modelling also seem large in light of important ongoing political debates on the implications of significant fiscal policy changes--such as tax harmonization and fiscal convergence in the European Union and among G-7 countries, and deficit reduction and health-care and welfare reforms in the United States. There are in addition important debates on the welfare gains of optimal taxation (see Lucas 1991, Cooley and Hansen 1992, and Mendoza and Tesar 1994), and on business cycle and growth implications of taxation (see Greenwood and Huffman 1991, and Easterly and Rebelo 1993b) the solutions of which depend critically on a realistic characterization of tax policies.

The measurement of tax rates for macroeconomic models has proven to be a difficult task. The large existing literature on the measurement of marginal income tax rates proposes different strategies to combine information on statutory tax schedules, tax returns, and tax codes with data on income distribution, household

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1/ As in Buiter (1981), Aschauer and Greenwood (1985), Pissarides (1985), Frenkel and Razin (1986), Greenwood and Huffman (1991), Rebelo (1991) and Baxter and King (1993). See Frenkel and Razin (1987) for a review of some of this literature.

surveys, and projections of real present values for investment projects in specific industries.2/ However, as Frenkel, Razin, and Sadka (1991) argue, the complexity of tax credits, exemptions, and deductions that exist in most countries, as well as the numerous equivalences that link broad categories of taxes, complicate the construction of effective tax rates useful for macroeconomic modelling. It is also not clear 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 national accounts. Moreover, time-series and international cross-section applications of existing methods for computing marginal tax rates are seriously limited by data availability.

Lucas (1990) and (1991) and Razin and Sadka (1993) have suggested an alternative method that produces effective tax rates using data on actual tax payments and national accounts. The method takes into account the effective, overall tax burden resulting from major taxes, and produces measures of tax rates that are consistent with the concept of aggregate tax rates at the national level and with the representative agent assumption. The empirical work they conducted suggests that the resulting tax rates are useful approximations to the taxes that distort economic decisions in dynamic macroeconomic models.

This paper proposes an extension of this method to compute time series of effective tax rates on consumption, capital income, and labor income for G-7 countries using information publicly available from the OECD. The three tax rates are measured as ad-valorem estimates by classifying virtually all forms of tax revenue at the general government level into one of the three taxes. Each measure of tax revenue is then expressed as a fraction of a precise estimate of the corresponding tax base. As Razin and Sadka (1993) show, these ad-valorem tax rates reflect specific (or per-unit) tax rates faced by a representative agent in a general equilibrium framework.

The main advantage of our method is that is less stringent on data requirements than existing methods because it exploits the consistency of available international sources on national accounts and revenue statistics, and hence is much easier to use to produce time-series and cross-country samples of tax rates. In addition to its

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2/ For the United States see Auerbach (1987), Barro and Sahasakul (1986), Joines (1981), and Seater (1985)) and for international studies see King and Fullerton (1984), McKee, Visser, and Saunders (1986) and OECD (1991b) and Easterly and Rebelo (1993b).

simplicity, our method also achieves simultaneously three objectives: (a) it takes into account the net effect of existing rules regarding credits, exemptions, and deductions, (b) it separates taxes on labor income from taxes on capital income, and (c) it incorporates the effects of taxes not filed with individual income tax returns (such as social security contributions and property taxes) on factor income taxation. However, our method has the disadvantage that it does not take into account information on statutory tax rates and income distribution per tax bracket. To examine the relevance of this simplification, we compare our estimates of tax rates with some available estimates of marginal tax rates derived in other studies. We find that, despite differences in levels, the tax rates constructed here are within the range of marginal tax rate estimates and display very similar trends.

Our estimates of tax rates suggest that there are important differences in the distribution of the tax burden on consumption, labor income, and capital income between North America, Japan, and large European economies. Consumption and labor taxes in Japan and the United States are significantly lower than in Canada and the European countries, while for capital income tax rates the opposite occurs. In all G-7 countries tax rates on capital income and consumption fluctuated without trend during the period 1965-88 (except in the case of the capital income tax rate in Japan), while labor income tax rates in all countries rose sharply. The cross-country evidence shows that countries with higher capital income taxes tend to display lower savings and investment rates. From a time-series perspective, there is a negative correlation between savings or investment rates and the capital income tax rate, and between hours worked and labor and consumption taxes.

The paper is organized as follows. Section 2 describes the methodology and sources used to construct effective tax rates and compares the resulting tax rates across G-7 countries. Section 3 compares the effective tax rates with estimates of marginal tax rates obtained in other studies. Section 4 concludes.

2. A Method for Computing Macroeconomic Measures of Effective Tax Rates

The concept of a marginal tax rate 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, however, less straightforward for several reasons. First, different taxes result in equivalent effects on observable variables that could be used to construct tax rate estimates (see Frenkel, Razin, and Sadka 1991). Second, the complexity and variety of tax exemptions, deductions, and credits make it difficult to extrapolate the actual tax burden from information on statutory tax rates. Third, tax revenue data and the tax system itself do not conform

to the aggregate concepts of a macroeconomic model. Fourth, most available methods for computing aggregate marginal tax rates require data on the distribution of income consistent with income tax schedules and returns and with the schedule of social security contributions. Finally, tax systems often include different forms of taxation affecting the same tax base--such as individual income taxes levied on wages and social security taxes, both of which constitute a tax on labor income. At an international level, the situation is complicated further by differences in the structure of tax systems and limitations of the information available on tax revenues and income distribution (see Easterly and Rebelo 1993a).

In this section we describe an alternative approach for computing tax rates for macroeconomic models. Our methods constructs aggregate effective tax rates based on actual tax payments and national accounts, following the theoretical foundations proposed by Razin and Sadka (1993) in their study of optimal taxation for Israel,3/ which was in turn based on guidelines suggested by Lucas (1990) and (1991). We then use the method to compute time series of tax rates for G-7 countries covering the period 1965-1988 using data from the OECD's Revenue Statistics (OECD, 1990) and National Accounts: Volume II, Detailed Tables (OECD, 1991a).

2.1 Macroeconomics of Ad-Valorem Tax Rates

Consider an economy with three goods, consumption (c), labor (l), and capital (k). Households' consumption allocations of each good are denoted by the vector $h=(h_c,h_l,h_k)$, and government sets exogenous policies with respect to expenditures in each good, denoted by the vector $g=(g_c,g_l,g_k)$. Firms produce c using k and l, which are provided by households, and government finances g by levying taxes on consumption, capital income, and labor income. There are two price vectors; the consumer post-tax price vector $p=(p_c,p_l,p_k)$ and the producer pre-tax price vector $q=(q_c,q_l,q_k)$. Tax policy is characterized by a vector of specific tax rates $t=(t_c,t_l,t_k)$ per unit of the respective good. Thus, $t=p-q$ and the corresponding vector of ad-valorem tax rates is $\tau=(\tau_c,\tau_l,\tau_k)$, where $\tau_i=t_i/q_i$ for $i=c,l,k$. Since the price vectors p and q are not readily available, it is easier

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3/ 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).

to approximate measures of the tax rates by multiplying t_i and q_i times an appropriate quantity measure, thus using data on tax revenues and tax bases rather than price data.

The appropriate quantity measures that should be used can be obtained by examining the bouseholds' budget constraint:

$$p \cdot (h-e-b) = q \cdot y - p_C D \tag{1}$$

In this expression, the vectors e and b represent possible endowments and government transfers of the three goods, y is the net output vector and $p_C D$ represents a lump-sum consumption tax that finances any government deficit.4/ The net consumption vector to which the specific tax vector t applies is (h-e-b). Note that the net consumption vector for l is negative and $b_l = 0$--i.e. households supply labor and government cannot make transfers in units of labor time. Also, y_c measures net output of the consumption good by the private sector ($y_c > 0$), while y_l and y_k correspond to production inputs ($y_l, y_k < 0$). It follows from this arrangement that q.y measures profits, whicb are a part of bouseholds' income.

The ad-valorem tax rates in this economy are:

$$\tau_C = \frac{p_C y_C - q_C y_C}{q_C y_C}, \tag{2}$$

$$\tau_l = \frac{q_l(e_l - h_l) - p_l(e_l - h_l)}{q_l(e_l - h_l)}, \tag{3}$$

4/ We base our discussion on a static model. Razin and Sadka (1993) argue that under certain conditions the equilibrium of a dynamic economy reduces to the equilibrium of the static economy with private saving added to current consumption and the government deficit lumped together with taxes.

$$\tau_k = \frac{-q_k y_k - \left(-p_k y_k\right)}{-q_k y_k} \qquad (4)$$

The numerators in the above equations measure the difference between the pre-tax and pos-tax valuation of consumption, labor income, and capital income respectively, which can be approximated by measures of tax revenue derived from each tax. The denominators are measures of consumption and the income derived from labor and capital valued at pre-tax prices, and thus correspond to measures of the tax base affected by each tax. The key issue for the construction of a reliable estimate of the τ vector is, therefore, the determination of measures of tax revenues and tax bases that reflect closely the corresponding measures of post-tax and pre-tax valuations of income and expenditures.

Note that the method described here, by suggesting the use of data on pre- and post-tax income and prices, produces aggregate effective tax rates that in fact correspond to realized average tax rates. These tax rates aggregate the information on statutory taxes, credits, deductions, and exemptions implicit in national accounts and revenue statistics in a manner that captures the overall tax burden from each tax and maintains consistency with the representative agent framework.

2.2 Data Sources

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. Other sources, such as the IMF's Government Finance Statistics are not adequate because for several countries data reflect only central government figures, thus ignoring state and local taxes, and correspond to budget estimates rather than cash receipts.5/ Also listed below are variables obtained from the OECD's National Accounts; Volume II, Detailed Tables which are codified using abbreviations in capitalized letters. The detailed tables of the OECD National Accounts are consistent with the Revenue Statistics data of the same source. Of particular importance for the computation of tax rates is the data at the disaggregated level that the National

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5/ This is a shortcoming hard to overcome in multi-country studies including non-OECD countries (see, for example, Easterly and Rebelo 1993a).

Accounts provide on detailed accounts for households, corporate enterprises, and government. The data from both OECD sources covers the period 1965-1988. The key to variables is:

Revenue Statistics:

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

National Accounts:

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

2.3 Effective Tax Rate on Consumption

Following the principles presented in 2.1, we assume a representative household that purchases an aggregate consumption good and pays an ad-valorem tax. The consumption tax rate corresponds to the percentage difference between the post-tax consumer price and the pre-tax price at which firms supply the good. Thus, using OECD data, the effective average tax rate on sales of consumption goods τ_c is:

$$\tau_C = \left[\frac{5110+5121}{C+G-GW-5110-5121}\right] \times 100. \qquad (5)$$

The numerator of this expression is the revenue from indirect taxation, which includes general taxes on goods and services plus excise taxes.6/ The total revenue from indirect taxation 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 consumption tax, which is the pre-tax value of consumption. The latter is 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 GW must be deducted from G.

2.4 Effective Tax Rate on Labor Income

The effective ad-valorem tax on labor income in equation (3) corresponds to the percentage difference between post- and pre-tax labor income. In practice, however, computing this 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 aggregate marginal labor income tax rates (as in McKee, Visser and Saunders 1986, Barro and Sahasakul 1986, and Easterly and Rebelo 1993a), is that tax revenue sources typically do not provide a breakdown of individual income tax revenue in terms of labor and capital income. This is due to the fact that tax returns are typically filed to cover all of a tax-payer's income, regardless of its origin. 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 statutory tax rates 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

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6/ Import and export taxes are excluded without affecting the results because they represent a minimal fraction of taxes on goods and services in G-7 countries. However, they should be kept in mind in extending the method to other countries.

are other important taxes on labor income such as social security contributions and payroll taxes that need to be taken into account (see Barro and Sahasakul 1986).7/

We begin by computing the households' average tax rate on total income τ_h:

$$\tau_h = \left[\frac{1100}{OSPUE+PEI+W}\right] \times 100. \qquad (6)$$

Thus, the representative agent's total 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).

We then estimate the revenue from the income tax on wages and salaries as $\tau_h W$ and compute the effective average tax rate on labor income τ_l as:

$$\tau_l = \left[\frac{\tau_h W+2000+3000}{W+2200}\right] \times 100. \qquad (7)$$

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 expands 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.

7/ We do not consider social security benefits paid to households, which could be viewed as a rebate of labor income tax revenue. Since these and other net government transfers are large and difficult to relate to a particular tax, they are best treated not as part of the tax system but of government expenditures.

2.5 Effective Tax Rate on Capital Income:

Continuing under the assumption that all sources of the households' income are taxed uniformly, the tax rate on capital is constructed by estimating first the revenue from the capital income tax on individuals as τ_h(OSPUE + PEI).8/ The effective capital income tax rate τ_k is then:

$$\tau_k = \left[\frac{\tau_h(OSPUE+PEI)+1200+4100+4400}{OS}\right]\times 100. \qquad (8)$$

This formula represents the difference between post-tax and pre-tax capital income divided over pre-tax capital income as postulated in equation (4). 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,9/ 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). Note that this definition of pre-tax capital income implicitly assumes zero net profits and an aggregate constant-returns-to-scale technology (see Razin and Sadka 1993).

2.6 International Comparisons of Tax Rates

Time series of the effective tax rates on consumption, labor income, capital income, and corporate capital income for G-7 countries over the period 1965-1988 are reported in Tables 1-4 and plotted in Figures 1-4. The tax rates provide some evidence on important differences in tax systems across G-7 countries. Tax rates have fluctuated markedly since 1965 in response to both long-term fiscal reforms and short-term policy changes in statutory taxes, tax credits, deductions and exemptions. Our estimates are also somewhat sensitive to cyclical

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8/ PEI includes dividends, interest, rents, and royalties which are forms of capital income. OSPUE, in contrast, may not reflect only capital income if it has implicit small business owners' salaries.

9/ 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.

factors and unusual shocks that may affect our measures of tax revenues and tax bases.10/ While tax rates on consumption and capital income appear to be stationary (except for the tax rate on capital income in Japan), the tax rate on labor income has followed an increasing trend in all countries.

Cross-country differences in tax rates, particularly labor income tax rates, narrowed considerably by the end of our sample period. Nevertheless, as of 1988 there were still marked differences in tax systems. In general, countries that taxed consumption and labor income more (less), tended to tax capital income less (more). The tax on consumption was significantly lower in Japan and the United States than in the rest of the G-7 countries. Turning to labor income tax rates, the countries in our sample 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 France stands apart with a rate of nearly 47 percent. Similarly, taxes on capital income can be broken down into three groups. The capital income tax was significantly higher in the United Kingdom and Japan, at about 57 percent, than in the other countries.11/ In Canada and the United States capital income was taxed at about 40 percent, while in France, Germany, and Italy, that tax rate was around 25-28 percent. A comparison of Figures 3-4 suggests also that the mix between corporate and individual capital income taxes shifted over time in most countries.

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

11/ The fact that the effective capital income tax rate in Japan has increased in a sustained manner since 1965 is interesting in light of the strong growth performance of this country over the same period.

Table 5 reports averages of tax rates for each country and time-series correlations with savings and investment rates and with an index of hours worked.12/ The averages of savings and investment rates and the hours index are also provided for cross-sectional comparisons. These statistics must be interpreted with caution because some of the series, in particular labor income tax rates, do not appear to be stationary. With regard to time-series co-movements, the tax rate on capital income is generally negatively correlated with savings and investment rates, and hours worked are negatively correlated with the sum of labor and consumption tax rates in all countries except Italy. Cross-country comparisons of mean tax rates 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 tax rates and higher consumption and labor income taxes coincide with less hours worked--with the exception of Germany.

Table 6 reports cyclical properties of tax revenues based on the estimated tax rates and using the Hodrick-Prescott filter. The revenue of all three taxes is more variable than output in each country, and capital income tax revenue tends to fluctuate more than the revenue from labor income tax and the consumption tax. Revenues are also generally procyclical. These results suggest that, while our measures of effective tax rates may be contaminated by business cycle effects, as explained before, the fact that tax revenues and tax bases tend to move together over the business cycle contributes to reduce that source of error.

3. Comparison with Estimates of Marginal Tax Rates

The ability of our tax rate estimates to approximate the tax wedges affecting macroeconomic decisions could be questioned because we do not use information on statutory tax rates and the peculiarities of the tax laws of each country, nor do we incorporate data on the income distribution according to income tax brackets and the schedule of social security taxes. In this section we examine the implications of these simplifying assumptions by comparing our results with those obtained in the literature on the computation of aggregate marginal tax rates, which makes extensive use of detailed tax information. In general, the alternative methods proposed in this

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12/ 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).

literature are impractical for international analysis given limitations of international data on tax returns and the complexities of tax systems in different countries. However, estimates of aggregate marginal tax rates are a good benchmark for evaluating the accuracy of our measures.

3.1 Marginal Tax Rates on Individual Income for the United States

A number of studies have computed estimates of aggregate marginal individual income tax rates for the United States, as in Joines (1981), Seater (1985), Barro and Sahasakul (1986), and Easterly and Rebelo (1993a).13/ These studies compute aggregate 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. Most of these studies consider both income tax returns and social security contributions, with the exception of Easterly and Rebelo (1993a) that due to data limitations abstracted from including social security taxes.

Seater defines each tax-bracket's marginal tax rate as the ratio of the difference between the tax bill of that bracket and the tax bill of the previous bracket divided over the difference between the income earned by individuals in the same two tax brackets. Joines' measure is similar but he adjusts for the number of tax returns in each bracket and incorporates property, sales, and other proportional taxes. In contrast, Barro and Sahasakul compute aggregate marginal tax rates by taking a weighted average of the statutory tax rates listed in income tax schedules. Because their analysis is based on statutory taxes, the estimates are biased upwards to the extent that credits, exemptions, and deductions are not taken into account. Easterly and Rebelo adopt a more eclectic approach that combines statutory tax rates with tax returns by computing income-weighted tax rates assuming a logistic functional from for the marginal tax schedule and a normal distribution for personal income. However, the intense data requirements of this approach limit the coverage to a point estimate for 1984.

All of the studies cited above faced the problem that individual income tax data do not provide a breakdown of revenue derived from labor income and from capital income. Seater, Barro and Sahasakul, and Easterly and Rebelo set this problem aside by focusing on tax rates for individuals, without distinguishing between capital and labor income. Joines takes a similar approach to the one proposed here by assuming that personal income tax rates apply uniformly to capital and labor.

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

Figure 5 plots the available time series for aggregate marginal tax rates on individual income from Joines (1981), Seater (1985), and Barro and Sahasakul (1986), together with the effective tax rate on labor income estimated in Section 2 and the two 1984 income tax rate estimates of Easterly and Rebelo (1993a).14/ The chart shows that despite methodological differences, which result in differences in the level of the tax rates, the general trend of the four series is very similar. The Barro-Sahasakul tax rates are the highest because, as noted earlier, the statutory tax rates they use ignore the information on tax credits and exemptions that estimates based on actual tax returns 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 our effective labor income tax rate. If our measure of the effective consumption tax is added to our effective labor income tax, the difference with Joines' marginal labor income tax rate series is negligible.15/ Note also that Easterly and Rebelo's 1984 point estimate of the income tax rate under the assumption of a zero minimum statutory marginal tax is very close to our estimate of the labor income tax for that year.

3.2 International Estimates of Marginal Tax Rates

We focus now on studies of aggregate marginal tax rates based on international data. These are the study on capital and labor income taxes in OECD countries by McKee, Visser, and Saunders (1986), the studies on effective tax rates on marginal investments by King and Fullerton (1984) and OECD (1991b), and the international tax rate estimates provided in the studies of taxation and growth by Easterly and Rebelo (1993a) and (1993b).

14/ Easterly and Rebelo (1993a) report two estimates depending on whether the statutory minimum marginal tax rate is assumed to be zero or set to some figure suggested by the data.

15/ Joines (1981) also constructed estimates of the U.S. marginal tax rate on capital income by computing a weighted average of proportional taxes (sales taxes, property taxes, corporate income taxes, and state and local income taxes) and non-proportional taxes (federal personal income tax). Joines' estimates are slightly higher than the effective tax rates on capital income reported here, but the two series display similar trends.

The tax rates on labor income constructed by McKee et al. differ from the marginal tax rates discussed in 3.1 in that they do not represent weighted averages of tax-bracket data. Instead, McKee et al. based their calculations on statutory taxes, tax returns, and post- and pre-tax labor income as they would apply in different countries at the income level of a hypothetical "Average Production Worker" (APW), which the OECD uses as a reference for international comparisons.16/ 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 are 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, so as to capture differences in credits, exemptions, and deductions. The estimates are for the years 1979, 1981, and 1983. The limitations of the sample are due to restrictions imposed by data availability.

We compare our tax rate estimates with the estimates produced by McKee et al. (1986) in Table 7. 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 tax rates computed in Section 2. The ranking of tax rates across countries is also very similar. Nevertheless, the estimates of McKee et al. are generally higher than our estimates. 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 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),

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

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 international estimates of capital income tax rates computed by McKee et al. (1986), OECD (1991b) and King and Fullerton (1984) illustrate the strengths and weaknesses of the King-Fullerton approach. The tax rates differ 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. showed that for the United States in 1983, the tax rate on investments in manufacturing, assuming inflation fixed at 8.3 percent, varied 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. Thus, while this methodology provides very accurate measures of the effective marginal tax on specific investments at the microeconomic level, it is nonetheless difficult to introduce in an aggregate model to produce the relevant tax rates for explaining macroeconomic phenomena. In addition, 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.

Easterly and Rebelo (1993b) constructed four cross-country measures of tax rates in the process of conducting their empirical analysis of fiscal policies and economic growth. One measure are the income-weighted marginal tax rates from Easterly and Rebelo (1993a) discussed earlier. The other three measures are: (a) average tax rates computed as ratios of tax revenues to rough measures of tax bases, (b) 1984 statutory tax rates from the study by Sicat and Virmani (1988), and (c) marginal tax rates computed as coefficients of time-series regressions of tax revenues on tax bases, as in Koester and Kormendi (1989). The first of these three estimates are closest in spirit to the method proposed in Section 2. The key difference is that in our analysis the different sources of tax revenue and the corresponding tax bases are clearly isolated. For instance, Easterly and Rebelo consider either the ratio of total tax revenue from income, profits and capital gains taxes to total GDP or the ratio of total individual income taxes to personal income, while we separate the revenue derived from taxes on labor income,

capital income, and consumption, and measure ad-valorem tax rates by constructing close estimates of pre- and post-tax measures of factor incomes and consumption. It is also worth noting that in Easterly and Rebelo's growth analysis, only two of the measures of tax rates are statistically significant at the 10 percent confidence level for explaining growth, and one of them is the average tax rate measured as the ratio of individual income taxes to personal income.17/

4. Conclusions

This paper presents a method for computing aggregate effective rates of taxation on consumption and the income derived from capital and labor based on data from revenue statistics and national income accounts. Following recent work by Lucas (1990) and (1991) and Razin and Sadka (1993), we construct estimates of the ad-valorem tax rates that represent the wedges distorting optimal plans in a macroeconomic, representative agent setting by comparing measures of aggregate post- and pre-tax incomes and prices. The method is used to compute time series of the three tax rates for G-7 countries covering the period 1965-1988.

The potential applicability of the resulting tax rates in the design of macroeconomic models of fiscal policy is examined by comparing the tax rates with several existing estimates obtained in the literature on aggregate marginal tax rates. The methods used to date in this literature are often impractical for international analysis given limitations imposed by data availability and difficulties in dealing with the complexity of actual tax systems. Nevertheless, the comparison between the effective tax rates computed here and available estimates of aggregate marginal tax rates shows that the trends of all these tax rates are very similar. Moreover, our measures of effective tax rates are within the range of existing estimates of marginal tax rates, and a large fraction of the difference can be attributed to the treatment of tax credits and exemptions and the treatment of consumption taxes, and not to the use of income distribution data to compute income-weighted tax rates.

The tax rates constructed here illustrate important trends and differences in the structure of the tax systems across industrial countries. While labor, capital, and consumption taxes have fluctuated sharply in response to changes in statutory taxes and policies regarding credits, exemptions, and deductions, capital and consumption

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17/ The second measure is the marginal tax rate defined as the coefficient of a regression of total income taxes on GDP.

taxes have not exhibited a marked trend in general, while the tax on labor income has increased over time in all G-7 countries. 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 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 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.

This paper's aim at providing an accurate, and yet flexible and accessible, method for computing aggregate tax rates is motivated by the fact that the development of quantitative dynamic macroeconomic models of fiscal policy depends critically on realistic measures of these tax rates. Existing empirical studies on implications of tax policy for growth and business cycles based on these models, as in Greenwood and Huffman (1991), Cooley and Hansen (1992), McGrattan (1994), and Easterly and Rebelo (1993b), are suggestive of the potential relevance that reliable estimates of tax rates can have in practice. Directions for further research that could exploit the tax rate estimates constructed here are therefore numerous. For instance, Razin and Yuen (1994) examine the potential for the estimates of capital income tax rates to explain cross-country growth differentials, and Mendoza and Tesar (1994) quantify the inefficiencies resulting from existing tax systems and the potential welfare gains of tax reforms in a dynamic model of an integrated world economy.

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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. Tax Rates and Macroeconomic Variables

	Savings/GDP Ratio		Investment/GDP Ratio		Hours 2/		Average Tax Rates		
							Capital Tax	Consumption Tax	Labor Tax
	Mean	Corr.(tk) 1/	Mean	Corr.(tk) 1/	Mean	Corr.(tc+tl) 3/	Mean	Mean	Mean
United States	0.17	0.32	0.18	0.11	104.7	-0.76	0.43	0.06	0.25
United Kingdom	0.18	-0.23	0.18	-0.37	104.8	-0.71	0.56	0.14	0.27
Germany	0.25	-0.85	0.22	-0.69	105.1	-0.92	0.25	0.16	0.36
Italy	0.21	-0.43	0.21	-0.93	101.3	0.66	0.26	0.12	0.38
France	0.23	-0.95	0.22	-0.81	102.2	-0.86	0.24	0.21	0.43
Japan	0.33	-0.45	0.31	-0.58	102.6	-0.49	0.33	0.05	0.20
Canada	0.24	-0.12	0.22	0.11	104.0	-0.73	0.40	0.12	0.22

Note: Data for the period 1965-1988, except for Italy (1980-88) and France (1970-88).

1/ Contemporaneous correlation with the capital income tax rate.
2/ Average annual hours in manufacturing (Index, 1982=100).
3/ Correlation between hours and the sum of the labor income and consumption tax rates.

Table 6. Variability and Co-Movement of Tax Revenues in Industrial Countries 1/

	Consumption Tax Revenue		Labor Income Tax Revenue		Capital Income Tax Revenue		Output
	Standard Dev.	Output Corr.	Standard Dev.	Output Corr.	Standard Dev.	Output Corr.	Standard Dev.
United States	3.04	0.11	3.74	0.35	5.83	0.74	2.30
United Kingdom	4.86	-0.38	4.71	-0.24	4.71	-0.38	2.03
Germany	4.49	0.75	4.53	0.84	5.92	0.51	3.08
France	2.66	0.59	2.54	0.17	3.94	0.37	1.93
Italy	4.09	0.54	2.45	0.13	3.97	-0.34	2.33
Japan	6.49	0.81	3.52	0.75	9.09	0.83	3.98
Canada	5.71	0.08	5.22	0.12	4.95	0.69	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.

Table 7. Comparison of Average Tax Rates on Labor Income

Country	Mendoza - Razin - Tesar 1/			McKee - Visser - Saunders					
				Single Worker APW			Married Couple APW		
	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 consumption tax.

Figure 1. Consumption Sales Tax
1965 to 1988

(In Percent)

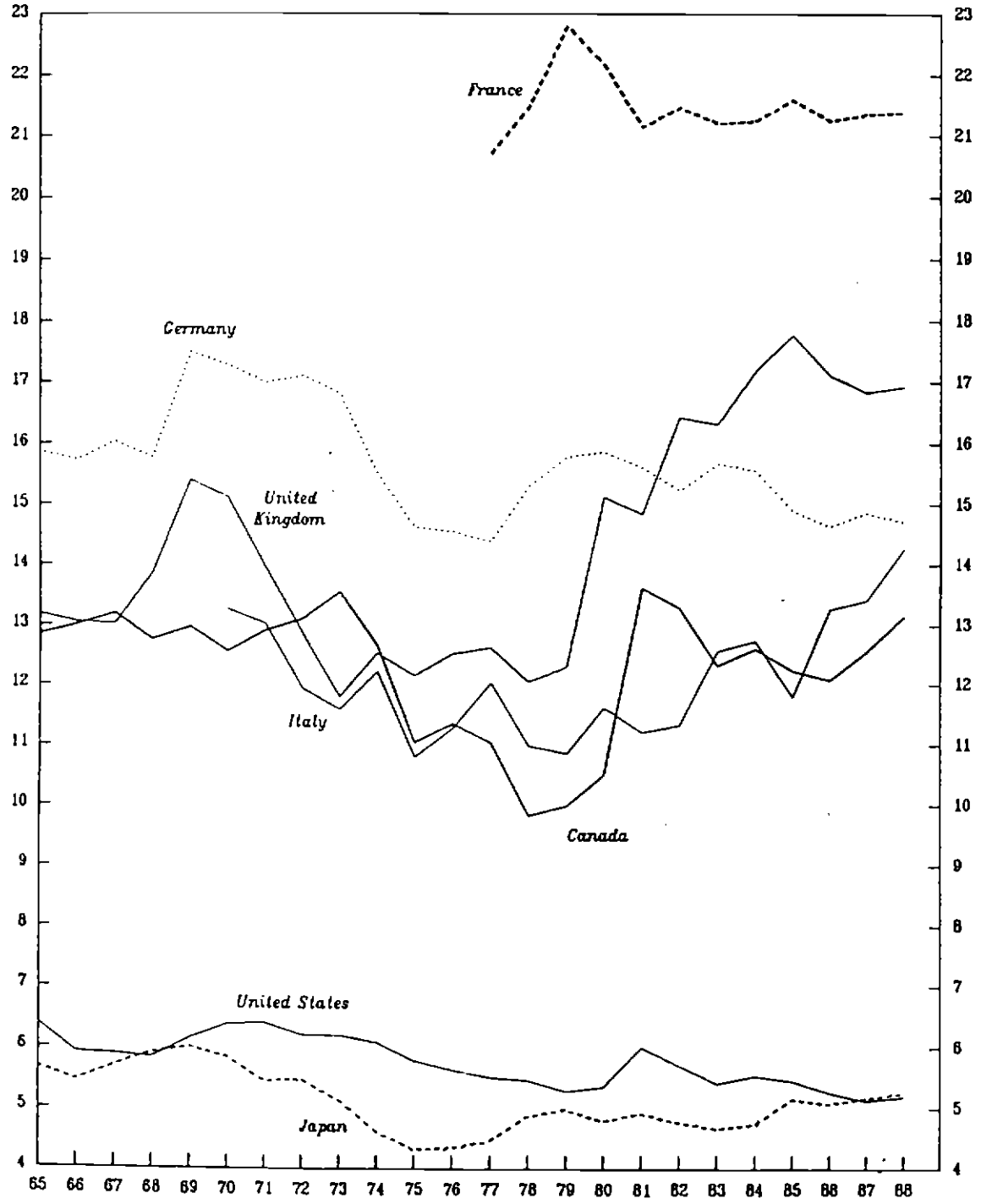

Figure 2. Labor Income Tax
1965 to 1988
(In Percent)

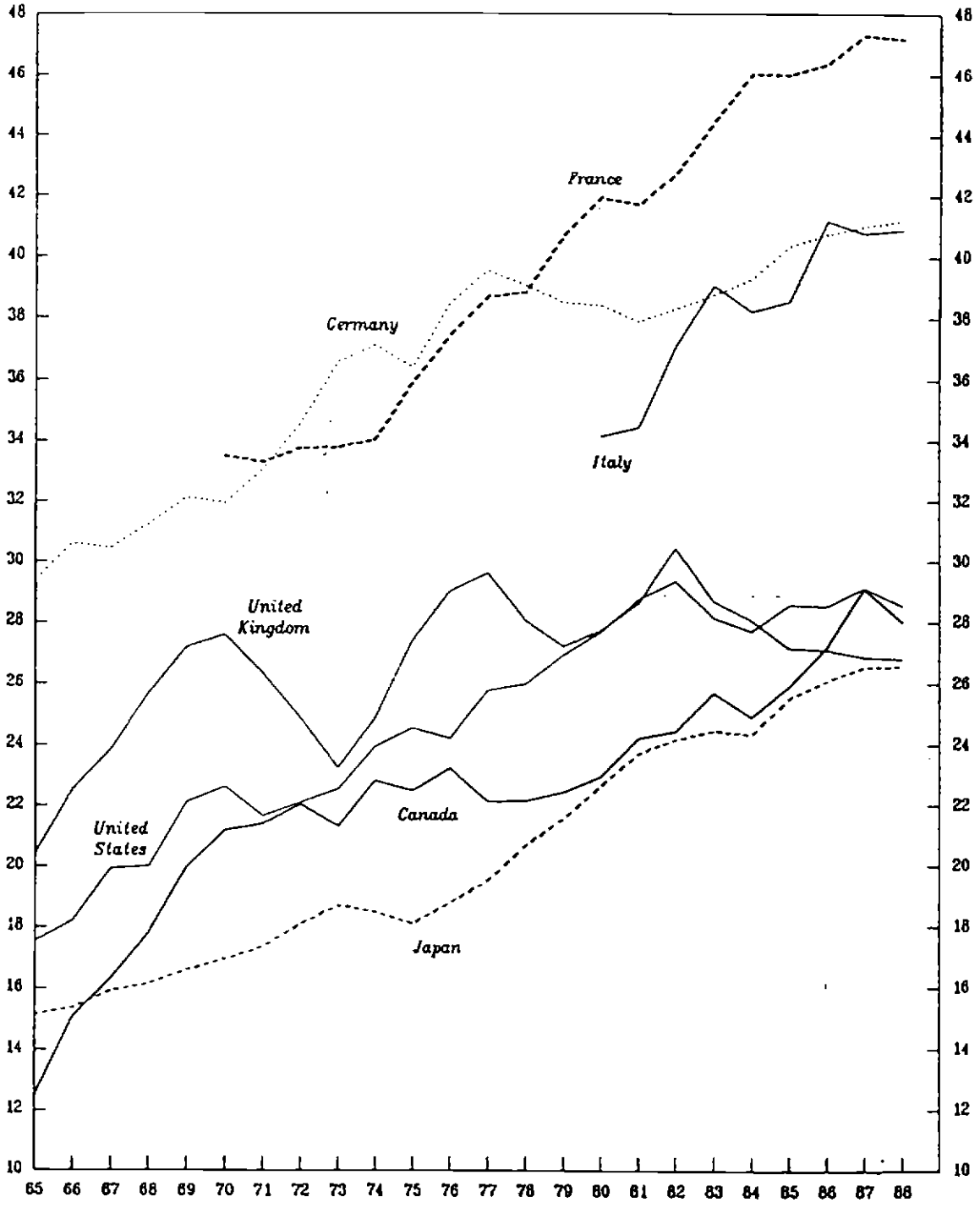

Figure 3. Capital Income Tax.
1965 to 1988

(In Percent)

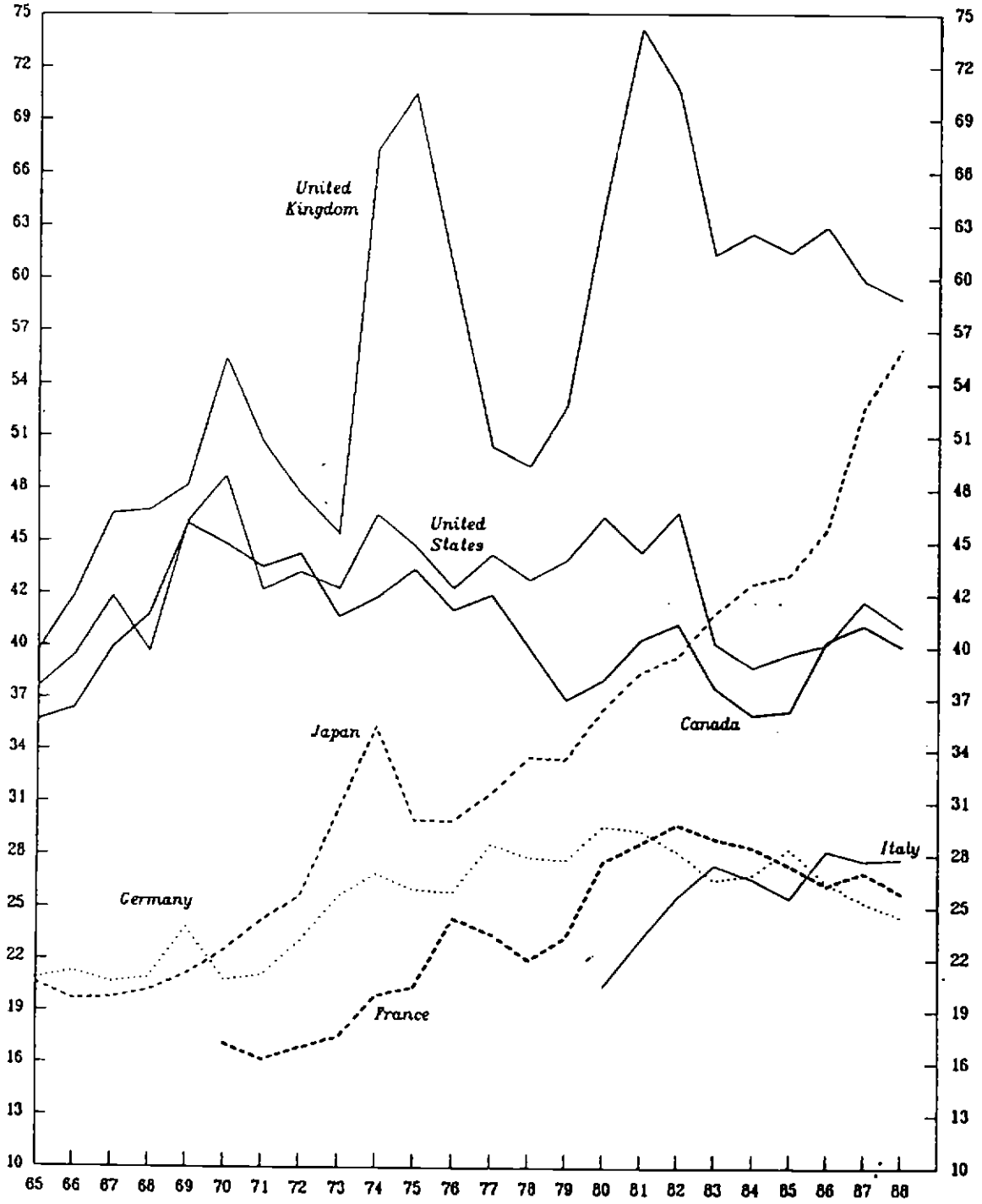

Figure 4. Corporate Capital Income Tax, 1965 to 1988

(In Percent)

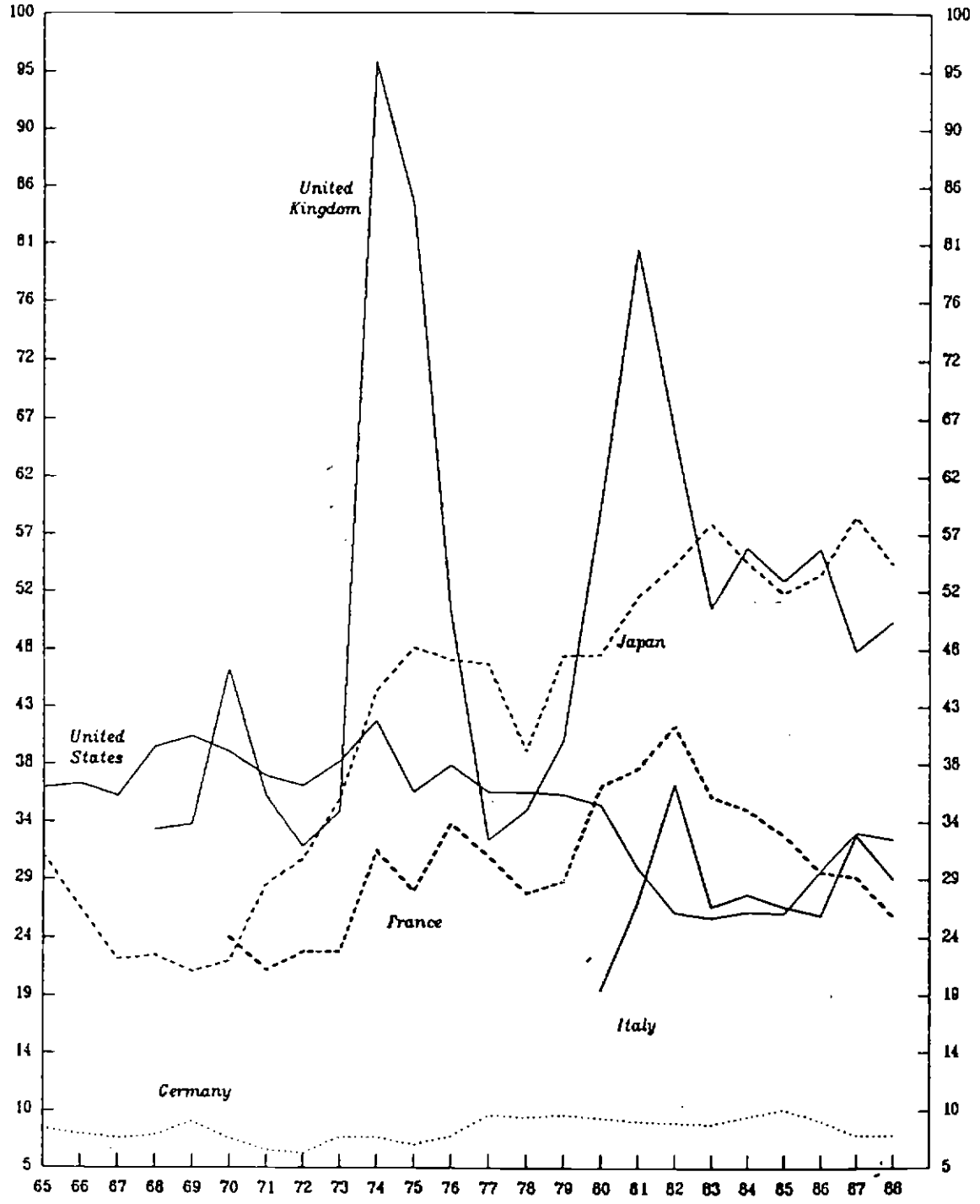

Figure 5. Estimates of Labor Income Tax Rates
(tax rate in percent)