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In this article, I first report and describe the construction of two new statistical series on the marginal Federal income tax rates for corporations and private individuals in the United States since the inception of those taxes and then analyze the behavior of these series over time. Several results on the determination of tax rates are derived; these generally are not consistent with Barro's theory of deficit finance.

1. Introduction

Economists have long bemoaned the lack of statistical series on marginal tax rates. However, it turns out that the appropriate series can be constructed fairly easily from data reported in Statistics of Income, published annually by the U.S. Treasury Department. These series are truly marginal rates and thus are a considerable improvement over the average tax rate proxies that economists have had to use heretofore. They should prove especially useful in computing after-tax rates of return. My estimates of the marginal personal and corporate income tax rates are reported in tables I and .

In analyzing the behavior of the series, I first examine the time series behavior of the average marginal personal and corporate tax rates. These rates are those facing the representative individual or firm. These rates' behavior can be explained by a very few variables. Besides being interesting in themselves, these results also are interesting because they shed light on Barro's (1979) recent explanation of deficit finance.

I next analyze the behavior over time of the entire graduation structure of the personal income tax. This analysis is of the cross-section time-series type, with the cross-sectional element being the variation of marginal tax rates across income levels within each year. This analysis not only shows how the

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*I thank Hendrik S. Houthakker for encouraging me to pursue the research reported in Part 3. Robert Inman and an anonymous referee for helpful comments, and Leslie A. Forster for excellent research assistance.

1For example, Christensen and Jorgensen (1973) compute an effective tax rate on labor compensation as the ratio of taxes on labor income to labor income including taxes.
graduation structure behaves but also helps interpret the time series results for the average marginal rate.

2. Construction of the series

First I describe how I constructed the tax rate series.

2.1. Marginal personal income tax rates

Each year the Statistics of Income reports the distribution of all personal income tax returns according to adjusted gross income classes, showing for each income class the number of returns, the total net income, and the total tax paid. Using this data, an average marginal income tax for each of the years 1916–1975 was computed in the following manner.

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*Estimate subject to upward bias. See text.

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<th>Year</th>
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Corporate income tax rates, 1909–1975 (percent).

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<sup>a</sup>Weighted average of graduated rates.

<sup>b</sup>Weighted effective rate. The flat rates underlying these tables are:

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This table is the surcharge rate times the sum of the normal income tax and surtax rates. For 1968–1969, the surcharge rate was 10 percent, and for 1970 it was 2.5 percent.

<sup>c</sup>Sum of all preceding columns.
Let $X$ be the midpoint of an income class; then $X$ can be used to index income classes. For example, the class of taxpayers earning between $2000 and $3000 has a midpoint of $2500 and would be called 'the $2500 income class'. Let $X_0$ be the first income class. Then the marginal tax rate for class $X_0$ is the same as the average rate, and the marginal rate for any class above $X_0$, denoted $MTR(X)$, is computed with the standard marginal formula

$$MTR(X) = \frac{\Delta \tau(X) - \tau(X-1)}{(X - X_{-1})}$$

where $\tau(X)$ is the total tax paid by those in income class $X$ divided by the number of returns in class $X$ (so $\tau$ is the average tax paid) and $X_{-1}$ is the income class preceding class $X$.

This procedure yields a collection of marginal tax rates, one for each income class. To obtain a marginal rate for the economy as a whole, a weighted average of the individual income class rates was computed, using for weights the fraction of total net income that fell within each income class. This weighted average is called the average marginal personal income tax rate for the year in question.

The use of eq. (1) ignores the distribution of income within each income class. It also ignores the fact that family size increases with income, which because of larger total exemptions for larger families, causes eq. (1) to underestimate marginal tax rates somewhat. Errors arising from these sources are likely to be quite small.

For the years 1913–1915, a different method of construction had to be used because the Statistics of Income was not yet in existence and the data by income classes was not published anywhere else. The government publication Historical Data Pertaining to the Individual Income Tax, 1913–
J.J. Seder, Marginal federal personal and corporate income tax rates lists the normal tax and surtax rates by income class for the years in question. To find the average marginal rate, one must determine how much net income was in each class. Precise income figures are not reported, but the Statistics of Income for 1916 does report total net income for the years 1913–1916 and the number of tax returns in each income class for 1914–1916. The Annual Report of the Secretary of the Treasury for the Fiscal Year 1914 reports the number of returns for 1913. An approximation to the amount of income in each income class for the years 1913–1915 was provided by multiplying the mid-point of each income class by the number of returns in that class. This was then divided by total net income to obtain the fraction of income in each class. Finally, these fractions were used to find a weighted average of the marginal tax rates for each year.

The average marginal tax rates computed in this fashion are likely to overstate the true average marginal rates. A marginal dollar of net income generally is subject to a number of exemptions, credits, and write-offs, so that less than the full dollar actually is taxed. The method of computing the average marginal tax rates for 1916–1975 automatically takes these write-offs into account because it uses the actual taxes paid in the computations. The method for 1913–1915, by using the schedule of marginal tax rates rather than actual taxes paid, ignores all exemptions, credits, and so on and thus overstates the true effective tax rates.

To get some idea of how severe this overstatement might be, the average marginal tax rate for 1916 was computed by both methods. The resulting rates were 3.32 percent for the method that uses actual tax payments and 4.97 percent for the method that uses the schedule of normal tax and surtax rates from Historical Data. Thus the second method yields an estimate 50 percent larger than the first method's estimate for 1916. The overestimate inherent in the second method should become more severe as the tax rates become more steeply graduated and as the percentage of net income in the higher brackets increases because, as rates increase, taxpayers have greater incentive to seek tax shelters for their income. Consequently, the amount of overestimation for the years 1913–1915 should be less than for 1916 because the graduation of the income tax rates was increased considerably by a change in the law for 1916 and because net income has shifted to the higher brackets over the years 1913–1916. Thus 50 percent apparently should be viewed as an upper bound for the degree of overestimation of the tax rates for 1913–1915.

For some purposes, it might be desirable to compute marginal tax rates for only some income earners. For example, in adjusting rates of return on bonds, one might argue that only the tax rates for the, say, highest 50 percent of income earners are relevant because those people constitute the vast majority of bond holders. Although I have not computed any such series, it is obviously possible to do so.
2.2. Marginal corporate income tax rates

The data on corporate taxes are inadequate to permit the same method of constructing marginal tax rates as was used for personal income tax rates. So I had to resort to the cruder method of using legal rather than effective tax rates. The synopsis of laws contained in *Statistics of Income* reports the legal tax rates year by year and also explains what kind of corporate income was subject to each tax rate. This information, together with corporate income data reported elsewhere in *Statistics of Income*, allows one to compute how much corporate income was subject on the margin to each legal tax rate and thus allows one to compute an average marginal corporate income tax rate for each year. A detailed description of how these computations were carried out is long and tedious; so it has been relegated to an appendix available upon request.

The use of legal rates will overstate the true effective marginal rates because various write-offs are ignored. Unfortunately, data do not exist to permit a guess at the size of this overestimation.

2.3. Cautionary remarks

The foregoing marginal tax rates are as accurate as I could make them. Still, there are obvious inaccuracies. Two general types are especially worthy of mention.

First, there are a number of special provisions that crop up in the history of the tax code. For example, in the late 1960s corporations were granted an investment tax credit and for a long time owners of houses have received special treatment on their mortgage interest payments. To the extent that marginal dollars of income are spent on activities subject to such special provisions, the tax rates computed in the preceding sections are overstated. It seems almost certain that some such overstatement occurs, but there seems to be no way to correct for it.

Second, inflation causes considerable distortion in the income tax, as Feldstein and Summers (1979) have shown. The resulting changes in the marginal tax rates may not be captured well by the procedures used in this study. Inflation was not especially severe until the 1970s, so the rates reported above probably are not much affected by inflation-induced distortion.

3. Analysis of tax rate behavior

In this section I first analyze the behavior of the average marginal personal and corporate tax rates reported in tables 1 and 2; I then analyze the graduation structure of the personal income tax.
3.1. Theories of marginal tax rate determination

The public finance literature concentrates on determining what the levels of government spending and average tax rates should be. There is comparatively little literature on how spending and tax rate levels actually are set. Moreover, virtually all of what literature exists on the subject of actual determination is concerned with spending and most of this deals with state and local, rather than federal, spending. Inman (1979) discusses this literature in detail. There is almost no discussion of how tax rates are determined. The major exception is Barro's (1979) work, which discusses some of the factors determining average tax rates. I know of absolutely no work that deals with how the structure of the graduated income tax is determined.

This absence in the public finance literature of a complete and rigorous theory of tax rate determination is obviously a handicap in trying to explain the marginal tax rate series developed in this paper, for it is not immediately clear what model one should use. Fortunately, the macroeconomic literature and reflection on the nature of the tax rate series in question provide some guidance on how to proceed.

In a stable economy that moves smoothly through time with no business cycles or exogenous shocks, government spending as a share of GNP would be set at the level considered optimal by the public and average tax rates would be set at whatever level was necessary to finance that expenditure. Thus a basic determinant of average tax rates is government expenditure as a share of GNP.

Of course, economies continually experience business cycles and exogenous shocks. Government expenditures and average tax rates may respond to these deviations of the economy from its equilibrium path, and, because of the possibility of deficits, the tax rate response may be at least partly independent of the expenditure response. This independent component of the tax rate response would be a function of whatever variables the government was trying to control through fiscal policy, the two most important of which historically appear to have been real GNP per capita and the inflation rate. Thus the macroeconomic stabilization literature suggests that average tax rates are a function of government expenditure as a share of GNP, real GNP per capita, and the inflation rate.

The data developed in this paper concern marginal rather than average tax rates. This distinction might seem especially important for the personal income tax, which is strongly graduated. As Table 1 shows, the average and average marginal personal income tax rates are not the same. Nevertheless, there is good reason to believe that the variables that explain the movement of average tax rates over time also explain the movement of average marginal rates. The usual justification for the graduated personal income tax
is that it produces an equitable distribution of the tax burden. Given this justification, one would expect the average and average marginal rates to move roughly together in order that the equity relationships embodied in the graduation structure be preserved. And, indeed, the average and average marginal personal income tax rates are very closely related, the correlation between them being 0.96. As for the corporate income tax, the average and average marginal rates are almost always virtually identical because almost all corporate income is taxed at the marginal rate; the only exceptions of any consequence occurred during certain wars, when the excess profits taxes that were imposed introduced an element of graduation into the tax.

It appears, then, that the variables that affect average tax rates can be expected to affect average marginal rates in the same general way. Thus one is led to the hypothesis that average marginal tax rates depend on government expenditure as a share of GNP, a real GNP per capita, and the inflation rate. In addition, it seems reasonable to suppose that, for a given average tax rate, the graduation structure and therefore the average marginal tax rate might depend on which political party controls the government. The major parties supposedly espouse different philosophies regarding taxation of different income groups. Thus one might expect variables that capture the prevailing political climate to be relevant in explaining average marginal tax rates.

The fact that the personal income tax is graduated leads to further observations on explaining its behavior. As just discussed, inclusion of real GNP per capita and the inflation rate in the list of variables explaining average marginal tax rates can be justified in terms of discretionary attempts by the government to stabilize the economy. However, with a graduated tax, automatic stabilization is relevant as well. In particular, even if the government makes no use of discretionary policy, both the average and average marginal rates of a graduated tax will respond to changes in nominal GNP per capita. This fact is another reason to expect real GNP per capita to play a role in explaining the average marginal personal tax rate. It also raises the possibility that the price level plays a role, too. If the price level were to fluctuate around some fixed long-run equilibrium level, then nominal income would do so as well, even if real income were fixed. If the government made no attempt to offset the effects of such fluctuation, tax rates would fluctuate in synchrony with the price level. In contrast, if the

\[ AMTR, = 0.685 + 1.3327 \cdot ITR, \]

\[ (0.858) (15.98) \]

where the numbers in parentheses below the coefficients are t-statistics and where the \( R^2 \) was 0.92. Thus the relation between the two rates seems extremely close.
price level were to follow, say, a random walk, so that no fixed equilibrium level existed, it seems inconceivable that the government would fail to adjust tax rates to account for the change in nominal income caused by the changed price level. Of course, such an adjustment might well occur with a lag, in which case tax rates would tend to be correlated with the rate of price change. Thus, whether the price level or its rate of change matters depends at least in part on the nature of price movements through time. As a check, both can be included as explanatory variables for the average marginal personal tax rate.

Recently, Barro (1979) has challenged elements of the foregoing traditional line of argument. Barro argues that the costs associated with collecting taxes rise with the average tax rate. Therefore, the optimal policy is to smooth tax rates over time and to finance transitory changes in expenditure through deficits and surpluses. According to this theory, departures of variables from their trends should not affect tax rates, so that business cycles and abnormal inflation rates should not be significant in explaining tax rate movements. In particular, deviations of tax rates from their trends should be random and unrelated to the deviations of nominal GNP and inflation from their trends. Thus several of the explanatory variables included by the traditional theory are excluded by Barro’s theory. Such a sharp distinction between theories is eminently testable.

3.2. Average marginal tax rates

The foregoing theories suggest the following regression equation:

\[
\log MTR_i = a_0 + a_1 \log \frac{FGOV_i}{GDP_i} + a_2 \log \frac{GNP_i}{POP_i} + a_3 \log GNPD_i + a_4 \log \frac{GNPD_i}{GNPD_{i-1}} + a_5 CONG_i + a_6 PRES_i + a_7 WW1_i + a_8 WW2_i + a_9 KW_i + a_10 VNWi_i + a_{11} t. \quad (2)
\]

where \( MTR \) is the marginal tax rate, either personal or corporate, \( FGOV \) is real Federal government expenditure on an administrative budget basis, \( GNP \) is the real gross national product, \( POP \) is the total U.S. population,

\[^6\text{The equation is in non-linear form because of tax graduation, which clearly implies a non-linear relation between average marginal rates on the one hand and real income, the price level, inflation, and possibly government expenditure on the other hand. The personal income tax obviously is graduated. In a limited sense, the corporate income tax can be considered graduated, too. Throughout much of its history, notably during wars, excess profits taxes were imposed on corporate income; these introduced a weak element of graduation. In any event, the regression results for a linear equation are qualitatively the same as those reported for (2).}\]
GNPD is the GNP deflator, CONG is a measure of Democratic control of the U.S. Congress, PRES is a dummy equal to one when a Democrat sat in the White House and zero otherwise, WW1 is a World War I dummy equal to one in 1917–1919 and zero otherwise, WW2 is a World War II dummy equal to one in 1941–1946 and zero otherwise, KW is a Korean War dummy equal to one in 1950–1953 and zero otherwise, VNIV is a Vietnam War dummy equal to one in 1966–1970 and zero otherwise. All data are annual. These variables and the sources of data are described in more detail in the appendix.

An increase in government expenditure relative to GNP generally will raise average marginal tax rates, as already discussed; so $a_1$ should be positive.

The next two variables are meant to capture countercyclical tax policy. When nominal GNP rises, tax rates should rise through both discretionary and automatic effects. The effects might differ depending on whether real GNP or prices rise, so these two components of nominal GNP are entered separately. As discussed above, it is not clear a priori whether price effects are better captured by the price level or the inflation rate; so both variables are entered. The coefficients $a_2$, $a_3$, and $a_4$ should be positive if significant; but it seems unlikely that price level and inflation effects should matter at the same time, so I expect only one of $a_3$ and $a_4$ to be significant.

The next two variables indicate the extent of Democratic Party control of the Federal government. The CONG variable is described in the appendix. Under the usual hypothesis that Democrats are more inclined than Republicans to favor heavier taxation of the rich and less inclined to worry about market incentives, $a_3$ and $a_6$ should be positive.

The next four variables are war dummies. Their meaning is most easily discussed later.

The final variable is a time trend. As mentioned above, Barro's theory of deficits and taxes implies that the deviation of tax rates from trend should be unrelated to the deviations of other variables from their trends. Inclusion of a time trend term has the effect of detrending all variables in the equation so that the coefficients of the remaining explanatory variables can be interpreted as the effects of those variables' deviations from trend upon the dependent variable's deviation from trend. See Klein (1974). Insignificance of the trend term implies that changes in the explanatory variables due to trend have the same effects as changes due to deviations from trend. Consequently, Barro's theory requires that the time trend term be significant.

Regression of (2) was carried out in first-difference form to correct for the possible heteroskedasticity implied by the double-log form of (2). Examination of the pattern of residuals showed serial correlation of the first, second, and third orders. The TROLL package being used for this study has canned routines for first and second order serial correlation correction but not for third order correction. Consequently, I decided to use Durbin's
method to correct for the three orders of serial correlation. Durbin’s method is a simple two-step procedure, but it uses up a large number of degrees of freedom with so many independent variables and orders of serial correlation. Unfortunately, to be valid, the method requires a fair number of degrees of freedom. To circumvent this impasse, I first ran the first-differenced form of (2) with TROLL’s second order correction routine.\(^7\) I then discarded the insignificant variables, except the constant, and ran the equation with Durbin’s method.\(^8\)

When the dependent variable was the personal marginal tax rate, the independent variables that remained significant after second order correction were \(FGOV_t/GNP_t\), \(GNP_t/POP_t\), and \(GNPD_t/GNPD_{t-1}\). Thus these three variables, plus a constant, were included in the Durbin’s method of estimation with the following results:

\[
\log \text{PERMTR}_t = -\log \text{PERMTR}_{t-1} = -0.002 \\
(0.011)
\]

\[
+0.539 \left( \log \frac{FGOV_t}{GNP_t} - \log \frac{FGOV_{t-1}}{GNP_{t-1}} \right) \\
(0.052)
\]

\[
+0.807 \left( \log \frac{GNP_t}{POP_t} - \log \frac{GNP_{t-1}}{POP_{t-1}} \right) \\
(0.238)
\]

\[
+0.729 \left( \log \frac{GNPD_t}{GNPD_{t-1}} - \log \frac{GNPD_{t-1}}{GNPD_{t-2}} \right) \\
(0.298)
\]

\[
R^2 = 0.6971, \quad \rho_1 = -0.12, \quad \rho_2 = -0.31, \quad \rho_3 = -0.49. \quad (3)
\]

where \(\text{PERMTR}\) is the average personal marginal tax rate and \(\rho_i\) is the \(i\)th order serial correlation coefficient. Numbers in parentheses are standard errors. The sample period is 1917–1975.\(^9\) All variables are significant at the 1

\(^7\)This is an iterative Cochrane-Orcutt routine.

\(^8\)The most important drawback to the two-step approach is that variables that are insignificant under a second order correction might become significant under a third order correction. To provide some check on this possibility, I examined the \(t\)-statistics on all coefficients estimated with no correction, a first order correction, and a second order correction. These \(t\)-statistics changed little for the insignificant variables and were quite low. Such stability suggests that the \(t\)-statistics would not have reached the significance level under a third order correction.

\(^9\)The sample period starts with 1917 rather than 1913 because first differencing uses up one observation and Durbin’s third-order serial correlation correction uses up three more.
percent level except the constant, which is not significant at any reasonable level. Because (3) is a first difference equation, the constant is the coefficient of the time trend in (2). The $R^2$ is reasonably high for a first difference regression.10

When the dependent variable was the corporate marginal tax rate, the independent variables that remained significant after second order correction were $FGOV_t/GNP_t$, $GNPD_t$, and $WWI$. These three variables plus a constant were included in the Durbin's method of estimation with the following results:

$$
\log CORMTR_t, \\
- \log CORMTR_{t-1} = -0.014 \\
(0.047) \\
+ 0.535 \left( \log \frac{FGOV_t}{GNP_t} - \log \frac{FGOV_{t-1}}{GNP_{t-1}} \right) \\
(0.147) \\
+ 1.830 \left( \log GNPD_t - \log GNPD_{t-1} \right) \\
(0.524) \\
+ 0.668 \left( \log WWI_t - \log WWI_{t-1} \right). \\
(0.182)
$$

$$
\bar{R}^2 = 0.6439, \quad \rho_1 = 0.24, \quad \rho_2 = -0.36, \quad \rho_3 = -0.45. \quad (4)
$$

where $CORMTR$ is the average corporate marginal tax rate and the sample period is 1913–1975. Again, all variables are significant at the 1 percent level except the constant, which was insignificant at any reasonable level; and, again, the $R^2$ is reasonably good.

Let us examine these results in some detail. First, the time trend never is significant. It was not significant in the second order correction regression; nor was it significant in the Durbin's method regression, as evidenced by the insignificant constant term in (3) and (4). Thus changes in the explanatory variables due to trend and to deviations from trend have identical effects on average marginal tax rates.

10An anonymous referee has pointed out that the calculation of $PERMTR$ for the years 1913–1915 is very crude, as discussed in section 2.1. The errors involved may have significant impacts on the regression results, especially because these cruder estimates are the starting values for the $PERMTR$ series.
Second, none of the political variables is significant. Thus, despite campaign rhetoric, it seems the Republicans and Democrats have indistinguishable records on marginal tax rates.

The share of GNP purchased by the government is the only variable significant in both (3) and (4). Its significance in (3) has an especially interesting implication. Since the beginning of the New Deal, a great deal of the growth of federal spending has been in social welfare expenditures, most of which are at least partly designed to redistribute income from the wealthy to the poor. The fact that this growth has been accompanied by an increase in the average marginal personal income tax rate suggests that government welfare programs may redistribute income in two ways: by spending the welfare money predominately on the poor and by making the income tax even more progressive than it otherwise would have been. Of course, high average marginal rates do not necessarily indicate progression, so this issue will be explored further in the next section.

The significance of real GNP in (3) suggests that taxes rise in business booms and fall in recessions. How much of this effect is automatic and how much is discretionary cannot be told from this result and will be explored further in the next section. However, if countercyclical tax changes were discretionary, one would expect GNP to be significant in (4), too; but it is not. Note that, because of the way the data were constructed, changes in corporate rates can reflect only changes in the law (i.e., discretionary changes), whereas changes in personal rates can reflect either legal changes or automatic stabilization effects. Thus the insignificance of GNP in explaining corporate rates at a minimum means that these rates simply are not used for discretionary purposes. In addition, it probably means that changes in personal rates are not discretionary, either; but more on this in the next section.

Next, consider the results on the price level and the inflation rate. In explaining personal tax rates, the former is not significant but the latter is. I interpret these results to mean that Congress does not suffer money illusion but does have imperfect expectations. Thus, should the price level rise once and for all, Congress recognizes that real incomes have not changed even though nominal incomes have; and it adjusts the tax schedules to offset the price rise, rendering insignificant the $\text{GNPD}_t$ term in (3). In contrast, when the inflation rate rises, it takes Congress a while to recognize that the price changes it observes will keep happening; consequently, Congress fails to anticipate and properly keep up with price changes, rendering the $\text{GNPD}_t/\text{GNPD}_{t-1}$ term significant in (3).

Surprisingly, it is the price level and not the inflation rate that is significant in explaining corporate tax rates. The significance of $\text{GNPD}_t$ is all

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1For some evidence that welfare programs indeed do transfer income to the poor, see Browning (1975).
the more surprising given that real GNP is not significant and that, as already noted, the corporate rate series can only reflect discretionary and not automatic effects. What kind of countercyclical tax policy is being used here? The results say that the corporate tax law is changed to combat high (but not rising) prices but not to combat recessions, etc. This seems implausible to me. In fact, I suspect that this result is a statistical artifact arising from collinearity between $G_{NP1}$ and $G_{NP1}/G_{NP1-1}$. These variables are systematically related, one being the rate of change of the other. If their cycles were perfect sine waves, $G_{NP1}/G_{NP1-1}$ would lead $G_{NP1}$ by a quarter of a cycle. The correlation of their first differences is 0.52, not especially large but not small, either. Also, if $G_{NP1}/G_{NP1-1}$ replaces $G_{NP1}$ instead of being run simultaneously with it, then it becomes significant (and, interestingly, the World War I dummy drops out). Still, I cannot be sure how to interpret the inflation and price level results from eq. (4).

Finally, the war dummies generally are insignificant. The only exception is the First World War dummy in (4), and, as just explained, this result may be a statistical artifact. If, however, the World War I dummy result is taken at face value, then visual examination of the data in table 2 suggests an explanation for this exception. From 1909 through 1916, the effective corporate marginal tax rates were very low. In 1917 they jumped up tremendously and only fell back moderately after the War. They never approached the low levels that prevailed before the War. I suspect that the tax rates were low in 1909 because the income tax itself was new and probably being handled gingerly by the politicians of the day. The rates may have stayed low because of a political partial adjustment process. Changes in the law are controversial and often costly to politicians; consequently, such changes occur slowly. The War provided an opportunity to move the tax rate quickly to its long-run equilibrium level without paying any severe political cost. In any event, with this one exception, the war dummies are irrelevant once government spending, output, and price behavior are considered.

The implications of these results for Barro’s theory of deficit finance are mixed but mostly seem to reject the theory. On the one hand, the elasticity of both personal and corporate average marginal rates with respect to the federal government’s share of GNP is about 0.535 and is significantly less than 1.0. This result is consistent with Barro’s theory in that large swings in government expenditure are not matched by equiproportionate swings in tax rates; in particular, abnormally high expenditure would be financed disproportionately by deficits.

On the other hand, the remaining results reject Barro’s theory. The insignificance of the constant (i.e., time trend) term in (3) and (4) means that, for each of the remaining explanatory variables, trend movements and
deviations from trend have the same effects on average marginal tax rates. According to Barro's theory, none of the deviations from trend should have been significant. The results on the war dummies confirm the indistinguishability in the effects of trend and deviations from trend. Wars are times of very high expenditures that are clearly transitory. If Barro's theory were correct, then for a given level of $F_{GOV}/GNP$, one would observe lower tax rates during wars than at other times. Thus Barro's theory predicts significantly negative effects of the war dummies in (3) and (4). Yet the dummies are not significant, with the possible exception of the significantly positive World War I variable in eq. (4).\footnote{In fact, the war dummy coefficients were almost always positive. The only exception was $\text{WW}2$ in eq. (4), which had a negative coefficient. Of course, not much weight can be placed on these point estimates because of the low $t$-statistics (always less than 0.85 in magnitude).}

Thus, taken as whole, the results seem to reject Barro's theory of deficit and tax finance.

3.3. Structure of the graduated income tax

I now turn to an examination of the graduation structure of the personal income tax. Such an examination is interesting for two reasons. First, it will aid in interpreting some of the time series results just discussed. Second, of course, it is interesting in its own right to see how the graduation structure responds to various economic forces.

A graduated income tax means by definition that, for any given year, the marginal tax rate increases with the income of the taxpayer. In general, then,\footnote{In fact, the war dummy coefficients were almost always positive. The only exception was $\text{WW}2$ in eq. (4), which had a negative coefficient. Of course, not much weight can be placed on these point estimates because of the low $t$-statistics (always less than 0.85 in magnitude).}

$$PERMTR (X,t) = f(X_x),$$

where, as in section 2.1, $X$ is both the income at the midpoint of a tax bracket and the index for that bracket (or income class, as it was called in section 2.1); and $PERMTR (X,t)$ is the marginal tax rate for bracket $X$ at time $t$. The fact that the tax is graduated means that $f'' > 0$ but in itself implies nothing at all about the sign of $f''$. Perhaps an examination of optimal tax theory would shed some light on the sign of $f''$; I have not attempted such an examination. One simple explicit form for $f$ that captures these properties and that is econometrically tractable is

$$f(X_x) = a_0 X_x^{a_1}, \quad 0 < a_0, \quad 0 < a_1 \leq 1.$$
the tax law:

\[ a_0 = g_0(Z_t), \quad a_1 = g_1(Z_t), \quad \text{so that} \]

\[ \text{PERMTR}(X, t) = [g_0(Z_t)]X^t^{[g_1(Z_t)]}, \quad \text{or} \]

\[ \log \text{PERMTR}(X, t) = \log [g_0(Z_t)] + [g_1(Z_t)] \log X_t. \]

Unfortunately, the multicollinearity problems with this formulation seem severe, so the subsequent analysis concentrates on the simplification where \( a_0 \) is constant:

\[ \text{PERMTR}(X, t) = a_0X_t^{[g_1(Z_t)]}. \]

The results from the preceding section show which variables affect marginal rates on average. It seems reasonable to suppose that the vector \( Z \) comprises a subset of those variables. To know exactly what form the function \( g_1 \) takes requires a more detailed theory than is within the scope of this paper, so I simply conjecture the following fairly general form:

\[ g_1(Z_t) = b_0 + b_1 \log \left( \frac{FGOV_t}{GNP_t} \right) \]

\[ + b_2 \log \left( \frac{GMP_t}{POP_t} \right) + b_3 \log \left( \frac{GNPD_t}{GNPD_{t-1}} \right). \]

Thus one obtains the following function for marginal tax rates:

\[ \text{PERMTR}(X, t) = a_0X_t^{[g_1(Z_t)]}, \]

where \( 0 < a_0, b_0 \). Without a deeper theoretical analysis, I see no way to predict the signs of \( b_1, b_2 \) and \( b_3 \).

Eq. (6) can be re-written in logarithmic form:

\[ \log \text{PERMTR}(X, t) = \log a_0 + b_0 \log X \]

\[ + b_1 \log \left( \frac{FGOV_t}{GNP_t} \right) \log X \]

\[ + b_2 \log \left( \frac{GMP_t}{POP_t} \right) \log X \]

\[ + b_3 \log \left( \frac{GNPD_t}{GNPD_{t-1}} \right) \log X, \quad \text{or} \quad (7) \]

\[ \log \text{PERMTR}(X, t) = c_0 + c_1v_1 + c_2v_{2t} + c_3v_{3t} + c_4v_{4t}, \quad (7') \]
where

$$v_1 = \log X, \quad v_2 = \log (\text{FGOV}_t/\text{GNP}_t) \log X.$$  

$$v_3 = \log (\text{GNP}_t/\text{POP}_t) \log X, \quad V_4 = \log (\text{GNPD}_t/\text{GNPD}_{t-1}) \log X.$$  

Eq. (7') makes it clear that this is a pooled cross-section time-series estimation problem with the cross-sectional elements being the tax brackets and the time-series elements being the aggregate variables from the previous section.

Before (7) can be estimated, the cross-sectional units must be standardized. Two sources of variation must be filtered out. First, Statistics of Income reports brackets in nominal terms. As shown in the previous section, changes in the price level have no effect on the average marginal tax rate, implying that Congress attempts to base tax payments on real incomes. Consequently, the nominal brackets must be converted to real terms. This was done by deflating each $X$ for a given year by $\text{GNPD}$ for that year. Second, real income tax brackets do not coincide across years. One reason for this lack of coincidence is the deflation procedure just described. If the nominal brackets for two years are identical but the price level is different, then the real brackets cannot coincide. The other reason is that Statistics of Income does not use the same nominal brackets each year. Some years it uses many fairly fine brackets; other years it uses only a few coarse brackets.

A detailed description of the method used to standardize brackets is available on request, but the basic idea is illustrated by the following example. The year with the fewest brackets was chosen as the base year; the brackets for all other years were forced to conform to those of the base year. The base year happened to be 1964. Suppose the first two brackets for 1964 were $0$ to $5,000$ and $5,000$ to $10,000$. Suppose that the first two brackets for some other year, say 1970, were $0$ to $7,500$ and $7,500$ to $10,000$ and that the marginal tax rates for these two brackets were computed to be 10 percent and 20 percent. Then the standardized brackets for 1970 would be $0$ to $5,000$ and $5,000$ to $10,000$ with marginal rates of 10 percent and $[(7,500-5,000)/(10,000-5,000)](10) + [(10,000-7,500)/(10,000-5,000)](20) = 15$ percent.

These standardized brackets and the corresponding marginal tax rates were substituted into (7), which was then estimated by the Parks method for pooled cross-section time-series data.\textsuperscript{13} The resulting estimates were

\textsuperscript{13}This method is part of the SAS package and is described in detail in Kmenta (1971, pp. 512-514). It treats the estimating equation as a cross-sectionally correlated and time-wise autoregressive model, where the serial correlation is of the first order. This last assumption regarding the order of serial correlation is questionable given the results of section 3.1, but programming limitations prohibited altering the canned program to expand the serial correlation structure to one of first, second, and third order.
completely meaningless, with a number of significant but incorrect signs. Further investigation isolated the trend component of \( \text{GNP}_t/\text{POP}_t \) as the source of the trouble; when per capita \( \text{GNP} \) was expressed as a deviation from trend, the estimates made sense and were consistent with the results of the previous sections.\(^{14}\) The results were

\[
\log \text{PERMTR} (\bar{X}, t) = -7.584 + 0.587 \log \bar{X} \\
\quad + 0.03 \log \left( \frac{\text{FGOV}_t}{\text{GNP}_t} \right) \log \bar{X} - 0.012 \log \left( \frac{\text{GNP}_t}{\text{POP}_t} \right) \log \bar{X} \\
\quad + 0.0961 \log \left( \frac{\text{GNDP}_t}{\text{GNDP}_{t-1}} \right) \log \bar{X},
\]

where \( \bar{X} \) is standardized income, \( \text{PERMTR}(\bar{X}, t) \) is the personal marginal tax rate corresponding to \( \bar{X} \) in year \( t \), and \( (\text{GNP}_t/\text{POP}_t)* \) is the deviation of real per capita \( \text{GNP} \) from trend. The sample period was 1916–1975.\(^{15}\) The \( R^2 \) was 0.60, which is good for a first difference regression.

The constant and first two variables were significant at the 1 percent level; the other variables all were insignificant even at the 10 percent level. Thus an individual's marginal tax rate is determined by his tax bracket and by the level of Federal government spending.

The significance of \( \text{FGOV}_t/\text{GNP}_t \) supports the interpretation of the previous section that Federal welfare expenditures, which are responsible for most of the post-Depression growth in \( \text{FGOV}_t/\text{GNP}_t \), have a double effect on redistribution, one part of the effect coming through the expenditure of funds and the other part, demonstrated by the results of this and the previous section, coming through an increase in the progressivity of the income tax.

To interpret the insignificance of \( (\text{GNP}_t/\text{POP}_t)* \) and \( \text{GNDP}_t/\text{GNDP}_{t-1} \), note the nature of the dependent variable. \( \text{PERMTR}(\bar{X}, t) \) is the effective marginal tax rate for the given bracket \( \bar{X} \). Given the tax law, there will be no changes in \( \text{PERMTR}(\bar{X}, t) \) through changes in the level or distribution of nominal income. Therefore, \( (\text{GNP}_t/\text{POP}_t)* \) and \( \text{GNDP}_t/\text{GNDP}_{t-1} \) can be significant in eq. (8) only if changes in them cause changes in the tax law. Both these variables are insignificant in (8), so the conclusion must be that the tax law is insensitive to them. This conclusion then implies that the significance of these variables in explaining the average marginal tax rate, as

\(^{14}\)When the trend component was included as a separate variable along with the deviation component, perverse results emerged again. I am unable to explain why the trend in \( \text{GNP}/\text{POP} \) has these effects.

\(^{15}\)The sample period had to start in 1916 rather than 1913 because, as mentioned in section 2.1, tax data was not reported by income classes until 1916.
shown in eq. (3), must arise entirely from automatic stabilization effects and bracket creep. It appears, then, that discretionary changes in the personal income tax have not been used to stabilize real output or to combat inflation. Thus the inside lag with respect to this fiscal policy tool seems to be infinite.

4. Conclusion

In this paper, I have constructed true marginal tax rates for the Federal personal and corporate income taxes. These series and their methods of construction should be useful to economists in future research.

I also have analyzed these series and have found that they can be explained by a very few variables. In particular, the personal average marginal tax rate is explained by federal government expenditures as a share of GNP, GNP per capita, and the inflation rate. The corporate average marginal tax rate is explained by federal government expenditures as a share of GNP, the price level, and a World War I dummy. It is noteworthy that political variables have no explanatory power.

The time series results give mixed results on Barro's theory of deficit finance but as a whole seem to reject it. On the one hand, the low elasticity of tax rates with respect to expenditures as a share of GNP is consistent with Barro's theory; on the other hand, all the other results contradict it.

The cross-section time-series results suggest that an individual's marginal tax rate is determined by his tax bracket and government expenditure as a share of GNP. The failure of GNP per capita or the inflation rate to have any explanatory power suggests that the reason these variables have explanatory power in the time series regressions is that they cause endogenous changes in taxable income, not because tax rates are adjusted in a discretionary way for stabilization purposes. The significance of government expenditure as a share of GNP suggests that federal welfare expenditures redistribute income not only through the expenditure of funds (which would raise average tax rates) but also by making the income tax more progressive.

Appendix

In this appendix, I describe the sources of data and methods of construction underlying the variables used in section 3.

expenditures were no longer reported and so were taken to be the same as 'total outlays of the Federal government from Federal funds', reported for 1968 in the Economic Report of the President, 1975, p. 325 and for 1969–1976 in the Economic Report of the President, 1978, pp. 338–339. Calendar year expenditures were obtained by averaging the current and succeeding fiscal year tables.


CONG is measured in two ways. The first, CONG1, is a dummy variable equal to one when the Democrats controlled both houses of Congress (in only two sessions of Congress did the Democrats and Republicans each control one house). The second, CONG2, is the percentage of the total number of seats in both houses of Congress held by Democrats, where the total number of Senate seats and the number of Senate seats held by the Democrats have been multiplied by the ratio of House seats to Senate seats to scale them up to equipropportionality with the House numbers. All data on the composition of Congress are from Historical Statistics of the United States, Colonial Times to 1970, p. 1083 and Statistical Abstract of the United States, 1979.

PRES is a dummy equal to one when a Democrat sat in the White House and zero otherwise. Data is from Historical Statistics of the United States, Colonial Times to 1970, p. 1083.

References

U.S. Congress, 1959, Historical data pertaining to the individual income tax, 1913-1959, Staff of the Joint Committee on Internal Revenue Taxation (Washington, DC).
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