Forecasting Individual Income Tax Revenues: A Technical Analysis

Special Study

August 1983

CONGRESS OF THE UNITED STATES CONGRESSIONAL BUDGET OFFICE

FORECASTING INDIVIDUAL INCOME TAX REVENUES: A TECHNICAL ANALYSIS

The Congress of the United States
Congressional Budget Office

PREFACE

Reliable estimates of federal spending and revenues, and a clear understanding of associated issues, are important to the budget process. The Congressional Budget Office (CBO) has developed elaborate techniques to generate budgetary estimates and to analyze issues affecting spending and revenue totals. In order that these procedures and issues can be evaluated by those outside the agency, it is CBO's practice to provide published analyses of its estimating procedures and of current issues related to major spending items and revenue sources. This paper provides such analysis for individual income tax revenues, the largest single component of federal receipts.

The study was prepared by Frederick Ribe and Kathleen O'Connell of CBO's Fiscal Analysis and Tax Analysis Divisions, respectively, under the direction of Rosemary Marcuss. Mr. Ribe is the principal author. Ms. O'Connell is responsible for parts of Chapters II and IV, and provided expert advice during all other phases of the project. Others to whom the authors are grateful for valuable comments are Timothy Considine, Edward Gramlich, Robert Hartman, Frank de Leeuw, Robert Lucke, Steven Malin, Joseph Pechman, and James Verdier. Susan Goeransson, Debra Holt, and Naif Khouri provided research assistance, Patricia H. Johnson edited the manuscript, and Shirley Hornbuckle and Linda Brockman typed it for publication.

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August 1983

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SUMMARY

Developing budgetary and revenue forecasts to provide assumptions underlying congressional concurrent resolutions on the budget is an important function of the Congressional Budget Office (CBO). This paper describes major aspects of the techniques used by CBO to forecast revenues from the individual income tax: procedural methods, accuracy, comparison with other techniques, and implications about the future behavior of individual income tax revenues.

AVAILABLE REVENUE ESTIMATING TECHNIQUES

The most prominent available technique for estimating revenues from the individual income tax is the large-scale "microanalytic" model. This model consists mainly of a detailed computer-based miniature replica of the taxpaying population of the United States. The revenue implications of different economic conditions and statutory tax provisions are analyzed by calculating the effects that they would have on the liabilities of taxpayers in different categories, and then adding these estimates together to predict the economy-wide impact.

From a practical perspective, large-scale models are versatile and accurate, but also cumbersome and expensive. These models are especially useful for estimating the revenue implications of changes in tax statutes, which sometimes require detailed analysis that only this technique offers. On the other hand, the elaborate computations of large-scale models are sometimes unnecessary to estimate how revenues change from year to year in response to changes in economic conditions. In fact, if no significant changes in tax statutes occur, such year-to-year revenue forecasts are sometimes developed using extremely simple procedures consisting primarily of a rule of thumb for predicting growth in taxes on the basis of the growth rate of aggregate income. Of course, periods in which the tax structure is unchanged are rare, especially since enactment of the Economic Recovery Tax Act of 1981 (ERTA), which mandated a series of important changes in the structure of the income tax over five years.

THE CBO TAX MODEL

CBO's income tax model represents a compromise between the relatively complex and relatively simple alternatives just described. Al-

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though much smaller than large-scale models, it contains enough detail to account for the revenue implications of the significant current and prospective changes in the tax structure.

Essentially, the CBO model consists of four equations that determine how important constituent parts of the tax have behaved over long periods of time. When combined with current institutional information on statutory tax rates, brackets, and exemption levels, these equations permit forecasts of individual income tax liabilities and federal budget revenues from the individual income tax to be generated on the basis of a separate economic forecast of such variables as personal income, employment, and the price level. The model is designed specifically to account for the effects of several important recent and current developments on the income tax. These are:

- Changes in statutory tax bracket rates, such as those entailed in the Economic Recovery Tax Act of 1981;

- "Bracket creep," or the movement of taxpayers' incomes upward through the bracket structure as a consequence of inflation or productivity growth;

- Indexation of statutory tax brackets and the personal exemption, which is scheduled to take effect in 1985; and

- Cyclical swings in aggregate income.

The main advantages of the model are that it is of manageable size but still accurate and versatile enough to account for many different economic and legislative developments that affect individual income tax revenues. Unlike the other forecasting methods, the CBO model is well-documented and open to scrutiny and constructive criticism by tax professionals (or anyone else). Moreover, since the CBO procedure is different from most other techniques, it can provide a check on their accuracy.

The analysis of overall individual income tax revenues is divided into four parts. The first part produces an estimate of the tax base (gross taxpayer income minus all deductions and exemptions) on the basis of an economic forecast derived separately by CBO's Fiscal Analysis Division, together with assumptions concerning relevant provisions of the tax code. The economic forecast (covering gross national product (GNP), prices, employment, and other variables) is developed in the Fiscal Analysis Division separately from the revenue forecast developed in the Tax Analysis Division and the outlay forecast in the Budget Analysis Division. The three forecasts are, however, adjusted in light of one another to ensure consistency. Sometimes several different adjustments are made before a final set of forecasts is derived.

The second part of the analysis predicts the effective tax rate that applies to the tax base developed in Part 1. This computation involves predicting the pattern by which the tax base will be spread over the statutory tax bracket structure and how this pattern changes through bracket creep. By taking detailed account of the statutory characteristics of the bracket structure, this part of the model permits analyses of various changes in statutory bracket boundaries and rates, such as the changes mandated by ERTA.

The third part of the model develops a forecast of aggregate tax liabilities before credits using the results from Parts 1 and 2. Finally, the fourth part generates and incorporates estimates of tax credits and other tax items, and applies timing and other accounting adjustments to the tax liability forecast to derive a forecast of budget revenues from the individual income tax.

The Forecasting Record

The most important test of the reliability of any forecasting model is a comparison of the record of its forecasts, together with those of alternative procedures, to actual data after the forecasting period is completed. CBO's model is quite new, and therefore doesn't have an extensive record. Nevertheless, CBO has developed evidence on the model's reliability by developing "ex post" (or after the fact) forecasts of revenues in past years. This is done by putting oneself in the position of an imaginary forecaster several years ago who is using the CBO model to forecast revenues in later years that by now have been observed.

CBO has developed figures comparing the accuracy of ex post forecasts by its tax model with the Treasury Department's published individual income tax revenue forecasts for the same years. Attention is restricted to forecasting errors caused by technical inaccuracy in the procedures as opposed to errors resulting from inaccurate assumptions about the economy and about the passage of tax legislation affecting revenues. CBO's average errors for forecasts one, two, and three years into the future were all smaller than CBO's estimates of corresponding Treasury Department errors. Overall, these figures show that the CBO model is quite accurate, and compares favorably with alternative procedures.

Responsiveness of Individual Income Tax Revenues to Changes in Income

As this discussion has already noted, much interest centers on summary measures of the response of overall tax revenues to changes in the economy. Several recent developments, moreover, have altered the responsiveness of the tax. For example, the ERTA rate cuts that make the tax less progressive by reducing the top rates have likewise made it less responsive to economic changes, and the ERTA provision calling for indexation of certain tax provisions to the Consumer Price Index starting in 1985 will reduce the responsiveness even more.

The CBO income tax model can be used to calculate the response of revenues to different economic developments under various configurations of the tax laws. For example, under the bracket tax rates that will be in effect during 1984--following all the reductions that were mandated in ERTA--simulations with the model show that the responsiveness of tax liabilities to changes in GNP depends significantly on whether the GNP change primarily reflects inflation or represents a change in real output. Revenues change more sharply when GNP changes because of inflation rather than other factors. This occurs because increases in GNP resulting from inflation alone are taxed at higher rates as taxpayers are pushed into higher tax brackets. In quantitative terms, individual income tax revenues may grow as much as 70 percent faster than GNP if nominal GNP growth is entirely due to inflation.

By contrast, when GNP increases because of an increase in real output, some of the resulting income accrues to existing workers as a result of productivity increases, and this can cause bracket creep for these individuals. At the same time, however, much of the increase in aggregate income accrues to new workers who are drawn into employment by the upswing in the economy. New workers' incomes are taxed at relatively low rates, and this makes the responsiveness of income tax revenues to changes in real GNP relatively small. Estimates from the CBO model suggest that revenues increase roughly 30 percent faster than GNP when the GNP change is entirely real.

When the tax structure is assumed to be indexed to the price level, as it will be in 1985 and later years under the terms of ERTA, the tax will be more responsive to changes in aggregate income that are primarily "real" than to those that reflect inflation. Indexation prevents inflation from causing bracket creep, and this reduces the strength of the revenue response to inflation. Estimates from the CBO model suggest that revenues under the indexed income tax will grow at roughly the same rate as GNP when the GNP change is entirely due to inflation. This is a dramatic reduction in responsiveness from that in the unindexed tax, where revenues are estimated to grow as much as 70 percent faster than income under the same conditions. Income increases that result from strong growth in real output, by contrast, accrue in part to new workers and in part to existing workers as a consequence of growth in productivity. Productivity growth can cause these workers' incomes to move into higher tax brackets without protection from indexation, which is designed to eliminate bracket creep only when it results from inflation. Thus, some bracket creep may occur in response to real economic growth under the indexed income tax. As a result, CBO estimates that revenues from the indexed income tax will grow 30 percent faster than GNP if the GNP change is entirely real.

Economic Effects of Indexation

The shift in the behavior of the income tax that will be caused by indexation may have significant implications for the economy. Taxpayers will gain because indexation will protect them from unlegislated tax increases caused by inflation-induced bracket creep. Increases in economic efficiency may also result since marginal tax rates will be prevented from drifting upward. Indexation could also have adverse impacts, however. It could contribute to the tendency of structural budget deficits to increase over time (in the absence of legislation to control them). The expectation of large and rising deficits, in turn, may help explain the persistently high levels of interest rates, which may ultimately reduce living standards by reducing investment. Indexation may also reduce the value of the income tax as an automatic stabilizer of the economy.

CHAPTER I. INTRODUCTION

A principal responsibility of the Congressional Budget Office (CBO) is to forecast federal revenues and spending in future years under various assumed budgetary policies and economic conditions. Generating such estimates can sometimes be an elaborate process for certain revenue sources and spending programs. Because of its complexity, the individual income tax is one such case. This paper describes the various procedures that are available for estimating individual income tax revenue and, in particular, the nature and forecasting record of CBO's methods.

HOW REVENUES ARE ESTIMATED

Occasionally, when the tax structure is not expected to change, accurate revenue forecasts can be made using simple rules relating the growth of tax liabilities to the projected growth in the economy. This is possible because, during periods in which the tax law has not changed in the past, the response of individual income tax liabilities to growth in the tax base has exhibited some regularity.[1]

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1 The most common summary measure of the response of tax liabilities to income changes is the "tax elasticity," expressing the percentage by which tax liabilities change for every percentage change in income. Estimates of the elasticity are available from several sources. See, for example, Joseph A. Pechman "Anatomy of the U.S. Individual Income Tax," in S. Cnossen, ed., Comparative Tax Studies: Essays in Honor of Richard Goode (North-Holland, 1983). This study reports estimates based on simulation of a microeconomic model as well as others based on time-series regression estimates. See also A. Fries, J. P. Hutton, and P.J. Lambert, "The Elasticity of the U.S. Individual Income Tax: Its Calculation, Determinants, and Behavior," Review of Economics and Statistics, vol. 64 (1982), which reports estimates calculated directly using an analytic formula; and Vito Tanzi, "The Sensitivity of the Yield of the U.S. Individual Income Tax and the Tax Reforms of the Past Decade," International Monetary Fund Staff Papers, vol. 23 (1976), which reports cross-section regression estimates based on data from different states. A number of technical issues surround the estimation of the tax elasticity. These are discussed in Chapter IV.

Often, however, changes in the income tax law are contemplated or enacted, and revenue forecasts must take these changes into account. For example, the Economic Recovery Tax Act of 1981 (ERTA) set in motion a sequence of tax rate cuts in 1981, 1982, 1983, and 1984, and of changes in exemption and tax bracket levels in 1985 and later years. As a result, simple revenue forecasting rules based on an unchanging tax structure are not of much value.

In order to forecast revenues under such changing tax provisions, tax analysts sometimes resort to elaborate computer representations of the tax law and of the taxpaying population.[2] The Treasury Department's Tax Calculator is one such procedure, and others like it are in use by the Congressional Joint Committee on Taxation and under development at CBO. These procedures essentially forecast the taxpaying decisions and calculations of individual taxpayers--grouped together with others like them whenever possible--taking into account the details of the tax code.

While these procedures can be accurate, they are also costly and time-consuming. Moreover, additional problems affecting the accuracy as well as the manageability of the procedures are introduced by the need to generate separate forecasts of certain underlying variables. These are economic and demographic variables that are not included in the formal economic forecast that forms most of the basis for the tax forecast. For example, supplemental forecasts are needed of the distribution of income, the number of dependents claimed by different types of taxpayers, itemized deductions, and certain income items like capital gains that are not covered by the formal forecast of personal income. Forecasts of these

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2 Such models are computer-based samples drawn from the population of U.S. tax returns, consisting of substantially fewer returns than the number actually filed but still representing in a statistically sound manner the characteristics of the taxpaying population. Different amounts of total taxable income, different income distributions, and different tax structures can be assumed, and the corresponding aggregate tax liabilities calculated by recomputing the taxes due on each return in the sample. This method was developed by Joseph A. Pechman and his associates at the Brookings Institution, and is described in Joseph A. Pechman, "A New Tax Model for Revenue Estimating," in Alan T. Peacock and Gerald T. Hauser eds., Government Finance and Economic Development (Organization for Economic Cooperation and Development, 1965); and Joseph J. Minarik, "The Merge 1973 Data File," in Robert H. Haveman and Kevin Hollenbeck, eds., Microeconomic Simulation Models for Public Policy Analysis, vol. 1 (Academic Press, 1980).

items are typically produced using simple rules that may detract from the sophistication and accuracy of the overall procedure. In addition, the need to carry out these supplemental forecasts makes the overall procedure still more cumbersome.

Since agencies that are responsible for budgetary revenue forecasts are sometimes called upon to generate many such forecasts in a short period, the detailed procedures that have just been described can be impractical. Instead, simpler procedures have been developed.

Two-Part Procedures

One simplified approach that is often used by the Treasury Department involves two separate parts. In the first part, a hypothetical "constant-law" revenue forecast is made on the assumption that no change in tax structure has taken place. Then, in a second part, this figure is combined with an estimate of the gain or loss in revenues that is entailed at the forecast level of taxable income by any changes in tax law that have occurred. The overall procedure is streamlined because the "constant-law" estimate in the first part is made using simple procedures for estimating the response of "constant law" revenues to changes in economic conditions. The forecast of the gain or loss in revenue from a given change in tax law in the second part of the procedure is made using a separate and more detailed model like those described in the last section. The overall procedure is nevertheless simplified because this estimate must only be made once for a given change in tax law, and then can be used again and again with minor adjustments as part of the simpler procedure.[3]

Even an occasional need to resort to a detailed tax model can make this two-part procedure cumbersome, however. It means, for example, that if a new tax change is proposed for which a revenue-change estimate has not already been made, the procedure cannot be completed until a revenue-change estimate is made with the detailed model. For this reason, some analysts have developed simplified revenue-change models that are more nearly self contained. The CBO income tax model is one example.

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3 The revenue change estimate can be adjusted for changes in the underlying economic forecast using simple rules.

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THE CBO MODEL

CBO's procedure is an extension of a time-series approach to income tax modeling that has been developed by several economists over the past 20 years.[4] Some of the model's advantages are that it is of manageable size and largely self-contained, but still quite accurate. The procedure incorporates enough detail about the tax structure to account accurately for past and current changes in tax provisions that have significant implications for revenues. Still, the model is quite flexible, primarily because it achieves considerable simplification relative to other approaches by representing the income tax in terms of relatively broad and aggregative characteristics, such as total returns, the ratio of the tax base to personal income, and the pattern by which the tax base is spread over the bracket structure. The behavior of these parts of the tax is forecast by exploiting regularities in their past responses to changes in economic variables whose predicted values are readily available as part of the (separate) economic forecast.

The CBO model accounts more carefully than others for the revenue implications of certain economic developments, such as changes in the rates of inflation and real economic growth. Apart from its technical characteristics, however, attractive features of the model are that, unlike other tax models that are used in the government, it is described in detail in public documents like this publication and can, therefore, be evaluated and criticized by outside analysts. There is value, moreover, in the fact that the approach underlying the CBO model is different from most others

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4 See E. Cary Brown and Richard Kruizenga, "Income Sensitivity of a Simple Personal Income Tax," Review of Economics and Statistics, vol. 41 (1959); William H. Waldorf, "The Responsiveness of Federal Personal Income Taxes to Income Change," Survey of Current Business, vol. 47 (1967); Joseph A. Pechman, "Responsiveness of the Federal Individual Income Tax to Changes in Income," Brookings Papers on Economic Activity, 2, 1973; and Ned Gramlich and Fred Ribe, "More on the Elasticity of the Federal Personal Income Tax" (The Brookings Institution, processed, 1974). Ideally, such models should be developed in combination with larger models to enhance the data set on which the small models are based. A detailed model (a version of the Treasury tax calculator) is being developed at CBO for use in this and other ways. For discussion of ways in which smaller and larger models can be combined, see "General Discussion" in "Responsiveness of the Federal Individual Income Tax to Changes in Income," pp. 426-427.

that are in active use in policy analysis; it therefore provides a check on the reasonableness and accuracy of those procedures.

PLAN OF THE STUDY

Chapter II describes the CBO model in detail. Chapter III provides evidence on the accuracy of the model's forecasts, and Chapter IV presents estimates from the model bearing on current issues in federal revenues.

CHAPTER II. THE CBO INCOME TAX MODEL

This chapter describes CBO's revenue forecasting model for the individual income tax and how it is used. This model was developed for CBO's use in making five-year forecasts of federal budget revenues based on current tax policy. These forecasts are considered by the Congress in developing concurrent resolutions on the budget.

OVERVIEW

The model is designed to account explicitly for the effects of important current developments affecting income tax revenues. These include:

- o Cyclical swings in aggregate income;
- o "Bracket creep," the movement of taxpayers' incomes upward through the progressive tax bracket structure as a consequence of inflation and productivity growth;
- o Changes in statutory tax bracket rates, such as those enacted as part of the Economic Recovery Tax Act of 1981 (ERTA);
- o Indexation of statutory tax brackets, personal exemptions, and the standard deduction, which was also enacted as part of ERTA to take effect in 1985.

Revenue forecasts by this model are based upon--that is, they take as given, or "exogenous"--forecasts by CBO's Fiscal Analysis Division of macroeconomic variables, such as real GNP, the levels of wages and prices, employment, and other variables.[1] Similarly, values for all statutory tax provisions are specified outside the model.

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1 After a preliminary revenue forecast is made by the Tax Analysis Division, the Fiscal Analysis Division reviews its forecast of GNP, taxable personal income, and other National Income and Product Accounts variables in light of the revenue forecast to ensure that the two are consistent. If necessary, revisions are made in the economic figures. This process of adjustment of the economic forecast to the revenue projection is sometimes repeated several times.

The model itself consists of four parts. The first develops a forecast of the tax base--the narrow Internal Revenue Service "Taxable Income" measure--from the forecast of the broader taxable personal income aggregate in the National Income and Product Accounts (NIPA).[2] This part represents the effects of exemptions and deductions in shielding personal income from taxation and accounts for definitional differences between the tax base and NIPA personal income. The second part derives a weighted-average tax rate that applies to the tax base. This involves predicting the way in which the tax base is spread over the structure of statutory tax brackets and combining this prediction with detailed information on statutory tax rates. The third part of the model represents the derivation of tax liabilities by combining the tax base from the first part with the weighted-average tax rate derived in the second part. Since tax liabilities differ from individual income tax revenues collected by the government because of the timing of tax collections and other factors, the final part of the model adjusts the liability forecast for these factors, yielding a forecast of federal revenues.

This model, while quite detailed and complex, is intended to account directly only for economic and policy developments with major consequences for tax revenues. Tax policy measures with smaller revenue implications must be analyzed separately and their revenue consequences added to the projections of the main model. Examples of measures that currently must be handled separately are changes in capital gains tax provisions and changes in Individual Retirement Account and Keogh plan provisions, among others. Over time, these specific items become incorporated in the estimation of the tax base, but at any point in time recently legislated tax provisions with smaller revenue effects are handled separately.

Each of the four main parts of the model is estimated on the basis of historical data, and is described below in turn. All logs are natural logs.

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2 Taxable personal income (TPY) consists of wage and salary disbursements, personal interest income, personal dividend income, rental income of persons, and farm and nonfarm proprietors' incomes. Equivalently, TPY can be computed as personal income minus government transfer payments and other labor income plus personal contributions for social insurance. Since transfers are excluded and personal contributions for social insurance are included, TPY is the same as Pechman's "adjusted personal income". See "Responsiveness of the Federal Personal Income Tax to Changes in Income," p. 415.

PART 1: FORECAST OF THE TAX BASE FROM TAXABLE PERSONAL INCOME

Approach Used in Earlier Studies

In computing tax liabilities, each taxpayer first subtracts from adjusted gross income a set of "exclusions": one or more personal exemptions and either a "standard" deduction ("zero bracket amount") or a set of itemized deductions. What remains is taxable income, or the "tax base" for that taxpayer.

Most tax models, including that of CBO, analyze this process at the aggregate level, relating the total tax base in the economy to total gross income as well as to variables accounting for changes in the relevant provisions of the tax law. This is simpler than analyzing the decisions of individual taxpayers or groups of taxpayers, and is still quite accurate.

As an additional simplifying step, proxy variables are often used for aggregate adjusted gross income, aggregate itemized deductions, and total tax returns. This procedure is used because none of these variables is normally predicted by formal economic forecasting procedures, and attempts to forecast them separately may not improve the accuracy of the overall analysis of the tax base.

Several earlier studies have used personal income from the NIPA as a proxy for adjusted gross income and total population as a proxy for total returns.[3] Itemized deductions, for their part, have been assumed to be proportional to aggregate gross income so no separate proxy variable is needed.[4] The earlier studies then predict the fraction of aggregate gross income that appears in the narrower aggregate tax base in terms of the levels of gross income per tax return, capital gains per return, the statutory personal exemption, and the statutory standard deduction (zero

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3 See "Income Sensitivity of a Simple Personal Income Tax," "The Responsiveness of Federal Personal Income Taxes to Income Change," and "Responsiveness of the Federal Individual Income Tax to Changes in Income."

4 In addition to the studies cited in footnote 3, this assumption is made in "The Elasticity of the U.S. Individual Income Tax: Its Calculation, Determinants, and Behavior." Other analysts have pointed out, however, that the assumption is sometimes violated in practice and that the behavior of the tax can be affected significantly. See David Greytak and Richard McHugh, "Inflation and the Individual Income Tax," Southern Economic Journal, 45 (1978).

bracket amount). Once the fraction of gross income appearing in the tax base has been determined, it is a simple matter to compute the predicted level of the tax base itself.

Each of the explanatory variables used in these studies should be expected a priori to have an identifiable qualitative effect on the ratio of the tax base to gross income. Other factors being equal, increases in either the personal exemption or standard deduction should reduce the ratio, while increases in gross income per return should increase it. This second effect should occur because increases in income per return may accrue largely to existing taxpayers and thus may not be as well protected from taxation by exemptions and deductions as increases that accrue to new taxpayers. A greater proportion of an income increase accruing to existing taxpayers should, therefore, enter the tax base.

Representation in the CBO Model

The CBO model, like earlier studies, generally follows the approach outlined above. Like most earlier treatments, for example, the model assumes aggregate itemized deductions to be proportional to gross income. The CBO approach departs from the earlier studies in important ways, however. In particular, the CBO model uses total employment instead of population as a proxy for total returns, and taxable personal income from the NIPA instead of personal income as a proxy for aggregate adjusted gross income. Employment, like population, is easily forecast; it is routinely included, in fact, in economic forecasts developed at CBO. Unlike population, however, employment varies over the business cycle. Since total tax returns also exhibit such variation, using employment rather than population prevents the model from overlooking important cyclical aspects in the behavior of returns, as is done in other studies.[5] Taxable

5 In particular, this treatment implies that changes in aggregate gross income that reflect price increases alone are taxed more heavily than are changes in aggregate real income. This is because changes in real income change employment and the number of tax returns. Income per return, therefore, changes less quickly when the income change is real than when it is purely nominal. The quantitative implications of this and other properties of the CBO model are described in Chapter IV.

personal income, similarly, is a closer proxy for adjusted gross income than is personal income, and is also routinely included in CBO economic forecasts.[6]

The estimated equation that results from all these considerations, using historical time-series data for 1954-1980, is

$$
\begin{aligned}
(1)\ \log\left(\frac{Z}{TPY}\right) = & -2.16473 - .25983\left(\log\left(\frac{TPY}{EMP}\right) - \log(ESTAT)\right) \\
& \quad (-18.91) \qquad (-10.35) \\
& -.05442\left(\log\left(\frac{TPY}{EMP}\right) - \log(SDSTAT)\right) \\
& \quad (-2.846) \\
& -.03002 \log\left(\frac{CG}{EMP}\right) \\
& \quad (-2.054) \\
& - .02311\ D6469 \\
& \quad (-2.178) \\
& - .01980\ D7076 \\
& \quad (-2.609)
\end{aligned}
$$

$R^2 = .9809$
Standard error =.01369
Durbin-Watson statistic = 1.3985
Sample period = 1954-1980 (annual data)
(Numbers in parentheses are t-statistics)

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6 Another modification relative to earlier papers is more technical. If increases in taxable personal income per return that are accompanied by increases at the same rate in the personal exemption and deduction (as, for example, under the indexed tax in the face of "pure" inflation in which all prices and wages rise at the same rate), it is reasonable to expect that the tax base should rise at the same rate as taxable personal income. With this concern in mind, the coefficient of the log of taxable personal income per employee was constrained to be equal to minus the sum of the coefficients of the logs of the exemption and standard deduction. The implicit coefficient for log (TPY/EMP) in the estimate shown below is .31425, which differs by .00091 from its value when estimated freely. As this result suggests, the constraint on this coefficient appeared not to be binding: an F test rejects at the 99 percent confidence level the hypothesis that the coefficient of log (TPY/EMP) is not equal to minus the sum of the coefficients of log (ESTAT) and log (SDSTAT).

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Z is taxable income under the individual income tax (the tax base, IRS definition). To ensure consistency with data for earlier years, the figures exclude the zero bracket amount in 1977-1980. (Source: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns, annual issues.)

TPY is Taxable Personal Income (wage and salary disbursements plus personal interest income, personal dividend income, rental income of persons, and farm and nonfarm proprietors' incomes.) (Source: National Income and Product Accounts.)

EMP is total employment (household survey). (Source: Bureau of Labor Statistics.)

ESTAT is the statutory per capita exemption (Source: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns, annual issues.)

SDSTAT is 50 percent of the statutory maximum per-return standard deduction for joint returns (the zero-bracket amount in 1977-1980). (Source: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns, annual issues.)

CG is net capital gains. (Source: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns, annual issues.)

D6469 is a dummy variable that accounts for the presence of the minimum standard deduction during the period 1964-1969.

D7076 is a dummy accounting for the introduction of the low-income allowance during 1970-1976.

This equation does well at explaining the past behavior of the tax base. This is attested by the R^2 statistic, which indicates that the equation explains 98.09 percent of the variation in the tax base as a proportion of taxable personal income. In addition, all of the a priori theoretical suppositions listed above regarding the effects of changes in particular explanatory variables are confirmed by the estimated coefficients.

PART 2: DETERMINING THE EFFECTIVE TAX RATE

How the Effective Tax Rate Works in the Actual Economy

Once each taxpayer has subtracted exemptions and deductions from his gross income, the remaining income (the tax base for that taxpayer) is divided into pieces, or "brackets," and a different tax rate is applied to each. An overall effective tax rate for that taxpayer is determined by the different bracket rates that apply to his income in combination with the amount of his income that is subject to each rate. It is useful to think of the effective tax rate as a weighted average of the different statutory rates, in which the weight attached to each rate is the percentage of the taxpayer's taxable income that is taxed at that rate.

The way that this process works in the aggregate can be conceived in much the same way. Aggregate tax liabilities, L, can be determined using the tax base, Z, determined in Part 1, by applying an aggregate effective tax rate, t:

$$(2)\ L = Zt.$$

As it is for an individual, the effective tax rate for the whole economy is determined by two factors: the set of statutory tax rates that apply to the different brackets and the aggregate amount of taxable income that falls into each bracket and is taxed at the associated rate. Together, these two factors determine the aggregate effective tax rate as a weighted average of the statutory rates that apply to different brackets. Because of their important role in the determination of the effective tax rate in both the actual economy and in the CBO model, each of these two factors is described below in some detail.

The Structure of Brackets and Rates

Four different categories of tax returns have been established, and a different pattern of tax brackets, with a correspondingly different schedule of tax rates, applies to each one. These categories are joint returns and returns of surviving spouses, accounting for 70 percent of the tax base in 1980; returns of single persons (24 percent); returns of heads of households (5 percent); and separate returns of husbands and wives (1 percent).

Prior to 1979, each bracket structure was composed of 25 brackets. Beginning in 1979, however, each has consisted of at least 12 brackets that increase in width as income increases. On joint returns for 1984, for example, the first bracket (after the zero bracket amount), will be $3,400 to $5,500 while the top bracket will be $162,400 and over. The corresponding schedule of tax rates will rise from 11 percent on the first bracket to 50 percent on the last.

How the Tax Base is Spread Over the Bracket Structure

A relatively large percentage of all taxable income falls into the lowest brackets, while increasingly little falls into the higher ones. This is because every taxpayer--including those with high incomes--has some income taxed in the first bracket. Less and less income falls into each succeeding bracket because the incomes of lower-income taxpayers gradually are exhausted and do not reach the higher brackets. As a result, the percentage spread of the aggregate tax base over the bracket structure has a triangular shape: it is high for the low brackets and low for the high ones (see Figure 1).

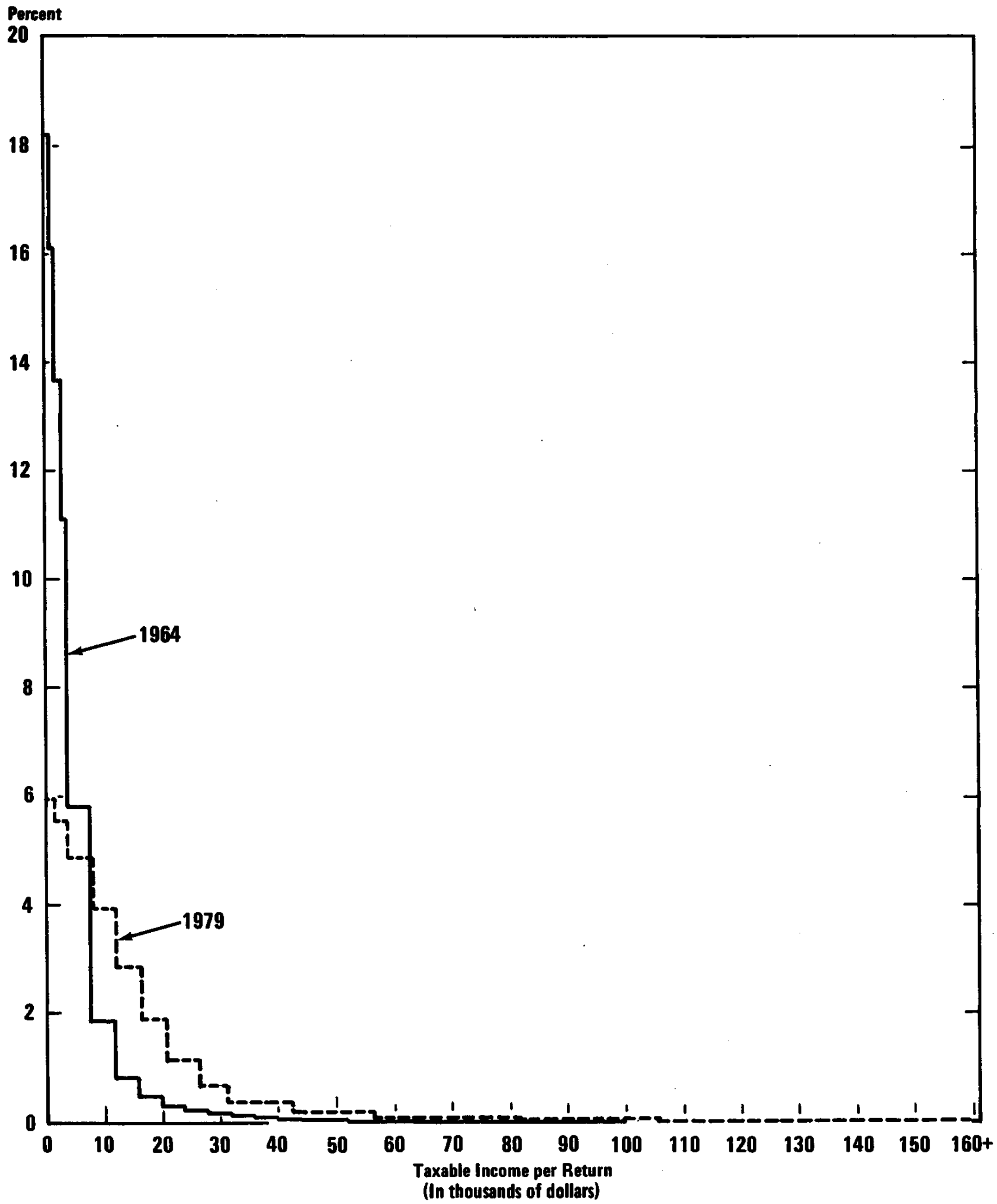
Inflation and productivity growth can bring about an increase in the percentage of total taxable income that appears in the upper brackets of any given category of returns, and a corresponding decline in the percentage appearing in the lowest brackets. Figure 1 provides an illustration of the way this process has worked in the past. The figure shows the bracket structure for joint returns in 1964 and 1979, together with "curves" showing the percentage of all taxable income on joint returns that appeared in each bracket in each of those years. In 1979, the curve was higher for the upper brackets and lower in the bottom brackets.

Modeling Movements of Taxable Income Through the Brackets

It is important to capture the effects of such income movements when forecasting individual income tax revenues. Changes in the rate at which incomes move into higher brackets affect the weights that are associated with different statutory tax rates, with significant implications for the weighted-average tax rate, and, consequently for income tax revenues. In order to explain and predict this process in a tax model, a means is needed first to replicate the distribution of the tax base over the bracket structure (shown in Figure 1) and then to account for the way economic and statutory factors cause it to change. Fortunately, a mathematical tool, the distribution function, is available and is well suited to this job.

A mathematical distribution function is a formula for a curve like those shown in Figure 1. Such formulas typically involve only a few variables, or "parameters," that must be assigned particular values in order to determine the full distribution explicitly. If a distribution function can be found that fits the actual spread of the tax base in different years

Figure 1.
Distribution of Taxable Income for Joint Returns Over the Bracket Structure, for Calendar Years 1964 and 1979.



closely enough, then the parameters of this function can be used as summary measures of the position and movement of the actual distribution. Equations can be developed explaining and predicting the behavior of these parameters in terms of the economic and statutory factors that determine bracket creep in the actual economy. To forecast the effective tax rate, it is necessary only to use these equations to predict values of the parameters; put these values into the mathematical formula to generate a predicted distribution of the tax base; and then use this distribution to calculate the predicted amount of the base that falls into each bracket. When these predicted figures are combined with values of the statutory bracket tax rates, the predicted weighted-average tax rate can be computed.

Treatment in the CBO Model. CBO has found that a relatively simple distribution function having only one parameter, the "exponential" distribution, works well in this role. The formula is

$$(3) \quad f(x) = (1/b)\, e^{(-x/b)}$$

or equivalently

$$\log f(x) = -\log(b) - (x/b) \ .$$

Here e is the mathematical exponentiation operator, b is the parameter, x is the level of the tax base on an individual return (in terms of which the statutory brackets are defined), and f(x) is the height of the curve above that level of the tax base. The percentage of the aggregate tax base that falls into the bracket associated with x dollars of tax base per return is shown by f(x). The parameter to be estimated is b.

An example might clarify how this distribution function is used. Suppose we want to find out how much of the tax base is predicted to fall into the first bracket on joint returns in a given year. Once b is known, each level of x in the first bracket is substituted into the formula, and values of f(x) that are given by the formula for these levels of x are added together.[7] The result is the percentage of the aggregate tax base reported on joint returns that is predicted to fall into the first bracket.

Before any of this can be done, a means of predicting b must be found. This is done in two steps. First, the b value is estimated for each year in the past using detailed data on the income distribution. Then, once

7 "Adding up" of the levels predicted by the exponential distribution is done simply and efficiently by a mathematical process known as "definite integration."

this series of past b values has been developed, it is used to estimate an equation that explains and predicts the behavior of b in terms of other variables.

In the first step, a b value was determined for each year during the 1964-1979 period, using a standard statistical procedure--the maximum likelihood estimator.[8] The second step mainly involved choosing the most appropriate other variables for determining how b behaves.

The most important factor in explaining the movement of the tax base through the bracket structure (represented by changes in b) seems likely to be aggregate income per tax return.[9] A good proxy for this

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8 The Internal Revenue Service has decided not to publish data on this distribution for 1978, 1980, and apparently for subsequent even-numbered years. Adequate information is, however, available in the annual figures published for 1977 and prior years and the semiannual data that will be published subsequently. For discussion of ways to fit and analyze income distribution functions, see Charles Metcalf, An Econometric Model of the Income Distribution (Chicago: Markham, 1972); A.B.Z. Salem and T.D. Mount, "A Convenient Descriptive Model of Income Distribution: The Gamma Density," Econometrica, vol. 74 (1974), pp. 1115-1127; and N.A.J. Hastings and J.B. Peacock, Statistical Distributions (New York: Wiley, 1974). The treatment in this paper is not based on a formal representation of the underlying frequency distribution of taxable personal income. The formal distribution function that is used here represents not the frequency distribution of personal incomes, but the percentage of all taxable income that appears at a given per return taxable income level on tax returns. In fitting the exponential distribution, the dollar amounts in terms of which the statutory tax brackets are defined were expressed in units of $100,000. The mean of the actual distribution in each year was computed by multiplying the lower boundary of each bracket by the percentage of all of the tax base reported on that type of returns that was in that bracket. Then the mean was computed as a weighted average by adding together the figures for all the different brackets. The data on amounts of the tax base falling in different brackets are reported in annual issues of U.S. Treasury Department, Internal Revenue Service, Statistics of Income: Individual Income Tax Returns. For figures for joint returns in 1979, for example, see p. 97, column 23.

9 The distribution of the tax base over the bracket structure (of which b is the mean) is related to, but not equivalent to, the conventional frequency distribution of income (of which per capita income is the

variable, in turn, is some measure of per capita income. This is simply because such movement results directly from changes in per capita income. (Variations in per capita income, in turn, are explained or determined by inflation, real economic growth, and other economic developments that are outside the scope of the tax model.) Using the ratio of the aggregate tax base, Z, to total employment, for example, CBO has estimated the following equations to explain b:

$$(4)\quad \log(b_{jr}) = \underset{(-18.96)}{-3.36733} + \underset{(10.95)}{.68414} \log\left(\frac{Z}{EMP}\right) + \underset{(2.982)}{.11996} \log\left(\frac{CG}{EMP}\right) - \underset{(-4.023)}{.16990}\, D6469 - \underset{(-2.514)}{.06396}\, D7076$$

R^2 = .9929
Standard error = .02422
Durbin-Watson Statistic = 1.7071

$$(5)\quad \log(b_{sr}) = \underset{(-20.57)}{-4.09986} + \underset{(7.089)}{.64559} \log\left(\frac{Z}{EMP}\right)$$

Footnote Continued

mean). For this reason, use of per capita income to explain b is not tautological, as it might at first appear. The relationship between the two distributions is close enough, however, that factors that increase the mean of one also increase that of the other. In particular, one of the main hypotheses of this paper is that inflation increases the means of both distributions more strongly than do cyclical increases in real GNP. This hypothesis is supported in a qualitative way with respect to the frequency distribution by at least one formal study. See A.B.Z. Salem and T.D. Mount, "A Convenient Model of Income Distribution: The Gamma Density," Econometrica, vol. 74 (1974). The argument here is also consistent with empirical evidence developed by Charles Metcalf on the behavior of the distribution of income among families in which both spouses are in the labor force. See Charles E. Metcalf, "The Size Distribution of Personal Income During the Business Cycle," American Economic Review, vol. 59 (1969). Metcalf's evidence for other components of the population, however, is only partially consistent with the present argument, as is that in Lester Thurow, "Analyzing the American Income Distribution," American Economic Review, vol. 60 (1970); and Joseph J. Minarik, "The Size Distribution of Income During Inflation," The Review of Income and Wealth, 4 (1979).

$$- .20467\ D6469 - .10884\ D7076$$
$$(-2.600) \qquad (-2.178)$$

$R^2 = .9674$
Standard error = .04765
Durbin-Watson Statistic = .9447

Estimation period: 1964-1979 (annual data); data for 1978 are excluded because figures for that year are unavailable. (Figures in parentheses are t-statistics.)

b_{jr} is the maximum likelihood estimate of the b parameter for joint returns. (Source: calculations described in text. For purposes of this computation, income per return is expressed in units of $100,000.)

b_{sr} is the maximum likelihood estimate of the b parameter for returns of single persons. (Source: calculations described in text.)

Z is IRS Taxable Income. (Source: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns, annual issues.)

EMP is total employment, (household survey). (Source: Bureau of Labor Statistics.)

CG is net capital gains. (Source: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns, annual issues.)

D6469 is a dummy variable that accounts for the presence of the minimum standard deduction during the period 1964-1969

D7076 is a dummy variable accounting for the introduction of the low-income allowance during 1970-1976.

Predicting Values of the Effective Tax Rate

The above analysis is sufficient to permit predictions of the aggregate effective tax rate to be made. First, predicted values of the tax base, Z, drawn from equation (1) are substituted with actual values for employment, EMP, in equations (4) and (5). These yield predictions of the b parameters determining predicted distributions of taxable income for joint and nonjoint returns. The distribution for each type of return in each year is given explicitly by equation (3) after the b value for that type and year is substituted. The predicted bracket weights (percentages of taxable income predicted for each bracket) are then computed taking into account the statutory boundaries of each bracket. Combining these predicted weights with the corresponding statutory tax rates yields the predicted effective tax rate for each of these two types of returns.

A final step in computing the effective rate is combining the separate effective rates computed above for joint and nonjoint returns to form an overall effective rate. This is done by computing a weighted average of the two rates, in which the weights are a percentage of the aggregate tax base that appeared on joint returns in a given year, and one minus this percentage, respectively.

Accuracy of the Model's Tax Rate Predictions

How accurate is this method of predicting weights and rates? The CBO predicted distributions for joint returns in 1964 and 1979 are shown with the actual data in panels one and two of Figure 2.[10] The fit is not precise, but the change over time in the predicted distribution corresponds to that of the actual data. Panel three of Figure 2 shows the model's projection of how the distribution will look in 1985 (based on a recent CBO projection of economic conditions in that year.) The outward shift in the profile continues according to the projections, despite the fact that recent and projected inflation rates are significantly lower than they had been.

Figure 3 presents the actual and CBO predicted effective tax rates for 1964-1980. The predicted rate is based on the predicted distribution and actual tax bracket rates. The predicted and actual tax rates move closely together. Both series drop in 1965 as a result of the "Kennedy" tax rate cut, and in 1979 as a result of the Revenue Act of 1978. They rise during 1968-1970 because of the Vietnam surtax, and otherwise show a rising trend reflecting bracket creep. The predicted rate falls below the actual rate by a consistent percentage, resulting from the fact that the distribution function underpredicts the percentages of taxable income that fall into the upper brackets. Part 3 of the model is able to correct for this problem, as the next section shows.

The most important test of the accuracy of the predicted tax rate as a representation of the actual rate, however, is the closeness with which it

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10 The exponential distribution actually slopes continuously downward. It is represented as a step function in the figure to facilitate comparison with the actual percentages. The step function shown for the exponential distribution was derived by computing the percentage implied by the function for each bracket and then spreading this percentage uniformly over the bracket.

Figure 2.

Actual and CBO Predicted Distributions of Taxable Income for Joint Returns Over the Bracket Structure for Calendar Years 1964 and 1979 and CBO Predicted Distribution for Calendar Year 1985.

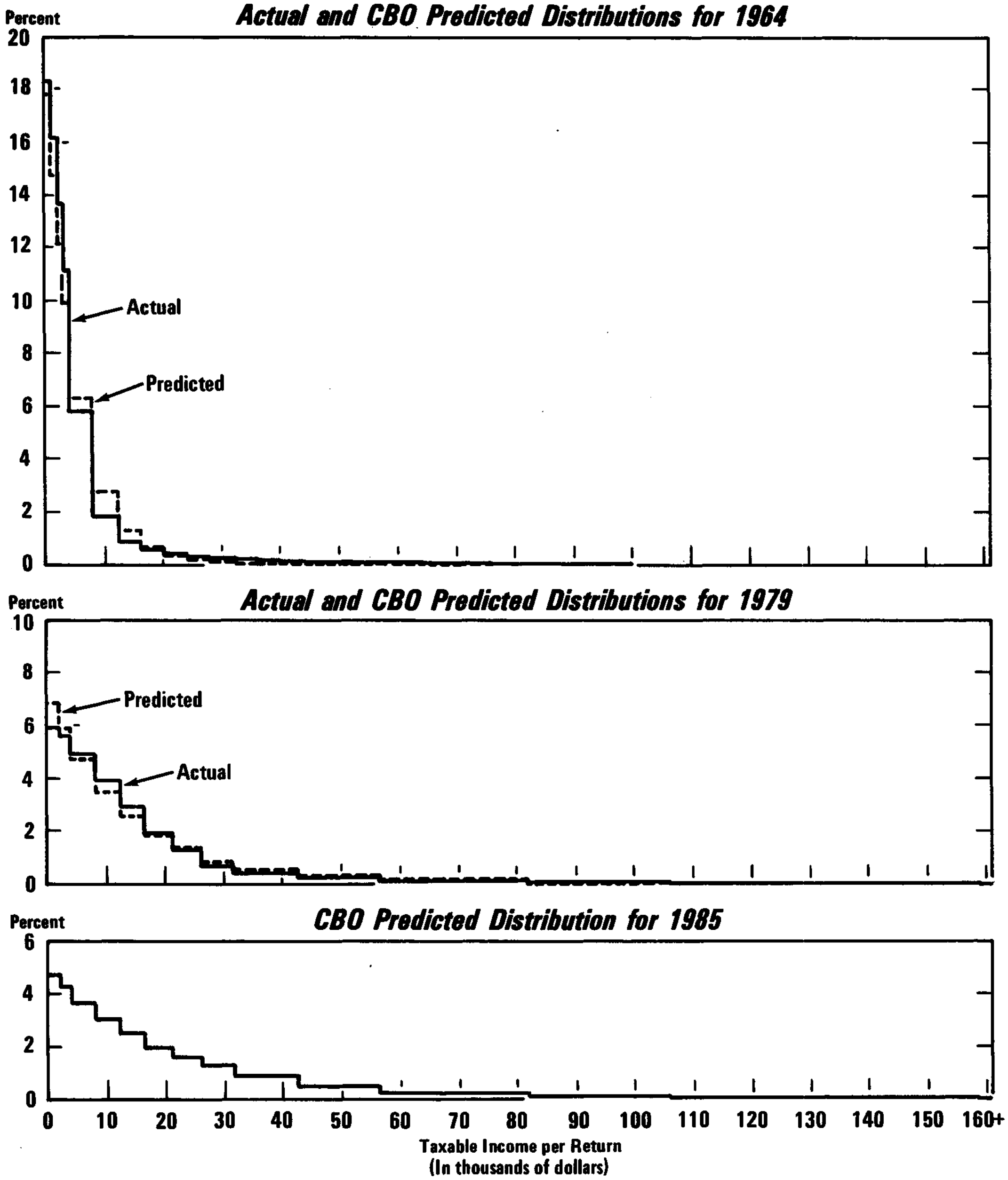
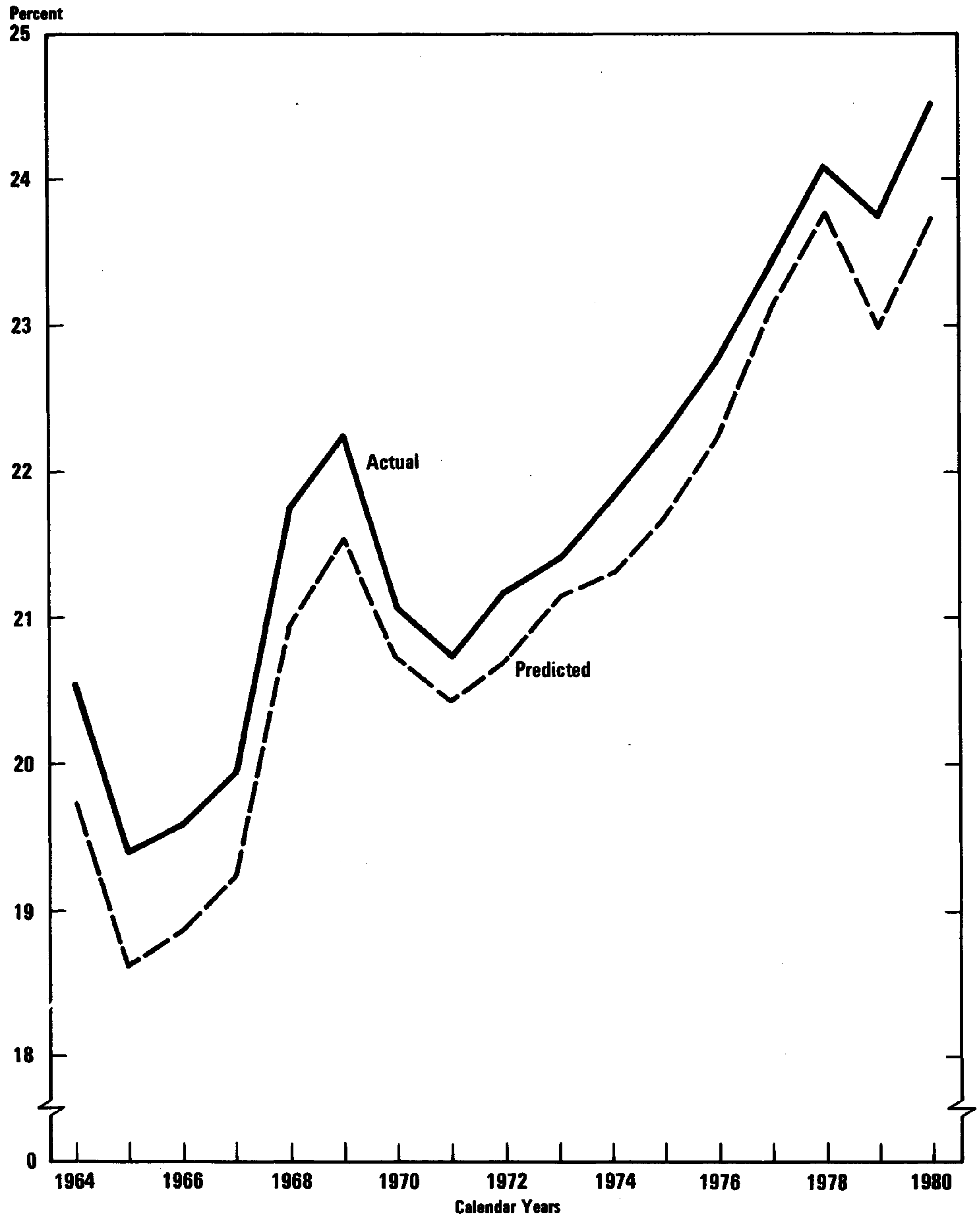


Figure 3.

Actual and Predicted Effective Tax Rates, Calendar Years 1964-1980.



explains the historical behavior of tax liabilities. The evidence on this score is presented in the next section.

PART 3: PREDICTING INDIVIDUAL INCOME TAX LIABILITIES

Once the weighted-average tax rate has been estimated in Part 2, developing a means of predicting tax liabilities involves using the predicted tax rate in place of "t" in equation (2) and estimating that equation using historical time-series data. Making this estimate permits a test to be made of the quality of the estimated weighted-average tax rate as an approximation of the true rate. The estimate also permits certain other factors that affect the relationship between the tax base and tax liabilities to be taken into account. The results, in logarithmic form for 1954-1980,[11] are

$$(6)\ \log(L) - \log(WRP) = \underset{(-.3680)}{-.00867} + \underset{(245.0)}{1.00813}\log(Z) \underset{(-23.48)}{-.08795}\,D5463 \underset{(-6.156)}{-.02451}\,D70$$

$R^2 = .9999$
Standard error = .00517
Durbin-Watson Statistic = 1.6774
Sample period = 1954 to 1980 (annual data)
(Figures in parentheses are t-statistics)

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11 In this form, the percentage response of tax liabilities to percentage changes in the predicted effective tax rate from Part 2 is constrained to equal its expected one-to-one value in order to focus on the percentage response of liabilities to the tax base. This response also has an a priori expected value of unity if the predicted average tax rate is an adequate representation of the actual tax rate. Consequently, whether or not the liability-tax base relationship does turn out to be unity is a test of the adequacy of the predicted tax rate. A formal statistical "t" test of this proposition confirms that one can conclude with 99 percent confidence that the response of liabilities to the tax base takes its expected 1.0 value. Consequently, the predicted effective tax rate can be inferred to be a good representation of the actual rate.

L is individual income tax liabilities before credits. (Source: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns, annual issues.)

WRP is the predicted weighted-average tax rate. (Source: computations described in text.)

Z is IRS taxable income. (Source: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns, annual issues.)

D5463 is a dummy variable accounting for the discontinuous behavior of the effective tax rate during the sample period; the rate was inexplicably stable before 1964. Accordingly, this variable takes the value unity before 1964 and zero thereafter. The fit of this equation is not significantly changed if the sample period is confined to 1964-1979, permitting this dummy to be dropped.

D70 is a dummy variable accounting for the effects of the Tax Reduction Act of 1970 in changing the percentage of taxable income that appeared on nontaxable returns. It also accounts for a minor inconsistency in the data for L before and after 1970; before that year, these figures are net of small amounts of tax credits, but they are gross of all credits in 1970 and later years. D70, accordingly, is zero before 1970 and unity subsequently.

The dummy variable for 1954-63 helps offset the fact noted above that the predicted effective tax rate WRP systematically understates the actual rate. The overall result is satisfactory, as is shown by the R^2 statistic, whose value in this case is .9999. That figure states that the equation explained all of the variation in tax liabilities during the sample period. The equation, therefore, seems likely to forecast accurately, though a more direct test is the record of accuracy of actual forecasts by the complete model. This record is described in the next chapter.

PART 4: CONVERTING PREDICTED TAX LIABILITIES TO INDIVIDUAL INCOME TAX REVENUES

Projections of income tax liabilities described above do not indicate the amount of revenue that will be available to the government in a given budget cycle. Several additional computations must be made in order to produce an estimate of fiscal year individual income tax receipts. These computations fall into three categories: adjustments to liabilities for credits and additional taxes for tax preferences, adjustments for the timing of tax payments, and adjustments for the effects of recent tax legislation.

Adjustments to Liabilities

The measure of liabilities used thus far in the CBO model, liabilities before credits, is the appropriate measure for calculating the amount of tax generated by the assumed levels of income and characteristics of the taxpaying population. It is not, however, a measure of total income tax liabilities. Because some taxpayers are allowed credits against the amount of taxes owed and some taxpayers are required to pay tax additional to the amount resulting from the standard tax calculations, adjustments must be made to account for these items.

Tax credits are allowed for a variety of reasons. The earned income credit is intended as relief for low-income taxpayers with dependent children; other credits, such as the investment credit and the jobs credit are intended to encourage certain kinds of behavior on the part of some taxpayers. Because total tax credits bear a stable relationship to overall income, CBO projects the aggregate amount of credits using a trend based on recent tax credit experience. The estimate of liabilities before credits developed in Part 3 is reduced by this amount.

An additional adjustment is made to liabilities to account for the payment by some taxpayers of a minimum tax on certain income and deduction items they claim on their tax return. Because the preferential treatment of these items results in lower taxable income and, therefore, lower tax liabilities, these items are designated in the tax code as "tax preferences." Taxpayers who claim these items are required to pay a minimum of 15 percent tax on the amounts, computed according to IRS rules. Because the total "additional tax for tax preferences" has, for several years, followed the same pattern as total net capital gains, CBO projects these additional taxes on the basis of projected capital gains, using the most recently observed ratio of these two variables. The projected amount of additional tax for tax preferences is then added to liabilities before credits. These adjustments are summarized below.

Total Income Tax Liabilities = Liabilities Before Credits
- Total Tax Credits
+ Additional Tax for Tax Preferences

Timing Adjustments

The computation of taxes owed is done on a calendar-year basis because the tax year coincides with the calendar year for most taxpayers. The federal government's budget year is different. The fiscal year now runs from October 1 through September 30 of the following year. (The current fiscal year, fiscal year 1983, began October 1, 1982, and will end on September 30, 1983.) The second timing distinction is definitional. Total income tax liability is a measure of taxes owed. The federal unified budget accounts for taxes on an "as paid," or cashflow basis. Because CBO is called upon to forecast tax revenues on a fiscal year, unified budget basis, estimated tax liabilities must be transformed to account for the timing difference that results from the varied schedule on which tax payments are made.

Payments from taxpayers to the Department of the Treasury fall into three categories: withheld taxes, quarterly estimated taxes, and final payments. Withheld taxes, by far the largest of the three types, are paid on liabilities derived from wage and salary income. Employers retain part of each employee's gross earnings and remit these to the Treasury on behalf of the employee. Therefore, withheld tax payments flow into the government accounts regularly throughout the year, about as often as paychecks are rendered. Quarterly estimated payments are required from taxpayers whose income is derived from sources other than wages and salaries (for example, interest, dividends, rents, royalties, capital gains, profits of unincorporated businesses, alimony payments, etc.) Deadlines for filing quarterly declarations are mid-January, April, June, and September, so payments are very heavily concentrated in those months. Because both withheld taxes and quarterly payments are based on predictions of taxpayers' annual income and deductible expenses, and these payments are required to cover a very large share but not 100 percent of tax liabilities, some final reconciliation is necessary. The familiar April 15 filing date is the deadline for making final adjustments and paying any amounts still due on the previous calendar year's tax bill. Most final payments are made between January and April but are particularly heavy in March and April. Taxpayers who have overpaid receive a refund from the Treasury Department as final reconciliation. Refunds, which reduce total federal revenues, are mailed mainly from February through May and are concentrated in April and May.

The resulting pattern of total income tax collections is dominated by withheld taxes, which flow into the Treasury on a regular and fairly smooth basis, with additional spurts from other types of tax payments in January, April, June, and September. Considerable historical data on the mix and timing of tax payments exist. CBO relies heavily on prior payment patterns in determining likely patterns for the future.

Because a fiscal year spans two calendar years, estimates of budgetary receipts are based on projected tax liabilities for two different tax years and on the payments schedule mentioned above. CBO incorporates all available historical data, institutional information, and analysis of collections-to-date (for the current fiscal year) in producing its fiscal year, unified budget estimates.

Adjustments for the Effects of Recent Tax Legislation

Newly enacted tax legislation has implications for the amount of tax owed and, sometimes, for the schedule on which taxes are paid. A model based on historical relationships, such as CBO's individual income tax model, cannot fully take account of some prospective tax changes. While the CBO model does allow for changes in income brackets and tax rate schedules, it is less able to account for smaller changes in deduction and income adjustment items. Since the tax legislation of the past two years has effected major structural changes in the tax code as well as a wide variety of smaller changes, the CBO model can explicitly account for some but not all of the implied revenue effects of the new legislation.

The Joint Committee on Taxation (JCT) is required to provide the Congress with estimates of the revenue effects of proposed tax legislation. CBO uses these estimates as marginal adjustments to the aggregate estimates of budget revenues. After a tax bill is passed and signed by the President, CBO uses the JCT estimates of provisions that the CBO model does not incorporate to increase or reduce its estimates of total individual income taxes. Adjustments of this kind are usually temporary. Once data become available on the actual effects of legislation, they are explicitly included in the model whenever possible.

GENERATING UNIFIED BUDGET RECEIPTS: A REVIEW

Forecasting Overall Revenues from the Income Tax

Estimates of overall individual income tax revenues over a given projection period--typically five years--are derived using economic assumptions (principally taxable personal income and employment) and assumptions about statutory tax provisions (principally the personal exemption, the bracket structure, and the bracket tax rates) that will be in effect during each year of the projection period. Then a revenue forecast is generated in several steps. First, the tax base is estimated (Part 1). Then the weighted-average tax rate that applies to this base each year is estimated, based on an estimate of the distribution of the tax base over the bracket structure (Part 2). The tax base estimates are combined with the weighted-average tax rates (Part 3). The resulting estimates of tax liabilities are adjusted for relatively minor items and then timing factors are applied to generate estimated unified budget revenues (Part 4).

Estimating Revenue Impacts of Changes in Tax Policy

The main responsibility for generating estimates of the revenue implications of changes in tax policy and of other developments lies with the staff of the Congressional Joint Committee on Taxation. Occasionally, however, CBO is called upon to make such estimates, and the CBO model can readily be used to make at least some of these calculations. A few examples follow.

Analyzing Changes in Statutory Tax Rates. Incorporating the effects of changes in bracket tax rates, such as those that were enacted as part of the Economic Recovery Tax Act of 1981, is done in Part 2 of the model. The tax rates that are combined with the predicted distribution of the tax base to form the weighted-average tax rate in that section of the model are altered as is specified in such legislation.

Analyzing Changing Rates of Bracket Creep. Bracket creep--the movement of taxable incomes through the bracket structure as a consequence of inflation--is analyzed in CBO's model by changing the assumed levels of per capita gross income. This is done because inflation works principally through its effects in increasing wage rates and salary scales, which increase per capita gross income directly. In this tax model, changes in per capita incomes are reflected in the ratio of taxable personal income to employment. A given increase in this variable (determined outside the model itself) causes the ratio of the tax base (determined in Part 1) to employment to increase (unless offsetting increases in the personal exemption or standard deduction occur). The predicted increase in this ratio then causes the spread of the tax base over the bracket structure, predicted in Part 2, to change. A higher percentage of the tax base is predicted to fall into higher tax brackets when the ratio of the tax base to total employment rises. This means that a higher percentage of the base is taxed at higher rates, so the overall weighted-average tax rate and, consequently, overall taxes, increase.

Variations in the rate of movement of the tax base through the bracket structure are represented independently of changes in the tax rates that apply to the different brackets. Thus the revenue increase due to rising incomes under unchanging tax rates can be estimated by holding the assumed tax rates constant in Part 2, while the predicted spread of the tax base over the bracket structure changes. Alternatively, if the tax rates are assumed to be changing at the same time that incomes are, as during the first two and one-half years after enactment of ERTA, the rates assumed in Part 2 can be changed at the same time that the predicted distribution of the tax base is changing.

Analyzing the Revenue Impact of Indexation. All tax brackets, the zero bracket amount (standard deduction), and the personal exemption are scheduled to be indexed to the price level (CPI-U) effective January 1, 1985. These developments are incorporated in revenue forecasts by the CBO model in a straightforward way. The personal exemption, zero bracket amount, and all remaining bracket boundaries appear as explicit variables in Parts 1 and 2. In order to account for indexation while carrying out a revenue forecast, it is necessary only to increase the levels assumed for these provisions by the percentage by which they are expected to be indexed in each year. This amount is given by projected increases in the CPI-U taken from CBO's macroeconomic forecast.

The process of taking account of indexation is perhaps most confusing in connection with the representation in Part 2 of the process by which incomes move upward through the bracket structure. In that section, a mathematical distribution function is used to predict how much of the tax base will appear at each taxable income level on tax returns. Then the amount that is predicted to fall into each different bracket is calculated.

When the brackets are assumed to be unchanged, as they will be prior to the introduction of indexation, increases in incomes imply that the predicted distribution of the tax base pictured in Figure 2 moves relative to the fixed brackets. Under indexation, the distribution and the brackets both move (assuming that there is some inflation). Once these movements are determined and both the distribution and the bracket structure are fixed in new positions, the computation of the weighted-average tax rate is carried out as it is for the unindexed tax--that is, the amount of taxable income that is predicted to fall into each bracket is computed and combined with the corresponding tax rate.

Further Research

The model that has been described here has proved to be a valuable revenue-forecasting tool, as the results presented in the next chapters will show. Still, the procedure can be improved in several areas, and CBO is continuing work on the development of this model.

The model's representation of the behavior of the tax base (Z, in the notation used elsewhere in this chapter) has the greatest scope for improvement. The tax statutes that helped determine the behavior of the base have been more complicated at times during the past than is accounted for in the model. (For example, the standard deduction, now called the zero bracket amount, has at various times been comprised of several different parts. An illustration is the 1964-1977 period when the deduction was a given percentage of income subject to given minimum and maximum dollar amounts.) Taking account of the more detailed information available in the data by making the relevant parts of the model more complicated might improve the procedure's forecasting accuracy.

A second way in which the model might be made more precise is by making more extensive use of the income distribution device that is now used only in connection with the tax rate forecast. In principle, the behavior of the frequency distribution of incomes is relevant to the determination of the tax base, and it also underlies the behavior of the related (but different) income distribution that helps determine the tax rate. Preliminary CBO research suggests that incorporating a representation of the frequency distribution might improve the precision of the overall model.

CHAPTER III. FORECASTING ACCURACY OF THE CBO INDIVIDUAL INCOME TAX MODEL

This chapter presents evidence on the accuracy of revenue forecasts by both the CBO and the Treasury Department individual income tax models. On the basis of these results, the CBO model is shown to compare favorably with the Treasury procedure.

CAUSES OF FORECASTING ERRORS

Several sources can cause errors in forecasting revenues. In particular, a revenue projection can be wrong because the economic forecast (including gross income, unemployment, etc.) on which it is based is wrong; because the wrong assumptions are made about future tax policy provisions; or because the tax model itself is inaccurate in technical ways.

This chapter focuses only on the third source of error--the technical accuracy of the model itself. The first source--inaccuracy in economic forecasts--is a separate topic that should be given a full discussion of its own. The problem of inaccurate assumptions about what tax policy will be in effect during a future period, similarly, is a separate subject. Legislative and executive decisions are inherently difficult to predict, and it seems best to separate the consequences of such prediction errors from more correctable technical errors.

THREE FORECASTS WITH THE CBO MODEL

A forecast is a prediction of the future. Evaluating its accuracy usually implies waiting until actual figures for the forecast period become available, and then comparing these figures with the forecast. Since the CBO tax model is quite new, it has only a short forecasting record.

CBO developed additional information on the model's forecasting accuracy by generating three "forecasts" of past years for which data were already available. Care was taken to base these forecasts only on information that was available before the forecast period began.[1]

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1 In particular, the statistical equations that are described in Chapter II are reestimated using only data for the shorter period. In this way,

In the first forecast, a version of the tax model was developed based only on data through 1977, even though actual revenue figures were available through 1980. This version was then used to predict tax revenues for 1978, 1979, and 1980. In the second forecast, the model estimates used data through 1978, while the forecast covered 1979 and 1980. Finally, the third version of the model was developed using data through 1979 to forecast revenues in 1980. In each case, the projection was made using the actual values of economic variables, such as gross income and employment, for the forecast period. Similarly, actual values were used for tax policy provisions, such as tax rates and bracket structures. This ensured that the accuracy or inaccuracy of the resulting forecasts reflected only technical properties of the tax model.

The forecast results are shown in Table 1. The average error for forecasts one year into the "future" is $3.6 billion, or 1.5 percent of actual revenues. For forecasts two years out, the average error is also 1.5 percent of actual revenues, while for three years into the future the error is 1.7 percent.

Is this degree of precision satisfactory? How does it compare with the accuracy of Treasury Department forecasts? This second question is hard to answer because the Treasury does not publish information on the structure of its revenue-estimating models or their accuracy. Lacking such information, CBO has done its own analysis of the accuracy of past Treasury forecasts. An effort has been made to break the overall forecasting errors into the components described above, namely, errors in economic forecasts, errors in assumptions about tax policy, and technical errors. This breakdown was done using Treasury figures on revenue effects of tax law changes. The results of the analysis of Treasury forecasts of individual income tax revenues during 1978-1981 are shown in Table 2.[2] A detailed description of the calculations underlying these figures is given in the appendix.

The results of this error analysis suggest that Treasury forecasts were not significantly better than CBO's ex post forecasts for this period. Treasury's average technical error for forecasts one year into the future

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Footnote Continued

the model is prevented from taking statistical account of information contained in actual data for the forecast period before it makes its forecast.

2 For an earlier and more detailed analysis of the accuracy of past Treasury revenue forecasts, using the same procedures that are used in this chapter, see Congressional Budget Office, A Review of the Accuracy of Treasury Revenue Forecasts, 1963-1978 (February 1981).

was 2.0 percent of actual revenues, slightly higher than CBO's error of 1.1 percent. The average error in Treasury forecasts two years into the future was 2.3 percent, larger than the corresponding CBO figure, 0.7 percent, while Treasury's error three years forward, 1.2 percent, is larger than CBO's 0.5 percent.

The Treasury Department's revenue estimates set a high standard of quality. While further analysis might be useful, the figures developed in this section suggest that CBO's model is at least as accurate as the Treasury's.

TABLE 1. THREE SIMULATED FORECASTS OF LIABILITIES FROM INDIVIDUAL INCOME TAX USING CBO TAX MODEL (By calendar year)

CBO Forecast Period	Last year of Actual Data Used by Model (1)	Actual Tax Liabilities (In billions of dollars) (2)	Forecast Tax Liabilities (In billions of dollars) (3)	Error (In percents)
1978-1980	1977	1978: 203.8	207.8	2.0
		1979: 220.1	220.3	0.1
		1980: 256.3	255.0	-0.5
1979-1980	1978	1979: 220.1	218.8	-0.6
		1980: 256.3	253.1	-1.2
1980	1979	1980: 256.3	254.2	-0.8

SOURCES: Column 2: Internal Revenue Service, Statistics of Income: Individual Income Tax Returns (annual issues). Column 3: calculations using CBO tax model estimated using data for period ending in year shown in Column 1. Forecast is based on actual values of taxable personal income and employment, and of all tax provisions such as tax brackets and rates.

TABLE 2. ANALYSIS OF ERRORS IN TREASURY DEPARTMENT FORECASTS OF INDIVIDUAL INCOME TAX REVENUES FOR FISCAL YEARS 1977-1981

						Memorandum	
Year In Which Forecast Was Made		Actual Revenues (In billions of dollars) (1)	Forecasted Revenues (In billions of dollars) (2)	Error (In percents) (3)	Technical Error (In percents) (4)	Error from Inaccurate Economic Forecast (Percents) (5)	Error from Inaccurate Legislative Assumptions (Percents) (6)
1977	1978	181.0	171.2	5.4	-1.1	4.2	2.3
	1979	217.8	205.3	5.7	2.9	5.5	-2.7
	1980	244.1	234.1	4.1	-0.5	5.9	-1.3
1978	1979	217.8	190.1	12.7	1.9	4.5	6.3
	1980	244.1	223.9	8.3	-0.1	4.5	3.8
	1981	285.9	262.9	7.9	-1.4	6.2	3.1
1979	1980	244.1	227.3	6.9	0.3	5.7	0.9
	1981	285.9	269.1	5.8	-1.4	7.8	-0.7
	1982	297.7	311.2	-4.5	1.7	3.9	-10.1
1980	1981	285.9	274.4	3.9	-1.8	6.3	-0.5
	1982	297.7	318.7	-7.1	4.6	-1.2	-10.5
1981	1982	297.7	331.7	-11.4	5.1	-7.7	-8.9

SOURCES: Columns (1) and (2): The Budget of the United States Government, issues for various fiscal years. Columns (4)-(6): calculations described in the appendix.

CHAPTER IV. ISSUES IN INDIVIDUAL INCOME TAX REVENUES

The effects of inflation on federal revenues have recently focused attention on several important questions. What has been the revenue impact of the recent slowdown in inflation? How will revenues--and the deficit--behave when indexation of the individual income tax takes effect in 1985 as currently scheduled? This chapter discusses these and other problems using estimates from the CBO individual income tax model.

THE RESPONSE OF TAX LIABILITIES TO INCREASES IN INCOME CAUSED BY INFLATION

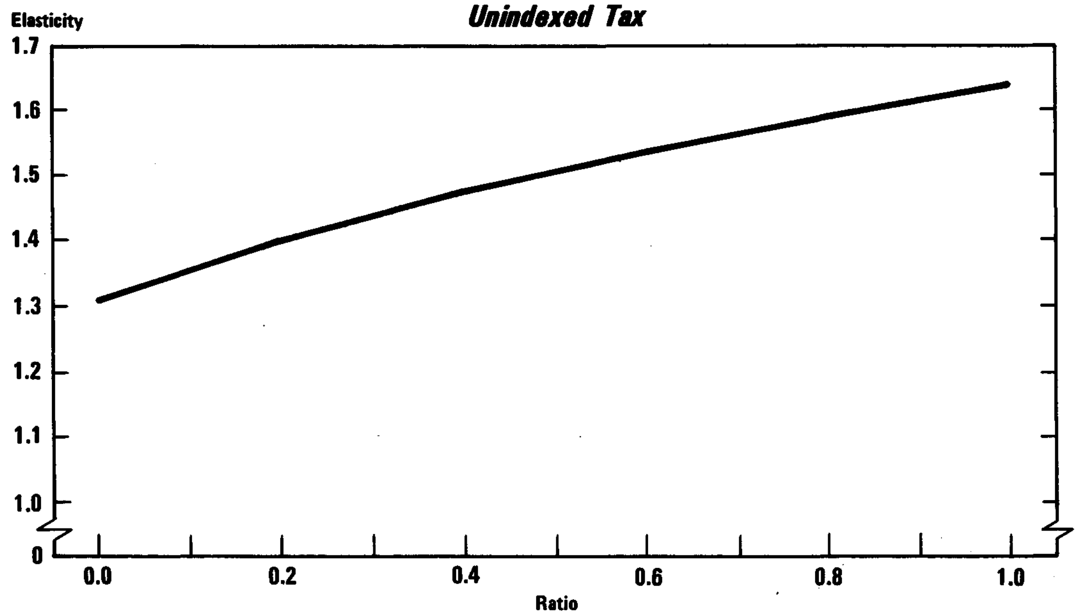
With an unindexed individual income tax, inflation causes revenues to increase relatively fast because of bracket creep. Increases in aggregate nominal income from inflation result in proportionally larger increases in income tax liabilities than those reflecting real economic growth.

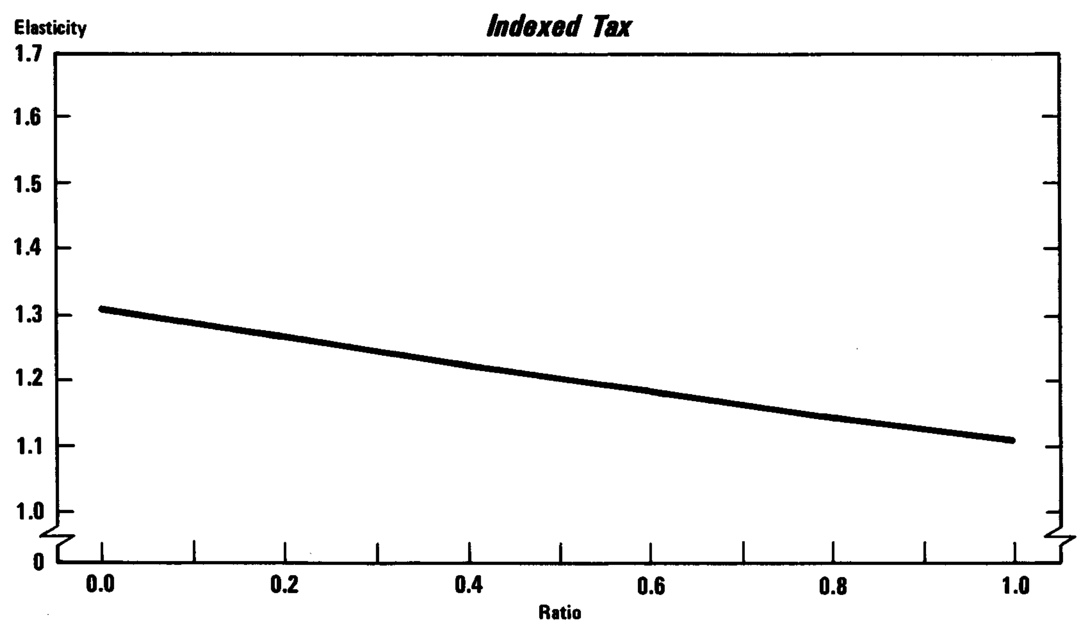
This difference in tax response arises from variations in the pattern by which different changes in income are distributed. Increases reflecting inflation accrue primarily to existing taxpayers and are added to these individuals' previous incomes. Because the personal exemption and (in the cases of many taxpayers) the fixed zero bracket amount have already been applied to existing income, they are no longer available to protect inflation-induced increases in income. In addition, such increases are likely to be taxed at higher rates than previous income because they fall into higher brackets. In contrast, when aggregate income expands because of real GNP growth, some of the increase generally accrues to existing taxpayers through increases in productivity, but some of it also accrues to new taxpayers. This is because increases in real output generally increase employment, and many of these new workers are also new taxpayers. Their incomes are relatively well-protected by deductions and exemptions, and are taxed at relatively low rates.

The differences in the response of tax liabilities to different changes in aggregate income are illustrated in the top panel of Figure 4. This figure shows estimates from the CBO individual income tax model of the elasticity of the unindexed tax with respect to income for different combinations of real growth and inflation. This "income elasticity" is defined as the ratio of the percentage change in tax liabilities occurring because of a change in income to the percentage by which income changes. The calculations are based on the assumption that all tax rate reductions

Figure 4.

Implicit Elasticity of Tax Liabilities with Respect to Taxable Personal Income Under Indexed and Unindexed Taxes, Assuming Different Ratios of Growth in the GNP Deflator to Total Nominal GNP Growth.





mandated by the Economic Recovery Tax Act of 1981 (ERTA) have taken effect, but not the indexing provisions. Different points on the graph, moving from left to right, represent different degrees to which the growth of nominal GNP is assumed to represent real economic growth as opposed to inflation. For example, at the extreme lefthand side of the graph, GNP growth is assumed to be entirely "real"; halfway from left to right, the nominal GNP growth rate is assumed to reflect real and inflationary growth in equal proportions; and so on.

The difference between the elasticity value shown in Figure 4 and 1.0 shows how much faster tax revenues grow than income. For example, the figures for increases in GNP that primarily reflect inflation (at the right-hand side of the graph) approach values of 1.7; this suggests that, under those economic conditions, individual income tax revenues may grow nearly 70 percent faster than income. At the other extreme, when increases in GNP stem entirely from real economic growth, the elasticity is 1.3, suggesting that income tax liabilities grow more slowly--30 percent faster than GNP.[1]

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1 These measures of elasticity show more variability than those presented in most other sources (see those cited in footnote 2 of Chapter I.) This is because this study, unlike others, takes into account the fact that changes in the business cycle affect the distribution of taxable income and, with it, the behavior of the tax. The general proposition that income distribution changes over the cycle has been demonstrated in several previous studies (cited in footnote 4 of Chapter 2), but only one other study has taken the tax implications into account. See Frank deLeeuw, Thomas H. Holloway, Darwin Johnson, David S. McClain, and Charles A. Waite, "The High-Employment Budget: New Estimates, 1955-80," Survey of Current Business (November 1981).

The estimates in Figure 4 were computed as follows. Using a current CBO projection of economic conditions in 1985 as a basis, and assuming that nominal GNP grows at 8 percent between 1985 and 1986, each of the different hypothetical combinations of growth rates for real GNP and the GNP deflator was analyzed in turn. On the basis of each, it was possible to predict consistent levels of aggregate employment and taxable personal income using separate econometric equations. These predicted levels were used in the full tax model to generate corresponding predictions of 1986 tax liabilities. The implicit elasticity of tax liabilities with respect to income was given in each case by the ratio of the predicted percentage growth in tax liabilities to predicted percentage growth in taxable personal income. The calculations are described in detail in Congressional Budget Office, It is important to realize that it is only the individual income tax among federal revenue sources that exhibits these relatively high levels of (and variations in) responsiveness to changes in income. This tax accounts for about half of federal revenues. Other important revenue sources, principally the social insurance payroll taxes and, to a lesser extent, the corporate income tax, respond less strongly to changes in income. Their responsiveness, moreover, varies less with changes in the composition of income.

REVENUE IMPLICATIONS OF THE RECENT SLOWDOWN IN INFLATION

Because individual income tax revenues under the unindexed tax are so sensitive to inflation, the unexpectedly sharp slowdown in inflation that took place during 1981 and 1982 has been singled out in some analyses as a major factor in increasing the budget deficit. Slower-than-expected price increases, it is argued, have reduced the rate of bracket creep and the associated growth in revenues, leading to bigger-than-expected deficits.[2]

The importance of this factor in the recent growth of the federal deficit can be investigated using the CBO income tax model. Table 3 shows CBO's projection of inflation for 1982-1986 as of midyear 1981 and early 1983. As the figures show, inflation actually experienced in 1982 was significantly less than projected. As a result, the early 1983 projection of future price growth was revised downward. The revenue implications of this revision can be isolated by comparing estimates of revenues generated by bracket creep based on the two different inflation forecasts.[3]

The results are shown in Table 3. The inflation rate, as measured by the CPI, was over two percentage points lower during 1982 than had been forecast in early 1981. Similarly, CBO's more recent forecast of inflation during the 1983-1986 period is below the 1981 forecast for the same period by more than two full percentage points over the four years. These reductions in inflation alone--apart from all other unforeseen economic and

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Footnote Continued

Simulated Individual Income Tax Elasticities, unpublished technical paper (1983).

2 See, for example, Budget of the United States Government, Fiscal Year 1984, pp. 3-19.

3 Using each inflation forecast, revenues were estimated by calculating the difference between the income tax revenues that would be collected in the absence of the Economic Recovery Tax Act, and those that would be collected if the income tax were indexed for inflation.

TABLE 3. CHANGE IN PREDICTED INDIVIDUAL INCOME TAX REVENUES FROM REVISION IN CBO INFLATION FORECAST FOR 1983-1986

Forecast	1982	1983	1984	1985	1986
CBO Forecast of Rate of Increase in Consumer Price Index (Calendar years, in percents)[a]					
September 1981	8.3	6.2	5.5	4.7	4.2
February 1983	6.2[b]	4.5	5.0	4.7	4.1
Change, 1981 to 1983	-2.1	-1.7	-0.5	---	-0.1
Estimated Reduction in Individual Income Tax Revenues (Fiscal years, in billions of dollars)	20	24	35	42	52

SOURCE: Congressional Budget Office.

a. Year over year.
b. Actual.

legislative developments--are estimated to reduce individual income tax revenues by $24 billion in fiscal 1983, and successively greater amounts in later years. This item represents 17 percent of the amount by which CBO's baseline deficit forecast for fiscal 1983 increased between mid-1981 and early 1983. The remainder of the increase was a consequence of the fact that the economy was weaker during 1982 than had been predicted earlier, and of the changes in tax and spending policy that were not assumed in the 1981 projections.

THE REVENUE IMPACT OF TAX INDEXATION IN 1985

ERTA includes provisions to protect taxpayers from bracket creep by indexing various tax provisions to the Consumer Price Index for All Urban Consumers (CPI-U) beginning January 1, 1985. The personal exemption, zero bracket amount, and all other bracket boundaries will be adjusted each year by the percentage by which the CPI-U has increased during the preceding fiscal year.[4] These provisions are designed to protect taxpayers from increases in effective individual income tax rates caused by inflation. Without indexation, inflation reduces the effectiveness of exemptions and the zero bracket amount in shielding income from the tax, and pushes incomes into higher and higher brackets. This will no longer occur under indexation.[5]

For federal budget trends, indexation implies that, for the first time, increases in individual income tax revenue may react more strongly to real economic growth than inflation. This shift will take place because any bracket creep under the indexed tax will result from increases in productivity rather than inflation. Income increases from this source would not be prevented from moving individuals into higher tax rate brackets by compensating changes in tax provisions under indexation.

The degree of importance of this productivity-induced bracket creep in quantitative terms can be investigated using the CBO income tax model. The bottom panel of Figure 4 shows model estimates of the income elasticity of aggregate income tax liabilities under the indexed tax. Like the data for the unindexed tax shown in the top panel, these estimates are given for different combinations of inflation and real economic growth.[6]

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4 The formal provision calls for adjustment on January 1 of each year by the proportion by which the CPI-U grew on average during the preceding fiscal year relative to its average level during fiscal year 1983.

5 The accuracy of this generalization is affected by certain complications regarding the indexing scheme. The tax provisions are indexed with respect to consumer prices rather than wages or other measures of incomes. As a result, in periods when consumer prices rise faster than incomes, taxpayers will be overprotected by indexation: their real tax burden may fall as a percentage of their incomes since indexed tax provisions will rise faster than incomes. In periods in which wages rise faster than consumer prices, on the other hand, the reverse will occur, and real tax rates may rise slightly. Even if wages and consumer prices change at the same rate, real tax burdens may fluctuate because incomes are determined by current inflation while the tax provisions are indexed with respect to inflation that occurred several months previously. If inflation increases from year to year, real tax burdens will rise, while if inflation falls, tax rates will fall too.

6 These data were computed as described in footnote 1 of this chapter, but with one additional provision. To take account of indexation, the

Figure 4 shows that, when aggregate income growth is entirely due to inflation, indexation protects taxpayers in the aggregate from any increase in their tax rate--any bracket creep, that is; revenues rise only as fast as real income does. When income increases are assumed to be entirely due to real economic growth, and to reflect productivity growth to the extent that they generally have in the past, however, some bracket creep will occur. As a result, income tax revenues will grow about 30 percent faster than income. This is substantially less than the proportion by which tax growth outruns income growth under the unindexed tax.

ECONOMIC IMPLICATIONS OF INDEXATION

Taxpayers will approve of the effects of indexation in eliminating the significant "unlegislated tax increases" that are caused by inflation and bracket creep under the unindexed tax. Certain gains in economic efficiency, too, may result over time from the introduction of indexation, since it will prevent marginal tax rates from drifting upward.

On the other hand, indexation could also have some adverse effects from the point of view of economic policy. The significantly slower growth in federal revenues that it implies will contribute to the tendency of federal budget deficits to increase over time (in the absence of legislation to control them). The persistent expectation of large and rising deficits, in turn, may be one explanation for the persistently high levels of interest rates, which threaten long-run productivity growth by reducing investment. Indexation may also reduce the automatic stabilization that the unindexed

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Footnote Continued

personal exemption and zero bracket amount in Part I of the model and all bracket boundaries in Part II were increased in each simulation by the percentage by which the GNP deflator was assumed to increase.

This procedure necessarily abstracts from the way the indexed tax will work in practice. As has already been pointed out, the tax is actually tied to lagged changes in the CPI, not to contemporaneous changes in the GNP deflator, as was assumed in the sumulations. The simpler assumptions underlying these calculations were chosen because no satisfactory quantitative generalizations are possible regarding differences between current and lagged inflation or between inflation reflected in the CPI and that reflected in the GNP deflator. The actual indexed tax will behave as is shown in the simulations to the extent that inflation does not change from one year to the next and to the extent of differences between the CPI and the GNP deflator.

tax contributes to the economy under some circumstances by automatically reducing incomes and spending when they grow too fast and become inflationary in themselves. Overall, then, the significant changes in the behavior of the income tax that are reflected in the estimates in this chapter have both positive and negative implications for the performance of the economy.

APPENDIX

APPENDIX. ANALYSIS OF ERRORS IN TREASURY REVENUE FORECASTS

This appendix explains the calculations underlying the analysis shown in Table 2 in Chapter III of errors in Treasury forecasts of individual income tax revenues. The discussion deals explicitly only with the errors in the forecast made in 1977 (the first three lines of the table). The procedure underlying the remaining entries in the table is identical.

All data, except actual values of personal income, are drawn from issues of The Budget of the United States Government for various fiscal years. This document will hereafter be called the "Budget." The following data were required to analyze the 1977 Treasury forecast (all dollar amounts are in billions; all years are fiscal unless otherwise noted):

1. Forecast individual income tax revenues (from the 1978 Budget, p. 46); see Table 2, column 2.

2. Actual individual income tax revenues (from the Budgets for 1980 (p. 61), 1981 (p. 61), and 1982 (p. 65)); see Table 2, column 1.

3. Estimated revenue impact of proposed legislation (from the 1978 Budget, p. 46):

   a. 1978: -19.2
   b. 1979: -22.5
   c. 1980: -31.8 .

4. Estimated revenue impact of enacted legislation

   a. 1978: -15.3 (1979 Budget, p. 51)
   b. 1979: -18.5 (1979 Budget, p. 51)
   c. plus: -10.2 (1980 Budget, p. 67)
   d. 1980: -18.4 (1979 Budget, p. 51)
   e. plus: -16.9 (1980 Budget, p. 67) .

5. Forecast of personal income on which initial revenue forecast was based (by calendar years):

   a. 1978: 1,684 (1978 Budget, pp. 41-42)
   b. 1979: 1,879 (1978 Budget, pp. 41-42)

c. 1980: 2,075 (1978 Budget, pp. 41-42) .

6. Forecasts of personal income on which estimates of revenue impacts of enacted legislation were based (by calendar years):

   a. 1978: 1,704 (1979 Budget, pp. 31-33)
   b. 1979: 1,892 (1979 Budget, pp. 31-33)
   c. 1980: 2,095 (1979 Budget, pp. 31-33)
   d. 1978: 1,707 (1980 Budget, pp. 35-36)
   e. 1979: 1,894 (1980 Budget, pp. 35-36)
   f. 1980: 2,078 (1980 Budget, pp. 35-36) .

7. Actual personal income (by calendar years; from National Income and Product Accounts, 1983):

   a. 1978: 1,733
   b. 1979: 1,951
   c. 1980: 2,160 .

The first computation was made for the error introduced into each revenue forecast by an inaccurate assumption about the level of personal income in the year being forecast. The appropriate adjustment involved multiplying actual revenues for a given year (item 2) by the ratio of assumed personal income (item 5) to actual personal income (item 7) after this ratio is raised to the power of the elasticity of tax revenues with respect to income. This elasticity was assumed to be 1.5. The result of this calculation was subtracted from actual revenues (item 2). Expressed as a percentage of actual revenues in each year, this difference appears in column (5) of Table 2.

The second computation was the error in each year's revenue forecast that was caused by inaccurate assumptions about the tax provisions that would be in effect in a given year. This was taken to be the difference in the Treasury's assumption regarding the revenue impact of tax legislation that the Administration was proposing at the time the revenue forecast was made (item 3) and its later estimate of the revenue impact of tax legislation that had actually been enacted (item 4). Before item 4 was subtracted from item 3, item 4 was adjusted for differences in the level of personal income that was assumed for a given year in estimating item 4 from the level that had been assumed for the same year in estimating item 3. A revenue impact estimate based on one income assumption can be adjusted to another assumption by multiplying it by the ratio of the two income levels raised to the power of the income elasticity of tax receipts, which was assumed here to be 1.5.

Before being subtracted from item 3a, for example, item 4a was multiplied by the ratio of item 5a to item 6a raised to the power 1.5. Similarly, the legislation adjustment for the 1979 revenue forecast was carried out by multipying item 4b by the ratio of 5b to 6b raised to 1.5, multiplying 4c by the ratio of 5b to 6e raised to 1.5, adding these two products together, and subtracting the result from 3b. The result of subtracting adjusted figures in item 4 from the corresponding element of item 3, taken as a percentage of actual revenues in the given year, is the estimated error introduced by inaccurate legislative assumptions. It is shown as a percent of actual revenues in column (6) of Table 2.

The estimated technical error is the residual--the component of the total error in each year's revenue forecast (column (1) in Table 2 minus column (2)) that remains after subtracting the errors due to inaccurate assumptions regarding personal income and tax legislation. It is shown, expressed as a percentage of actual revenues, in column (4) of Table 2.

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