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INFLATION AND THE PERSONAL TAX CODE: ASSESSING INDEXATION

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I. Introduction

For most of the American experience with a federal income tax, the U.S. economy has operated under a nominal tax system. The essence of a nominal tax system is the designation in dollar terms of rate brackets, exemption levels, and other items that figure into the definition of taxable income. The dollar levels of these items are set in legislation, only to be changed by subsequent acts of Congress.

The problems associated with a nominal tax system in an economy with sustained, nonzero rates of inflation, even perfectly anticipated and stable rates of inflation, have been long recognized and much discussed. Just a few of the better-known examples include the papers by Fischer and Modigliani (1978) and Fischer (1981), and the volumes by Aaron (1976), Tanzi (1980), and Feldstein (1983).

The past decade, however, has seen an important and historically unique development in the structure of the U.S. personal tax system. Motivated by the political recognition that distortions created by the interaction of the tax system and the high inflation rates of the 1970s had exacted significant costs on the U.S economy, Congress legislated limited indexation for inflation into the personal tax code with the Economic Recovery Tax Act (ERTA) of 1981. Although inflation rates had fallen substantially from the extraordinary levels of 1980 and 1981, ERTA's indexing provisions were extended in the Tax Reform Act of 1986.

Indexation of the personal tax code has important implications for current monetary policy debates. While few participants in these debates disagree with the proposition that the goal of monetary policy should be predictability of the inflation rate, few agree on the "correct" inflation rate. To the extent that a primary, perhaps <u>the</u> primary, case against positive sustained inflation involves distortions that arise through interactions with the tax system, we might ask whether these arguments are substantially mitigated by indexation. It is thus a good time to reexamine the potential costs of anticipated inflation in light of the inflation-indexing scheme currently in place. Such a reexamination is the focus of this paper.

After reviewing the specifics of the indexing legislated during the 1980s, we provide some back-of-the-envelope estimates of the distortionary costs of inflation under the current tax regime. We focus exclusively on the personal tax code and concentrate on two types of indexation -- bracket indexation and indexation for capital-income adjustment.[1]

Bracket indexation refers to adjustments in the dollar value of the tax bracket limits that determine an individual taxpayer's marginal tax rate. Failing to index tax brackets in the face of positive inflation causes marginal tax rates to increase independent of increases in real income, a phenomenon widely known as "bracket creep." The indexing provisions of the current tax system are primarily designed to alleviate the problem of

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[1] This terminology follows Tanzi (1980).

bracket creep. However, because inflation adjustments are made with a lag of approximately one year, bracket indexation in the current tax code is incomplete.

Indexation for capital-income adjustment refers to the problem of mismeasuring taxable capital income in inflationary environments. Specifically, when the rate of inflation is positive, a portion of the nominal rate of return to capital is repayment of principal. It is necessary to recognize this repayment in order to arrive at the real value of capital income. Doing so requires adjustment of the basis on which capital income is calculated, an adjustment that is not incorporated by simple bracket indexation. Indexation for capital-income adjustment thus requires taxable income to be adjusted in such a way that individuals are taxed on real capital income and not on nominal interest income. Such adjustments are not currently provided for in the U.S. personal tax code.

We maintain that distortions created by the combination of imperfect bracket indexation and the failure to index for capital-income adjustment likely result in substantial economic costs. Perhaps more important, raising revenues through inflation/tax-system interactions is very inefficient. According to our calculations, revenues raised by the effects of a permanent, perfectly anticipated inflation rate of 4 percent would result in an annual output loss in the range of 2.5 to 4.5 percent of GNP relative to a policy that maintains zero inflation (or with perfect indexation) and raises an equivalent level of revenues through proportionate increases in statutory marginal tax rates.

Although our estimates are admittedly back-of-the-envelope, we have attempted to make the envelope as reasonable as possible. We use the type of general-equilibrium simulation framework employed extensively in much formal tax research (for example, by Auerbach and Kotlikoff [1987]). Furthermore, one need not accept the specific quantitative implications of our simulation experiments to conclude that the costs of even moderate inflation continue to be substantial, even after accounting for the effects of tax reform in the 1980s, and that the magnitude of these distortions argues strongly against dependence on the interaction of inflation and the personal tax code as a revenue source.

II. The Indexing Provisions of the Personal Tax Code

Indexation of the personal tax code formally commenced in 1985 under the provisions of ERTA. Ad hoc indexation, in the form of periodic adjustments in nominal tax brackets, personal exemption levels, and so on, were periodically legislated prior to 1985, but ERTA represented the first time regular, ongoing inflation adjustments were codified in the tax laws.

Indexation, as defined by ERTA, requires annual adjustments in the dollar value of tax bracket limits and personal exemption levels using a cost-of-living index derived from the Bureau of Labor Statistics' Consumer Price Index for all urban wage earners (CPIU). The specifics of ERTA effectively define the rate of inflation for a given tax year as the change in the average CPIU for the 12-month period ending September 30 of the year prior to the tax year, relative to the average CPIU for the analogous period in 1984.

Due to the nonsynchronization of tax years and "index years," ERTA mandated that inflation adjustments be made with an approximate lag of one year.[2] For example, the cost-of-living index for 1986 was calculated by dividing the average CPIU for the period spanning October 1984 through September 1985 by the average CPIU for the period spanning October 1983 through September 1984. Tax-bracket limits and personal exemption levels for tax year 1986 were then adjusted by multiplying the statutory bracket limits and personal exemption levels in effect for the 1984 tax year by the resulting cost-of-living index.

Although the indexing provisions of ERTA were in effect for only two years before being superseded by the Tax Reform Act of 1986 (TRA86), TRA86 extended the indexing scheme specified by ERTA, with only minor modifications. First, TRA86 eliminated the zero-bracket amount of taxable income, that is, the taxable income level below which the marginal tax rate is zero. By way of compensation, personal exemption levels, the standard deduction level, and the earned-income tax credit for low-income

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[2] An "index year" is referred to in ERTA as a "calendar year." As our subsequent discussion makes clear, this terminology is somewhat misleading in that its reference to a calendar year does not correspond to a 12-month period that spans January to December. Tax years, on the other hand, do correspond to the usual January-to-December calendar year.

taxpayers were extended. In conjunction with this change, TRA86 extended inflation indexing to the standard deduction and the earned-income credit.

The second modification involved minor changes in the way the cost-of-living index is calculated. The cost-of-living index is now calculated by dividing the average CPIU for the 12-month period ending August 31 of the year prior to the relevant tax year by the average CPIU for the corresponding period ending August 31, 1987.

The indexing provisions of TRA86 are in force as of this writing.

III. What the Current Indexing Scheme Doesn't Index

Without discounting the importance of the indexing provisions introduced by ERTA and TRA86, it is clear that insulation of the current personal tax code from inflation is far from perfect, even ignoring problems associated with the construction of an adequate index of the true inflation rate. Our discussion focuses on what we perceive to be the two major inadequacies of the current indexing regime: lagged indexation of bracket levels and the failure to index for capital-income mismeasurement.

A simple example will suffice to demonstrate that, with an indexing scheme that adjusts tax brackets with a one-year lag, positive inflation will generally raise average marginal tax rates. Suppose that the tax-rate schedule at time zero is given by

Marginal Tax Rate	Tax Bracket
0	0 - Y
τ	> Y

Suppose further that the rate of inflation equals π in year 1 and every year thereafter. Then the sequence of marginal tax rates faced by an individual with a constant real income equal to Y is given by

Time	Nominal Income	Real Income	Nominal Tax Bracket Limit	Marginal Tax Rate
0	Y	Y	Y	0
1	$Y\cdot(1+\pi)$	Y	Y	τ
2	$Y\cdot(1+\pi)^2$	Y	$Y\cdot(1+\pi)$	τ
3	$Y\cdot(1+\pi)^3$	Y	$Y\cdot(1+\pi)^2$	τ
.	.	.	.	.
.	.	.	.	.

For the individual in this hypothetical example, sustained inflation permanently increases his or her marginal tax rate, even though the nominal income brackets are eventually adjusted for price-level changes.

It is important to reemphasize that our current indexing does indeed provide some protection against bracket creep. For a tax-rate schedule with static nominal bracket limits, sustained, positive inflation will ultimately push all taxpayers into the top rate bracket. This will not occur under the indexing provisions of ERTA and TRA86. With lagged indexation, however, the protection provided is imperfect: bracket creep is bounded, but not eliminated.

The second major deficiency of the current indexing regime that we will consider is the failure to index for capital-income mismeasurement. Since this problem is well known, a simple example will again suffice as illustration.

Suppose that an individual of age s has total income given by $Y_s=W_s^*+\iota a_{s-1}$, where W_s^* and ι are the nominal wage payments to an age s individual and the nominal interest rate, respectively. Bracket indexation is essentially equivalent to deflating Y_s by $1+\pi$. But this is clearly inappropriate for measuring real capital income. By definition, the nominal interest rate is defined by the relation $(1+\iota)=(1+r)(1+\pi)$. Real asset income is therefore given by

$$[\frac{1+\iota}{1+\pi}-1]\,a_{s-1} = (\iota-\pi)\,\frac{a_{s-1}}{1+\pi} = \frac{\iota a_{s-1}}{1+\pi}-\frac{\pi a_{s-1}}{1+\pi}.$$

This example clearly shows that bracket indexation alone does not adequately adjust nominal capital income for inflation, since the adjustment procedure ignores the fact that part of the nominal return to capital reflects an adjustment for the repayment of principal lost due to inflation (measured by the term $\pi a_{s-1}/(1+\pi)$).

Note that, as defined here, capital-income mismeasurement problems arise even when individuals face constant marginal tax rates. Under a progressive tax system, the overstatement of capital income because of incomplete adjustments for inflation can also have the effect of pushing individuals into higher marginal tax brackets. This effect is obviously not associated with an increase in real capital income.

We choose not to confound the capital-income measurement problem with the bracket creep problem in our subsequent analysis. For this reason, when we refer to pure bracket creep, we will define nominal taxable income as $Y^*=W_s^*+(\iota-\pi)a_{s-1}$. Similarly, when we refer to capital-income mismeasurement, we will adjust the calculation of income for tax purposes so that the addition of the term $\pi a_{s-1}/(1+\pi))$ does not cause individuals to be pushed into higher marginal tax-rate brackets solely as a result of higher inflation.

The balance of this paper is devoted to an assessment of the cost, in economic terms, of incomplete indexation given the current structure of the personal tax code. We address this issue specifically by way of simulation exercises with a simple general-equilibrium model of the economy. Before presenting the results of our model simulations, it will be useful to describe briefly the nature of our model. Readers interested only in the results of our simulations can skip the next section without much loss of continuity.

IV. A General-Equilibrium Model of the Economy

Our analysis uses the overlapping-generations framework of Auerbach and Kotlikoff (1987) (AK). We will only briefly describe its structure here. More detailed discussions of the model can be found in Auerbach and Kotlikoff (1987) or Altig and

Carlstrom (1990).

The basic AK framework assumes that the economy is populated by a sequence of distinct cohorts, identical in every respect, with the possible exception of size. Each generation lives for 55 years and is 1+n times larger than its predecessor. Like Auerbach and Kotlikoff, we assume that lifetimes and consumption/investment opportunities are known by all individuals with perfect certainty.

Given a sequence of interest rates and wages, an individual in our version of the AK model maximizes a time-separable utility function given by

$$U_v = \sum_{s=1}^{55} \beta^{s-1} \left[\frac{c_s^{1-\sigma_c}}{1-\sigma_c} + \alpha \frac{l_s^{1-\sigma_l}}{1-\sigma_l} \right]. \tag{1}$$

The preference parameters β, σ_c, σ_l, and α represent, respectively, the individual's subjective time-discount factor, intertemporal elasticity of substitution in consumption (c), intertemporal elasticity of substitution in leisure (l), and utility weight of leisure. The subscript s denotes a period of life, which we have interpreted as a year. Each cohort is indexed by the subscript v, which corresponds to the year in which the generation is "born."

Equation (1) is maximized subject to a sequence of budget constraints given by

$$a_{t,s} = (1+\overline{r}_t)\, a_{t-1,s-1} + (1-l_{t,s})\, e_s \overline{w}_t - c_{t,s} - \tau_{t,s}, \tag{2}$$

where a variable $x_{t,s}$ refers to the value of x for an individual age s at time t, $\bar{r}_t$ is the after-tax return to capital at time t, and $\bar{w}_t$ is the after-tax market wage at time t. The variable τ refers to a lump-sum tax. Equation (2) is easily extended to the case of multiple assets by interpreting $a_{t,s}$, $a_{t-1,s-1}$, and $\bar{r}_t$ as vectors and by including the appropriate market-clearing conditions.

The variable ϵ_s in equation (2) is the productivity endowment of an individual in the s^{th} period of life. The life-cycle profile for ϵ_s is specified exogenously by the function $\epsilon_s=4.47 + 0.033s - 0.00067s^2$. This specification is taken from Welch (1979), and yields a labor productivity profile that peaks at s=25 or, interpreting s=1 as age 20, when an individual is approximately 45 years old.

In addition to equation (2), we impose the initial condition $a_{t,1}=0$, for all t, and the terminal condition that the present value of lifetime resources not exceed the present value of lifetime consumption plus tax payments. In the present model, this lifetime wealth constraint implies that $a_{t,55}=0$. In other words, there is no bequest motive.

Wage and capital incomes are obtained as payments received from competitive firms that combine capital and labor using a neoclassical production technology. The aggregate production technology is Cobb-Douglas, defined over aggregate capital and labor supplies as

$$Y_t = K_t^{\theta} L_t^{1-\theta}. \tag{3}$$

The parameter θ is capital's share in production. Aggregate capital and labor supplies are defined from individual supplies as

$$K_t = (1+n)^{t-1} \sum_{s=1}^{55} \frac{a_{s,t-1}}{(1+n)^{s-55}} \tag{4}$$

and

$$L_t = (1+n)^{t} \sum_{s=1}^{55} \frac{\epsilon_s (1-l_{t,s})}{(1+n)^{s-55}}. \tag{5}$$

The assumption of perfect competition means that gross wage and capital-income payments (w and r) will equal the marginal products of labor and capital.

The specification of the model is completed by the goods-market-clearing condition

$$Y_t = C_t + K_t - \delta K_{t-1}, \tag{6}$$

where

$$C_t = (1+n)^{t} \sum_{s=1}^{55} \frac{c_{t,s}}{(1+n)^{s-55}} \tag{7}$$

and δ is the rate of depreciation on physical capital. Note that we have assumed that the economy is closed and that government expenditures are zero. Because we wish to isolate the distortionary effects of inflation-induced changes in marginal tax rates, we will always assume that all revenues raised by distortionary taxation are redistributed to the affected individuals via lump-sum transfers. Thus, we assume that net tax revenues are always zero, so that we can dispense with the specification of the government's budget constraint.

An equilibrium in this model will be characterized by sequences of wages and capital returns such that individual labor and consumption choices are consistent with the aggregate conditions in equations (3) through (7).

We do not explicitly model a monetary sector. Inflation is introduced into our framework by the addition of an arbitrary unit of account. We thus ignore the effects of seigniorage and any distortions that arise through the inflation tax per se.

Once values are chosen for the model's parameters, solutions are obtained using numerical methods. Our benchmark parameterization is reported in table 1. These values are generally consistent with those found in other simulation studies (see, for example, AK and Prescott [1986]), and are motivated by independent empirical studies.

V. Bracket Creep in the Current Tax Code

The potential for bracket creep effects has, as intended, been substantially reduced by ERTA and especially by TRA86. The mitigating effects of recent tax legislation arise not only from the introduction of indexation, but also from structural rate changes that lowered marginal tax rates and reduced the number of effective tax brackets.

An indication of how the magnitude of the bracket creep problem is dependent on specific tax-rate structures is given in figure 1, which depicts hypothetical time series for the average marginal tax rate under three distinct rate-structure assumptions. The chosen rate schedules include one from the pre-ERTA period (1971), one from the post-ERTA/pre-TRA86 period (1982), and one from the post-TRA86 period (1989).[3] The hypothetical series in figure 1 were generated as answers to the following question: Holding fixed both the tax-rate structure and the distribution of pre-tax personal income, what effect would our actual inflationary experience have had on the average taxpayer's marginal tax rate in the absence of any indexation?

Of the three rate schedules we considered, the 1971 schedule had the most rate brackets (24) and the highest marginal tax rate (70 percent). It is also the rate schedule under which the effects of bracket creep are most dramatic. Had the 1971 rate schedule remained in effect until 1989, our estimates indicate that inflation would have increased the marginal tax rate faced

[3] To provide a consistent basis for comparison, the dollar values of the bracket limits contained in the 1982 and 1989 rate schedules were converted to 1971 values using the CPIU.

by the average taxpaying household by a full 65 percent.[4] Restricting attention to the period prior to enactment of ERTA, by 1981 inflation would have raised the average marginal tax rate by 45 percent.[5]

By 1982, the number of tax brackets had been reduced from 24 to 12 and the top marginal tax rate had been cut to 50 percent. Simplifying somewhat, TRA86 further reduced the number of tax brackets to four and the top marginal tax rate to 33 percent.[6] Judged by the hypothetical impact of bracket creep depicted in figure 1, both ERTA and, especially, TRA86 appear to have significantly reduced the degree of progressivity in the personal

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[4] Our calculations assume that the average taxpayer is one of a family of four, claims slightly more than the standard deduction, and faces the statutory rate schedule for married persons filing jointly. We have also assumed, counterfactually, that the dollar amounts of personal exemption and standard deduction allowances kept pace with annual realizations of the rate of inflation, and that the ratio of taxable to nontaxable income remains unchanged.

[5] We do not suggest that this number reflects the actual change in the average marginal tax rate from 1971 through 1981. We have completely ignored tax avoidance behavior, changes in the distribution of income, and other complications that might have had a significant impact on the average rate actually realized. Furthermore, the Tax Reform Act of 1976 instituted, among other things, increases in the dollar values of rate brackets, thus implementing a degree of ad hoc indexation.

[6] The exact determination of marginal tax rates under TRA86 is complicated by the phase-out of personal exemptions at higher income levels. For simplicity, we utilize published rates for taxable incomes below $155,320 (Schedule Y-1 in the Instructions for Form 1040, Internal Revenue Service) and assume a marginal tax rate of 28 percent for all income above $155,320.

tax-rate structure.[7] If the 1989 rate structure had been in effect since 1971, our calculations imply that inflation would have increased the average marginal tax rate on personal income by only 17 percent.

It is clear from figure 1 that the rate reductions legislated in TRA86 can, relative to the rate structures of the two prior decades, significantly reduce the effects of bracket creep. The relevant question in the current environment is, of course, whether the current indexing scheme, in conjunction with the mitigating effects of the TRA86 rate structure, effectively eliminates the problem of bracket creep.

Recall from our discussion above that the specifics of the indexing provisions contained in ERTA and TRA86 are such that bracket indexation effectively takes place with a lag of one year. The issue of how well our current tax code protects individuals from bracket creep fundamentally concerns the issue of how much this one-year lag matters. What, then, does our version of the AK simulation model tell us about the long-run cost of a sustained inflation rate under a personal income tax

[7] We emphasize some important qualifications to this statement. First, measuring the progressivity of the tax system is a subtle and ambiguous enterprise (see, for example, Kiefer [1984]). Second, as we have noted, our calculations ignore changes in some important determinants of the level of taxable income to which specific tax rates apply. Chief among these for TRA86 are increases in standard deductions, personal exemptions, and the earned-income credit. These provisions are likely to have important effects on the progressivity of the personal tax code for low-income taxpayers (see Pechman [1987]). Our suggestion that progressivity was reduced by ERTA and TRA86 should thus be taken in the casual spirit in which it is given.

system with a rate structure and indexing provisions similar to the tax code as of 1989?[8]

The results of our bracket creep experiments are given in table 2 and figure 2.[9] Table 2 reports the steady-state, annual percentage loss in output caused by bracket creep for economies with 4 percent and 10 percent steady-state inflation rates, assuming an indexation scheme that adjusts with a one-year lag, as in ERTA and TRA86.[10] The output losses are measured relative to economies with zero steady-state inflation rates, and are reported in table 2 for several alternative parameterizations. Figure 2 plots the outcomes of simulations with inflation rates ranging from 1 percent to 10 percent for three different assumptions about σ_c, the intertemporal elasticity of substitution in consumption.

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[8] The actual tax-rate structure relevant to our simulations has marginal tax rates that range from 15 to 28 percent. These rates necessarily differ from those realized in the actual economy for two reasons. First, life-cycle variations represent the only income heterogeneity in our model. The distribution of income in the model is therefore substantially compressed relative to the actual economy. Consequently, no agent in the model faces the highest tax rate (33 percent) or the lowest tax rate (0 percent). Second, to facilitate convergence, we have allowed the tax code to be continuous for a small range of incomes along the transition from a 15 percent marginal tax rate to a 28 percent marginal tax rate.

[9] Recall that we isolate the effects of bracket creep only by first indexing for capital-income measurement in the simulation exercises. As noted above, this is accomplished by defining nominal income as $Y^*=W_s^*+(\iota-\pi)a_{s-1}$.

[10] With lagged indexation, steady-state inflation distortions amount to permanently increasing an individual's nominal income, relative to the tax bracket limits, by $1+\pi$.

In the benchmark model with a sustained, perfectly anticipated annual inflation rate of 4 percent, the distortionary effects of bracket creep result in an annual steady-state output loss of 1.3 percent. To put this number in perspective, real GNP in 1989 was $4,024 billion, 1.3 percent of which equalled about $52 billion, or about $209 for every American. Assuming an annual growth rate of 2 percent and an after-tax discount rate of 4 percent, the present value of an annual output loss of this magnitude is about $2.7 trillion.[11]

The distortionary effects are smaller when we let $\sigma_c=5$, thus assuming a lesser willingness of individuals to substitute consumption over time. Still, even in this more conservative case, the interaction of bracket creep and a 4 percent steady-state inflation rate results in an annual loss of about $48 billion, again using 1989 as a benchmark.

Note that, for the three cases depicted in figure 2, the magnitudes of the percentage losses that arise from bracket creep distortions diverge as the rate of inflation increases. Furthermore, for a given preference specification, the limiting value of output losses from bracket creep appear to be reached at lower rates of inflation, the higher the value of σ_c. This pattern reflects both the maintained preference structure and the assumed tax-rate schedule.

Consider, for example, $\sigma_c=5$ preferences. When $\sigma_c=5$,

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[11] In general, if the after-tax discount rate equals $\tilde{r}$ and the growth rate of output equals μ, the present value of a sustained output loss equal to YL equals $YL\cdot(1+\tilde{r})/(\tilde{r}-\mu)$.

individuals choose income and consumption profiles that are flat relative to the cases in which individuals are more willing to substitute consumption intertemporally. Furthermore, in the $\sigma_c=5$ case, the chosen profiles are relatively insensitive to policy-induced changes in after-tax wages and interest rates. Thus, individuals are less likely to substitute consumption and leisure to low marginal tax-rate phases of the life cycle than is the case when $\sigma_c<5$, and so relatively more individuals in the $\sigma_c=5$ economy end up facing the highest marginal tax rate. Because the bracket creep phenomenon disappears when there are no more brackets to creep into, the effects of bracket creep are less dramatic at higher inflation rates for the $\sigma_c=5$ case than for the $\sigma_c=3$ case. By the same logic, the effects of bracket creep are less dramatic at higher inflation rates for the $\sigma_c=3$ case than for the $\sigma_c=1$ case.

By focusing solely on the distortionary output loss associated with bracket creep, we leave out a potentially important, and arguably the most important, element of the analysis: the fact that bracket creep does indeed raise revenues. To the extent that bracket creep is a relatively efficient form of revenue generation, the output losses reported in table 2 and figure 2 are not appropriate indicators of the welfare losses arising from bracket creep.

To assess the efficiency of raising revenues through bracket creep, we can ask the following question: For a given rate of inflation, what is the level of steady-state output associated with bracket creep relative to steady-state output in an economy in which an equivalent amount of revenue is raised by increasing all marginal tax rates proportionately? In a strict sense, our simulations assume that net tax revenues are zero, since we have assumed that lump-sum transfers offset all revenues raised through distortionary taxation. In the subsequent analysis, we refer to the revenue raised in each of our simulations as the level of the lump-sum subsidy or tax necessary to maintain zero net taxes.

Figure 3 plots the loss of output from the distortionary effects of bracket creep measured relative to the distortionary costs of equal revenue changes in the rate structure. We again plot results for the σ_c=3, σ_c=1, and σ_c=5 preference structures.

The message of figure 3 is clear: Bracket creep is an extremely inefficient method of raising revenue. For the benchmark case with a 4 percent steady-state rate of inflation, taxes raised through bracket creep result in a steady-state output that is 1.2 percent less than the steady-state output level that would result from raising an equal amount of revenue through proportionate increases in statutory marginal tax rates. With the 1989 benchmark, this difference amounts to a $48 billion output loss from exercising the inflationary, rather than legislative, revenue option. Furthermore, the relative output loss increases with the rate of inflation. For a 10 percent rate of inflation, revenues raised through bracket creep in the benchmark simulation exact an additional annual output cost of almost $74 billion compared with revenues raised by proportionately increasing marginal tax rates.

It is useful to note that the different output levels in the bracket creep case and the statutory rate change case result from a difference in the life-cycle incidence of the two types of tax changes. Unlike the case in which revenues are raised from proportionately increasing all marginal tax rates, bracket creep alters the incentive to save across phases of the life-cycle in which individuals face high and low marginal tax rates. The resulting relative intertemporal price changes interact with general-equilibrium effects to disproportionately burden the high savers in our model when taxes are raised through bracket creep; hence the larger output costs associated with revenue generation via the interaction of inflation and the nominal tax structure.

VI. What Bracket Indexation Can't Fix: The Case of Capital Income

Thus far, we have examined only distortions created by the interaction of progression in the U.S. tax-rate structure and the current practice of adjusting nominal brackets with a one-year lag. These distortions could be eliminated, or at least substantially mitigated, either by making the tax-rate structure less progressive or by reducing the lag between the tax year and index year. Neither of these changes, however, would eliminate the other source of inflation distortion noted above: the failure to index for capital-income adjustment.

Recall that simply deflating by $1+\pi$ is not sufficient to convert nominal capital income to real capital income--converting income in this way ignores the fact that part of the nominal return to capital is a repayment of principal lost through the effects of inflation. But bracket indexation, even perfect bracket indexation, basically amounts to dividing nominal income by $1+\pi$, and so provides no protection to the taxpayer from the mismeasurement of capital income due to inflation.

Assessing the economic impact of inadequate inflation accounting in the measurement of capital income is complicated enormously by the different tax treatment afforded income from different asset types, and by the fact that a good portion of the tax levied on capital income occurs at the firm level.[12] We sidestep most of these complications and consider two very basic types of experiments. In the first, we abstract from the bracket creep problem and simply simulate the long-run effect of incorrectly calculating capital income when the steady-state rate of inflation is nonzero. In this case, taxable income is defined

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[12] A similar problem, which we have ignored, arises with respect to wage income and Social Security taxes, roughly half of which are imposed on employers. Although Social Security taxes certainly affect the marginal tax-rate structure, we feel that explicitly addressing the Social Security tax issue is of lesser importance than the capital income issues we address in this section. Our justification for this position is threefold. First, labor supply distortions in our model are quantitatively less significant than capital income distortions. Second, the Social Security tax does not involve the tax arbitrage opportunities that are introduced when firms are allowed to choose different capital structures. Third -- and this point is related to the second -- introducing Social Security taxes is likely to increase the costs associated with bracket creep; on the other hand, as we discuss later, ignoring capital-income-tax arbitrage will yield overestimates of the steady-state losses arising from the interaction of inflation and the tax system.

as $Y^*=(W_s^*+i\,a_{s-1})/(1+\pi)$. It is easily verified that defining income in this way overstates capital income by $\pi a_{s-1}/(1+\pi)$.[13]

In the second set of simulations, we also abstract from bracket creep, but introduce a richer asset structure into the model in order to capture some of the effect of tax arbitrage behavior. Specifically, we allow firms to purchase capital through the sale of two broad types of claims: debt and equity. Before proceeding to the results of these simulation experiments, we present a short digression on this extension of our framework.

VII. Debt and Equity in the General-Equilibrium Model

Our expanded framework essentially follows Miller (1977). We ignore issues of risk, agency relationships, and so on, and assume that these asset types are distinguished only by tax treatment. Equity finance is subject to two separate tax rates: a flat corporate tax rate, τ^f, levied at the firm level, and a capital gains tax levied at the individual level. Determination

[13] A technical adjustment in the choice of tax bracket limits is necessary to isolate the effects of not indexing for capital income in our cross-steady-state simulation exercises. To motivate the nature of the adjustment, consider an individual whose taxable capital income is incorrectly adjusted for inflation according to the formula $Y'=i\,a_{s-1}/(1+\pi)$, which we know overstates capital income by an amount equal to the lost value of principal due to inflation. Now consider an alternative economy with a steady-state inflation rate equal to $\tilde{\pi}$. Taxable capital income in this economy is $\tilde{Y}'=a_{s-1}/(1+\tilde{\pi})$. It is easily seen that, with static tax brackets, the marginal tax rate applied to Y' and $\tilde{Y}'$ will not generally be the same. This type of distortion is distinct from the distortion created by nonindexation of capital income that we wish to capture. To avoid this problem, we adjust the tax bracket limits in each of our simulations so that the only distortions are those that arise from not subtracting the term $\pi a_{s-1}/(1+\pi)$ in the calculation of real taxable income.

of the capital gains rate is, of course, significantly complicated by the fact that capital gains are taxed only upon realization. The effective marginal tax rate on capital gains depends on the statutory rate, the inflation rate, and the holding period of the equity instrument. We simplify by assuming that, in the absence of inflation distortions, capital gains are taxed at a flat rate τ^g.

With respect to debt finance, we allow firms to expense nominal interest payments fully. These interest payments are then taxed at the individual level according to the personal-income tax-rate structure.

Ignoring indexation for the moment, this extension of our simulation model yields the equilibrium conditions

$$i^E = i^d(1-\tau^f) \tag{8}$$

$$i^E(1-\tau^g) = i^d(1-\tau^{p*}), \tag{9}$$

where i^E is the nominal rate of return to equity, i^d is the nominal rate of return to debt, and τ^{p*} is the marginal tax rate of an individual who is indifferent between holding debt and holding equity. The tax rate τ^{p*} can be determined by noting that equations (8) and (9) yield the relationship $(1-\tau^{p*})=(1-\tau^g)(1-\tau^f)$.

Individuals who face marginal tax rates below τ^{p*} will choose to hold debt; those who face marginal tax rates exceeding

τ^{p*} will choose to hold equity. Inflation distortions that alter effective marginal tax rates will, therefore, typically induce some individuals to shift between debt and equity.

VIII. Nonindexation of Capital Income: Simulation Results

The significance of capital-income mismeasurement, and the mitigating effect of tax arbitrage behavior on distortions created by the interaction of inflation and tax rates, is apparent from the results of the simulation experiments depicted in figure 4. These experiments assume the benchmark parameter specification, and include the case where the personal tax-rate schedule is applied to homogeneous capital income, the case where both debt and equity income are mismeasured for tax purposes (but taxed at different rates), and the case where equity, but not debt, income is indexed for inflation. In each of these experiments we abstract entirely from bracket creep effects.

The latter two sets of simulations incorporate our extended capital structure, and hence admit some scope for tax arbitrage. In these simulations, we assume a capital gains tax rate of 18 percent and a corporate tax rate of 10 percent. The 18-percent rate for capital gains assumes a real pre-tax interest rate of 6 percent, a statutory personal tax rate of 28 percent, and an average holding period of 20 years.[14]

A corporate tax rate of 10 percent is almost certainly too

[14] The capital gains rate is derived from the formula $(1+r(1-\tau^g))^T=(1+r)^T-\tau((1+r)^T-1)$, where T= the average holding period.

low.[15] However, combining a higher corporate tax rate with our assumptions about personal marginal tax rates would quickly yield values of τ^{p*} so high that no individual would choose to hold equity. Since we are primarily interested in the personal tax code, we have chosen to maintain our assumptions about the personal tax parameters, which we believe to be reasonable, and compromise on the corporate tax rate.[16]

As seen in figure 4, the steady-state output losses caused by inflation when there is no indexation for capital-income measurement are uniformly higher in the absence of tax arbitrage opportunities. This result is hardly surprising. However, even when we admit tax arbitrage opportunities, the steady-state output losses are much larger than the losses that arise from pure bracket creep under the current indexing regime. With a steady-state inflation rate equal to 4 percent and constant equity tax rates, annual output without indexation for capital-income measurement is slightly more than 2 percent lower than annual output in a zero-inflation economy for the benchmark parameterization. Thus, with 1989 as the reference point, the

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[15] Estimates kindly provided to us by Jane Gravelle suggest that the average effective corporate tax rate is in the range of 30 to 40 percent.

[16] Furthermore, our inability to sustain the analysis with realistic corporate tax rates is almost certainly a result of the extremely simple problem with which we have confronted the firm. It is unclear to what extent introducing a more sophisticated capital structure problem would alter our conclusions. We believe that the missing elements have to do with omitted costs to debt finance that would alter the arbitrage condition in equation (8). To the extent that these costs are invariant to the rate of inflation, our analysis is probably robust to these omissions.

annual real output cost of failure to index for capital-income measurement is about \$87 billion (\$348 annually in per capita terms, \$4.5 trillion in present value terms). This figure is 50 percent greater than the output cost associated with a failure to fully index the tax-rate schedule for bracket creep.

For a given tax structure and inflation rate, the larger output losses arising from capital-income mismeasurement relative to bracket creep do not correspond to larger revenues. In figure 5 we separately plot the simulated increases in steady-state revenues collected from capital-income mismeasurement and bracket creep for the benchmark parameterizations with $\tau^g=.18$ and $\tau^f=.1$. Although revenues increase steadily with inflation in the bracket creep scenario, the revenues raised from the capital-income mismeasurement peak at $\pi=.05$ and decrease thereafter.

This "Laffer curve" associated with capital-income mismeasurement in our extended model clearly illustrates the potentially powerful effects of tax arbitrage. The pattern of revenue shown in figure 5 results from the effect of falling incomes on marginal tax rates, and induced shifts from equity to debt. As firms exploit the write-off provisions of nominal debt payments, corporate tax payments fall, more than offsetting the relative increases in personal tax payments at higher rates of inflation.

In the bracket creep case, income does not decline enough to offset the higher marginal tax rates induced by bracket creep. Although arbitrage occurs, the net movement is from debt to equity, and so both corporate and personal taxes increase in our simulations for inflation rates up to 10 percent.

The relative inefficiency of raising revenues through the capital-income mismeasurement phenomenon is also apparent when we consider the output losses relative to equal revenue changes in the marginal tax-rate structure plotted in figure 6. For the benchmark case with 4 percent inflation, output is just under 2 percent lower in the capital-income mismeasurement simulation. This difference represents an annual output loss of $78 billion in terms of 1989 GNP.

The primary distortion from capital-income mismeasurement in the extended capital structure case comes from the failure to index capital gains. It can be easily shown that, with perfect capital gains indexation and flat marginal tax rates, the tax-adjusted Fisher equation holds, and hence inflation is neutral, when the corporate tax rate equals the personal marginal tax rate of all debt holders.[17]

Even when the conditions necessary for the tax-adjusted Fisher equation to hold are violated, indexation of capital gains is sufficient to eliminate most of the capital-income distortions induced by inflation in our model. The bottom dashed line in figure 4 depicts the steady-state output losses from simulations

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[17] The tax-adjusted Fisher equation is given by $i=r+\pi/(1-\tau^{p^*})$. The Fisher effect will hold under a progressive tax system with perfect capital-gains indexation if borrowers and lenders face the same marginal tax rate. Under the same conditions, the tax-adjusted Fisher equation would be valid were we to introduce a consumption-loans market.

in which indexation for capital-income measurement is applied to equity income, but not to debt income. At a 4 percent inflation rate, steady-state output in this situation is only .16 percent less than in the zero-inflation economy. Even at a 10 percent rate of inflation, steady-state output is only about .3 percent lower than annual output in the zero-inflation economy.

Figure 6 illustrates another interesting aspect of the case in which income from equity, but not debt, is indexed. Revenue generation through capital-income mismeasurement with capital gains indexation is slightly more efficient than equal revenue generation through proportionate increases in statutory marginal tax rates.

As is apparent in figure 7, the relative efficiency of inflation-generated revenues is dependent, at least when capital gains are indexed, on the preference structure and the level of the inflation rate. Still, it is not surprising that our model includes some set of circumstances under which the output losses from nonequity capital-income mismeasurement are lower than those associated with across-the-board rate increases. The intuitive explanation is essentially the converse of the intuition for the inefficiency of raising revenues through inflation/tax-system interactions we have found in the simulations reported above.

It is clear from the equilibrium conditions (8) and (9) that equity will be held by those individuals who face the highest marginal tax rates. Given the structure of our model, these are precisely the individuals who are the largest savers in the steady state. Thus, compared to the proportionate-rate-increase scheme, indexing capital gains, in some circumstances, shifts tax incidence toward those who account for relatively less of the economy's capital accumulation, thereby mitigating the distortionary effects of the tax increases.

IX. Summing Up the Costs of Nominal Taxation and Inflation

We complete our investigation by simulating the combined effects of imperfect bracket indexation and failure to index capital-income measurement, both of which are features of our current tax code.

The steady-state output losses from these experiments are plotted for the benchmark parameterization, for the case with σ_c=1, and for the case with σ_c=5 in figures 8 and 9. Figure 8 plots results from experiments that abstract from arbitrage possibilities. Figure 9 depicts results from the extended model introduced in section VII.

Even for the most conservative of the three cases in figure 6, the σ_c=5 case with separate tax treatment of debt and equity, a 4 percent steady-state rate of inflation reduces annual steady-state output by almost 2.5 percent. Using the 1989 reference point one more time, this figure implies a one-year output loss of a bit more than $100 billion. In the σ_c=1 case without operative arbitrage opportunities, the case with the largest distortionary losses, 4 percent inflation means an annual loss of $181 billion.

Table 3 summarizes, for the benchmark parameterization, the comparisons of these distortionary losses with the losses from experiments with equal revenue rate increases. We report the simulation results for steady-state inflation rates of 4 and 10 percent, and have included for comparison the results from the simulation exercises reported above.

The most obvious message of table 3 is that the full distortion is much greater than the sum of its parts. For a 4 percent steady-state rate of inflation, incomplete bracket indexation and the failure to index for capital-income mismeasurement result in a distortionary annual output loss of \$117 billion relative to the loss from increasing marginal tax rates directly in our extended model with tax arbitrage possibilities. The corresponding cost with 10 percent inflation is more than \$260 billion (and more than \$338 billion in the model without tax arbitrage opportunities).

X. Concluding Remarks

Our analysis has important policy implications, the primary one being that the job of insulating the personal tax code from the distortionary effects of inflation is far from complete. Given the substantial costs that are likely to result from these distortions, we believe the cases for further tax reform or, failing that, for monetary policies that pursue the goal of price stability, are persuasive. However, we anticipate some possible objections to this conclusion.

The first of these objections involves legislative intent -- the belief that Congress was fully aware that inflation would eventually increase effective tax rates when it failed to fully index the tax code in ERTA and, later, in TRA86. This belief may or may not be correct, but our analysis clearly indicates that, as a means of raising general revenues, reliance on inflation/tax-system interactions is inefficient and therefore costly. If the functioning of government requires tax increases, we would be much better served by legislating proportionate increases in statutory marginal tax rates.

We are aware, of course, that normal economic growth will also result in a form of bracket creep. However, we believe that bracket creep through real economic growth has much different normative implications than bracket creep that results from inflation. In addition, we fully endorse indexing the personal tax code to nominal income growth per se.

Our analysis indicates that most of adverse consequences of inflation/tax-system interactions for moderate inflation rates could be eliminated by moving toward contemporaneous adjustment of rate brackets and indexation of capital gains. Perhaps the failure to implement these features arises from a practical inability to do so. In this case, the analysis clearly points toward a monetary policy that maintains price stability, or a rate of inflation that equals zero on average.

The most common objection to a zero-inflation monetary policy is the presumed costs that would arise along the transition path. We are generally skeptical of the view that an anti-inflationary monetary policy would necessarily have an adverse effect on real economic activity. But what if it did? Our most conservative estimate of the full effects of inflation/tax-system distortions suggests a present-value cost of more than $6 trillion with 4 percent inflation, even when measured relative to the output losses from an equal revenue increase in the statutory tax-rate schedule. Does any sensible analysis predict that the recessionary effects of tight monetary policy would cause a present-value loss of this magnitude?

Critics may argue that the numbers we derive from our simulations are generated from a highly simplified framework. We concede the point, but certainly do not believe that our analysis is any less realistic than analyses that predict substantial costs from monetary policies designed to arrive at zero inflation. At the very least, our estimates have the virtue of being generated from a general-equilibrium framework that is fully identified and not subject to the sample selection biases that contaminate many purely econometric estimates.

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Table 1: Benchmark Parameters

Parameter	Description	Value
σ_c	Elasticity of Substitution in Consumption	3.0
σ_l	Elasticity of Substitution in Leisure	5.0
β	Subjective Time-Discount Factor	0.97
α	Utility Weight of Leisure	0.5
n	Population Growth Rate	0.013
θ	Capital Share in Production	0.36
δ	Depreciation Rate of Capital	0.10

Source: Authors' calculations.

Table 2: Steady-State Output Losses From Bracket Creep Under Alternative Parameterizations

Parameterization	Percentage Change in Steady-State Output	
	4% Inflation	10% Inflation
Benchmark	-1.11	-1.81
$\sigma_c = 1.0$	-1.13	-2.34
$\sigma_c = 5.0$	-0.85	-1.17
$\beta = 0.99$	-0.61	-0.82
$\beta = 0.93$	-1.27	-2.64
$n = 0.0$	-0.96	-1.55
$n = 0.03$	-1.28	-2.19
$\delta = 0.0$	-0.97	-1.84
$\delta = 0.07$	-1.14	-1.87

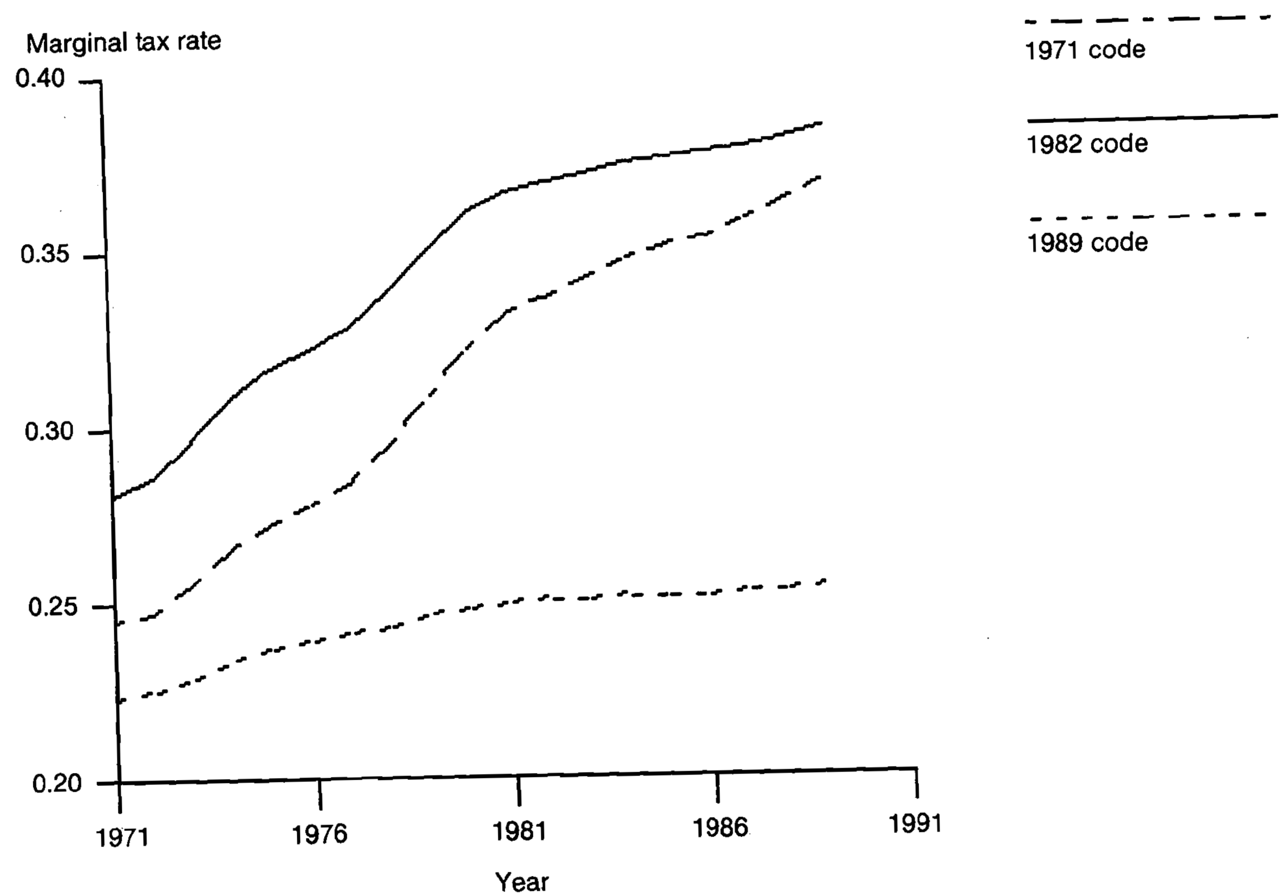
Source: Authors' calculations. Each entry records the percentage reduction in steady-state output, relative to an identical economy with zero inflation, that results from the effects of bracket creep when the inflation rate is as indicated. All parameters except the ones indicated are set equal to their benchmark values.

Table 3: Output Losses From Inflation/Tax Interactions Relative to Output Losses From Equal Revenue, Proportionate Increases in Marginal Tax Rates

Model	Percentage Difference in Steady-State Output (1989 Value of Difference, Billions)	
	4% Inflation	10% Inflation
$\tau^f=\tau^g=0$		
Full Distortion	3.68% ($148)	8.39% ($338)
Capital-Income Mismeasurement	1.70% ($68)	3.55% ($143)
Pure Bracket Creep	1.30% ($52)	2.17% ($87)
$\tau^f=.1,\tau^g=.18$		
Full Distortion	2.91% ($117)	6.46% ($260)
Capital-Income Mismeasurement	1.96% ($79)	4.45% ($179)
Pure Bracket Creep	0.82% ($33)	1.33% ($54)

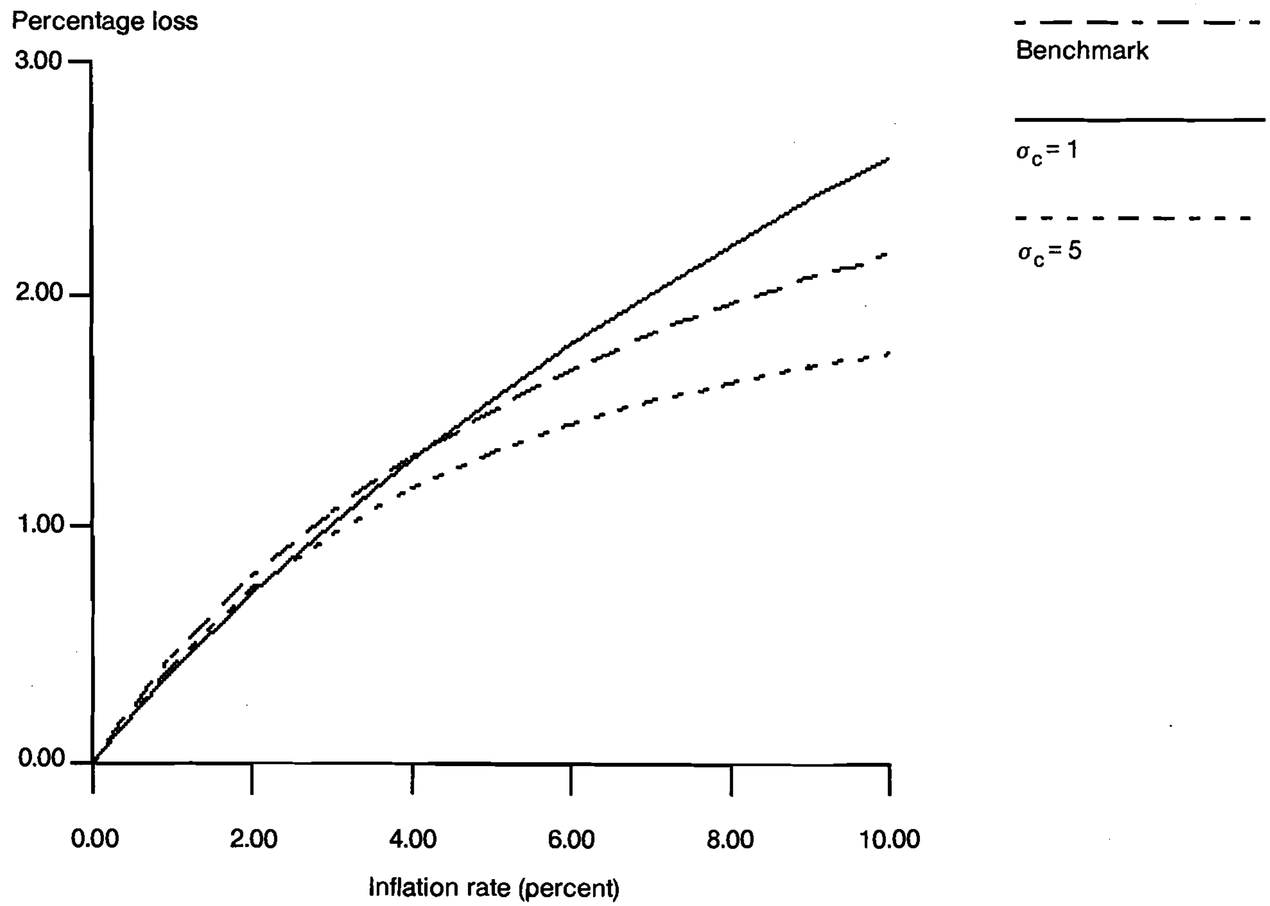
Source: Authors' calculations. Each entry records the percentage reduction in steady-state output (dollar value, in billions, of the steady-state output reduction using 1989 as a reference year), relative to an economy in which equal revenues are raised by proportionately increasing marginal tax rates on personal income. All parameters are set equal to their benchmark values.

Figure 1: Effects of Bracket Creep on Effective Marginal Tax Rates



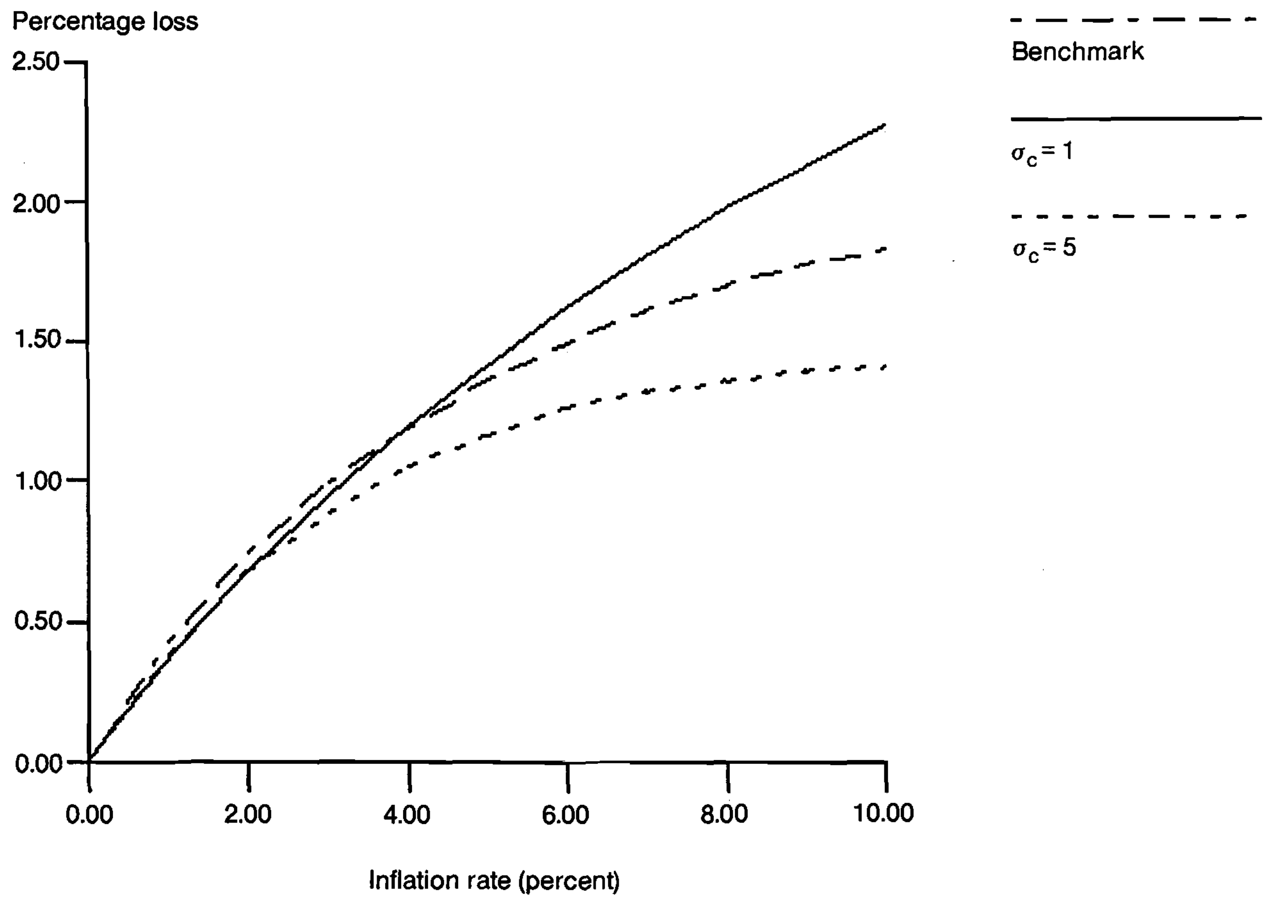
SOURCES: Authors' calculations and *Statistics of Income*, Internal Revenue Service.

Figure 2: Absolute Steady-State Output Loss (in Percent) from Pure Bracket Creep



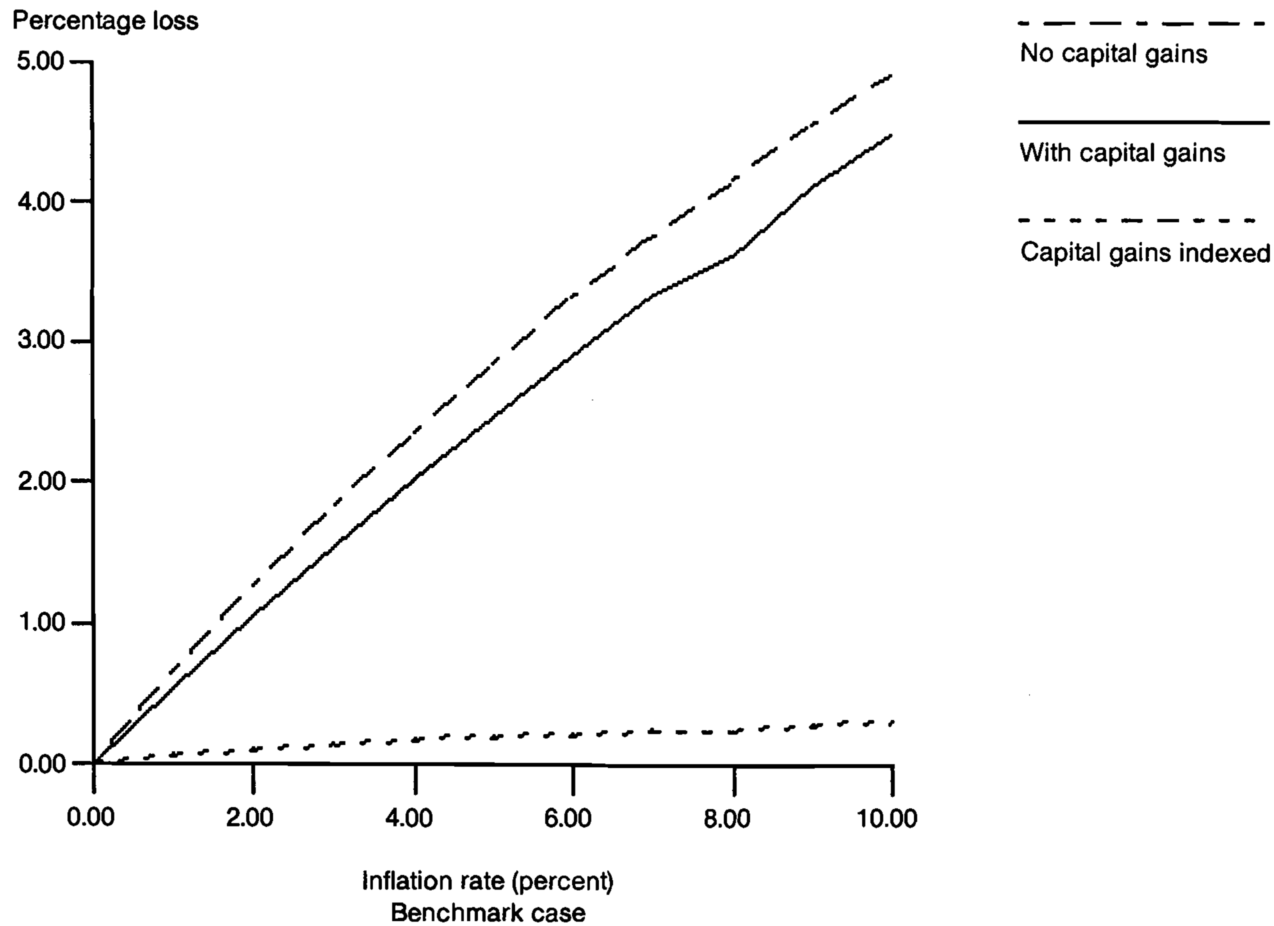
SOURCE: Authors' calculations.

Figure 3: Output Loss (in Percent, Relative to Equal Revenue Change in Tax-Rate Structure) from Pure Bracket Creep



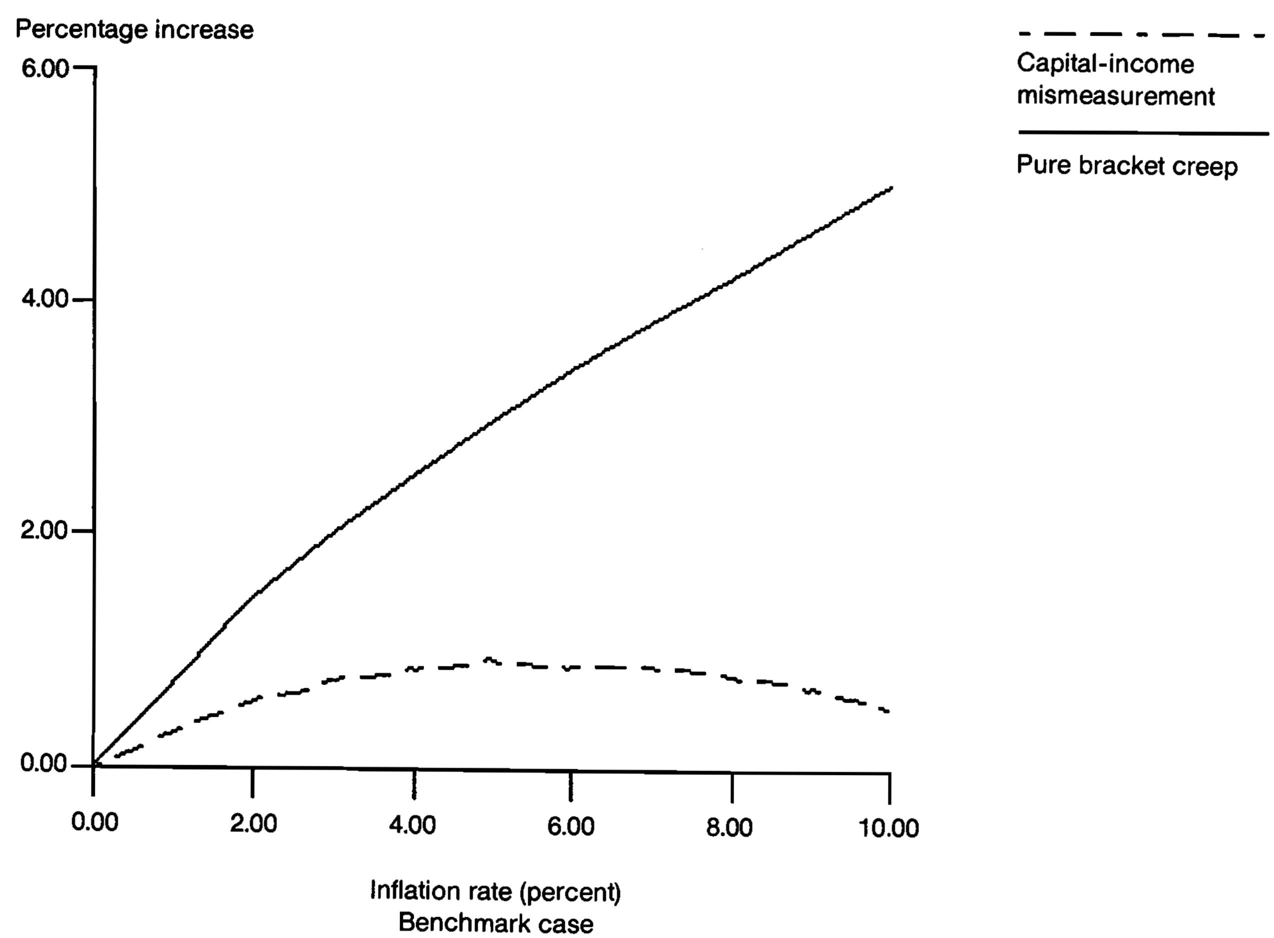
SOURCE: Authors' calculations.

Figure 4: Absolute Steady-State Output Loss (in Percent) from Capital-Income Mismeasurement



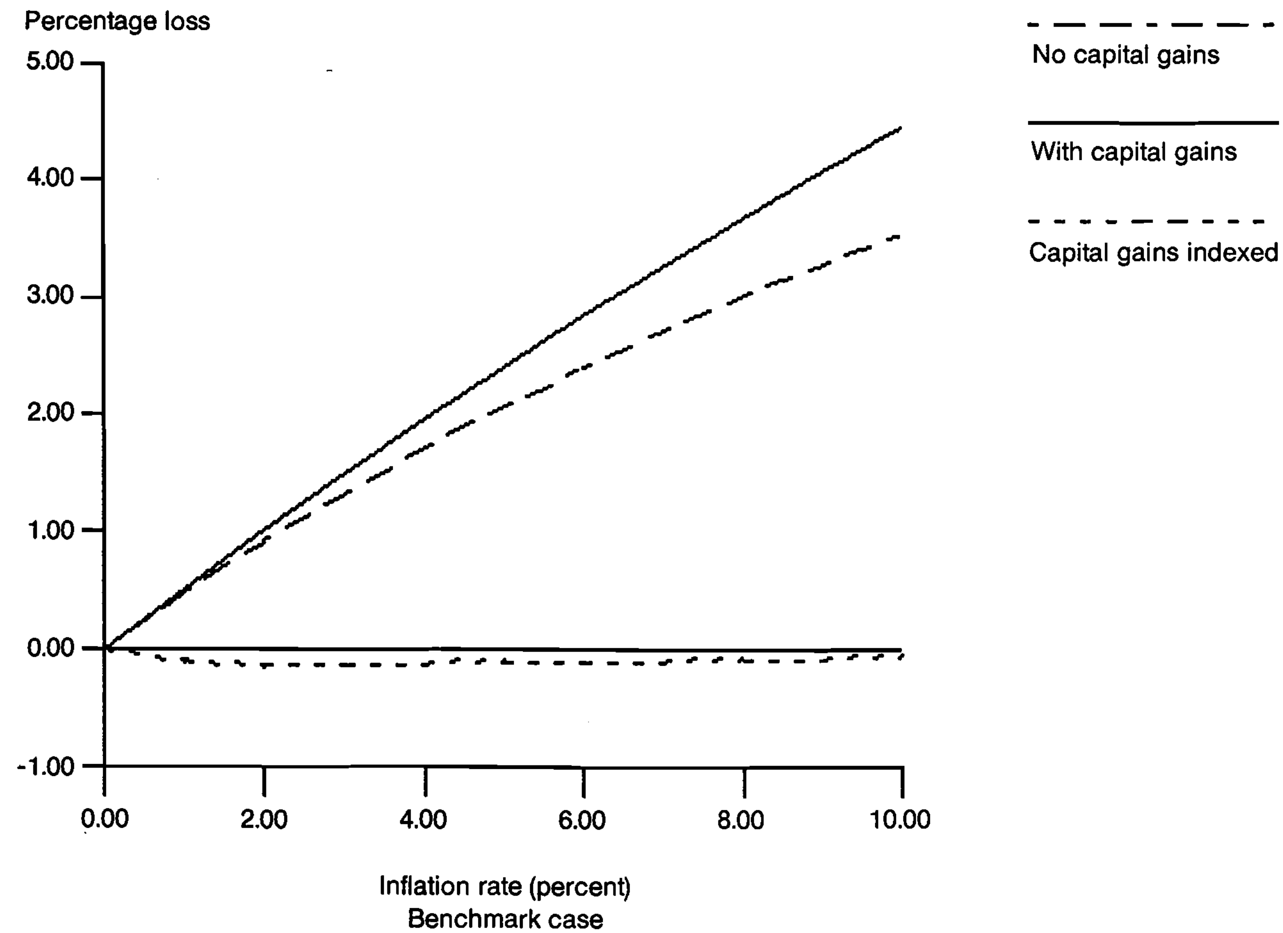
SOURCE: Authors' calculations.

Figure 5: Percent Change in Revenue



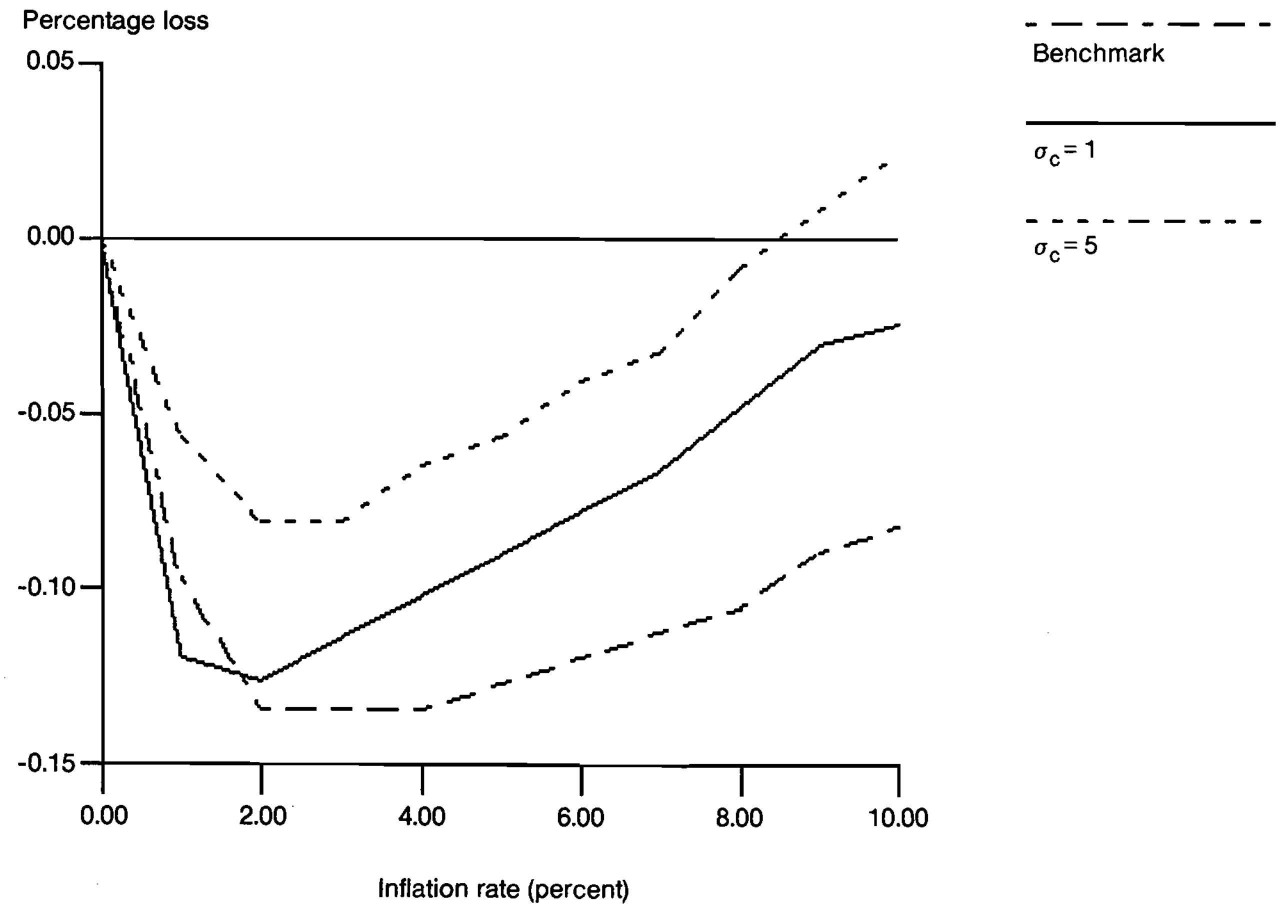
SOURCE: Authors' calculations.

Figure 6: Output Loss (in Percent, Relative to Equal Revenue Change in Tax-Rate Structure) from Capital-Income Mismeasurement



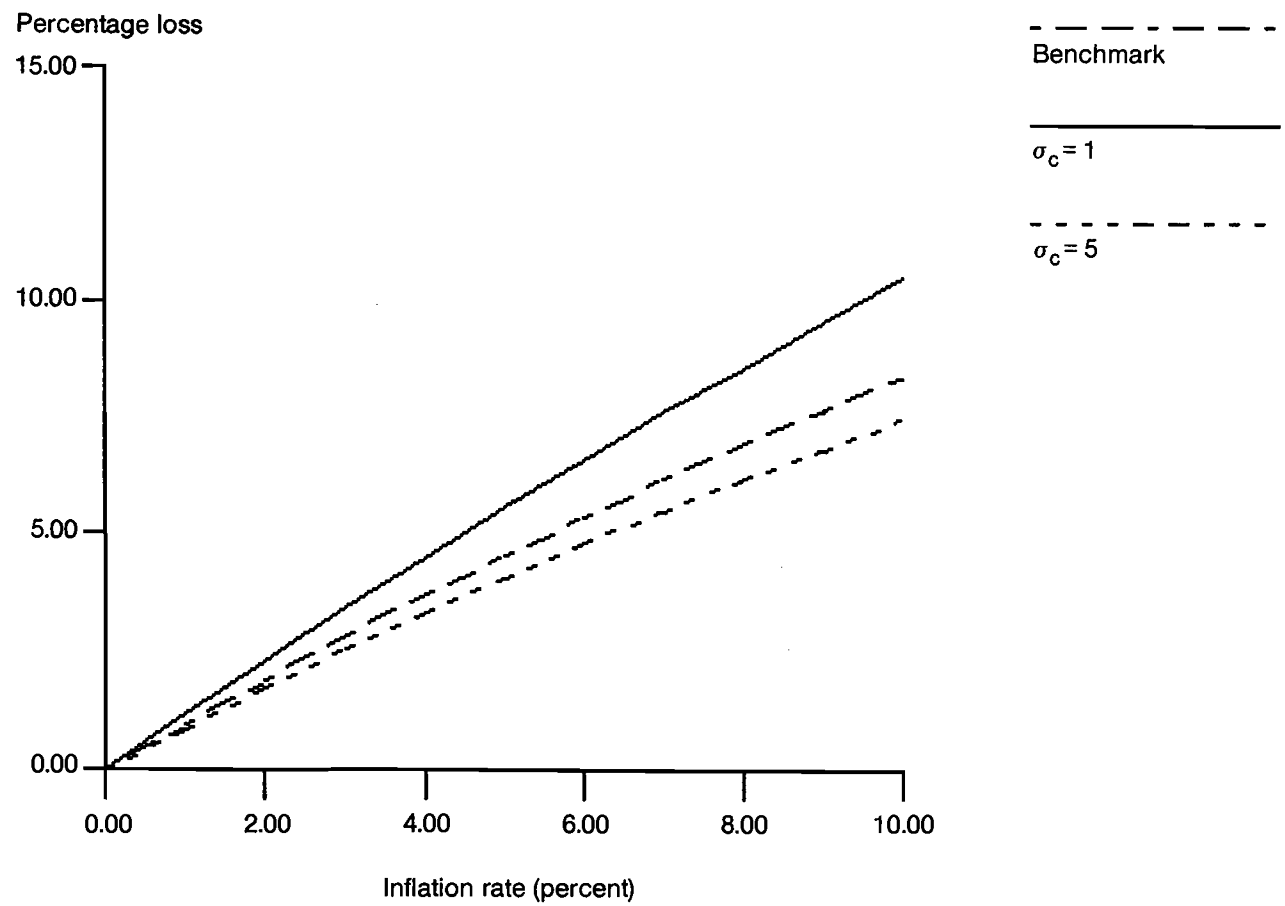
SOURCE: Authors' calculations.

Figure 7: Output Loss (in Percent, Relative to Equal Revenue Change in Tax-Rate Structure) from Capital-Income Mismeasurement with Capital Gains Indexed



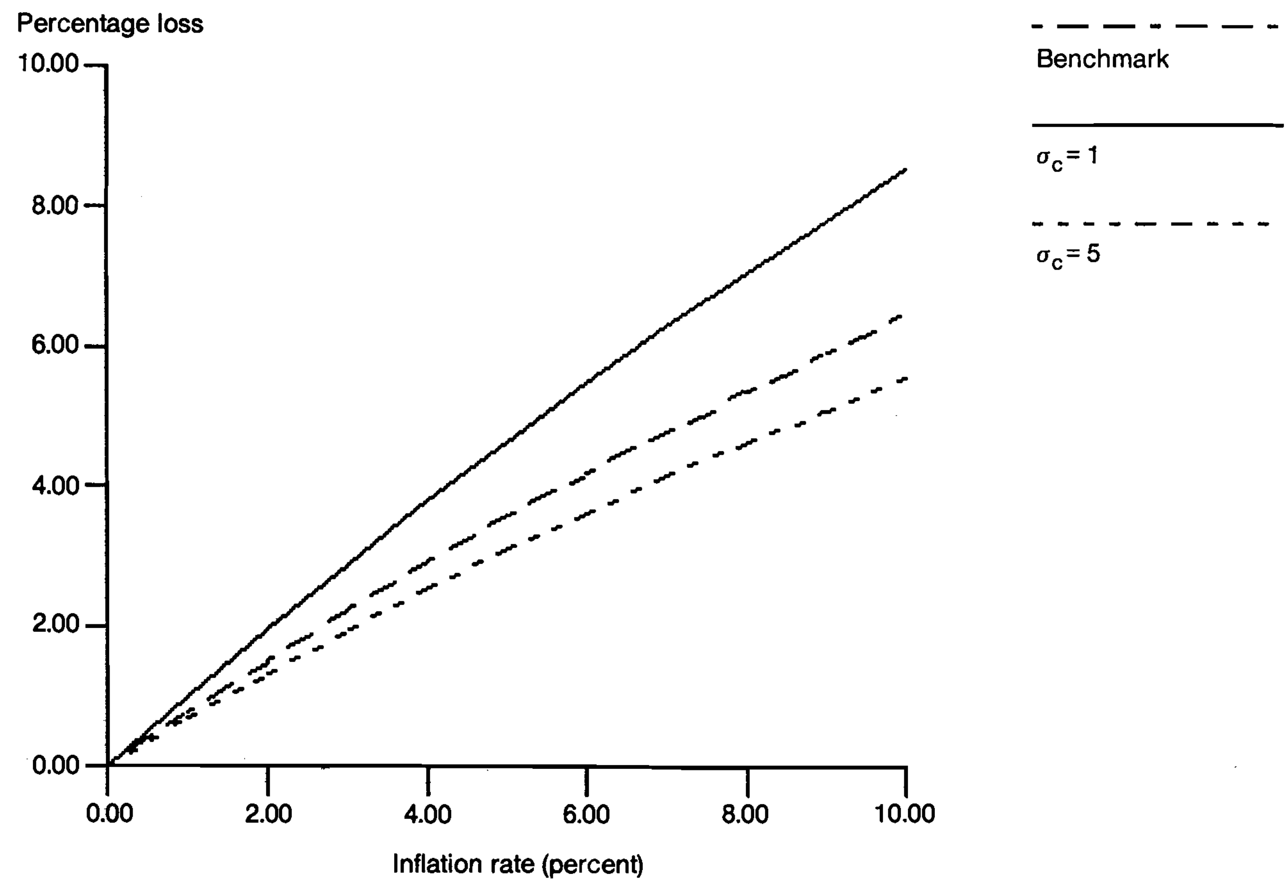
SOURCE: Authors' calculations.

Figure 8: Output Loss (in Percent, Relative to Equal Revenue Change in Tax-Rate Structure), Full Distortion Case, No Capital Gains



SOURCE: Authors' calculations.

Figure 9: Output Loss (in Percent, Relative to Equal Revenue Change in Tax-Rate Structure), Full Distortion Case, with Capital Gains



SOURCE: Authors' calculations.