NBER WORKING PAPER SERIES

# CAPITAL TAX INCIDENCE: FISHERIAN IMPRESSIONS FROM THE TIME SERIES

Casey B. Mulligan

Working Paper 9916
http://www.nber.org/papers/w9916

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2003

I appreciate the comments of Alan Auerbach, Austan Goolsbee, David Cutler, Marty Feldstein, Don Fullerton, and Bob Lucas, GSB Macro Lunch Eaters, seminar participants at the University of Chicago and NBER, and the research assistance of Fabian Lange and Justin Marion. This research was made possible by financial support from the University of Chicago's George Stigler Center for the Study of the Economy and the State, and joint work with Jason Hwang and Justin Marion. The views expressed herein are those of the authors and not necessarily those of the National Bureau of Economic Research.

Capital Tax Incidence: Fisherian Impressions from the Time Series
Casey B. Mulligan
NBER Working Paper No. 9916
August 2003
JEL No. E21, H30, E22

**ABSTRACT**

This paper accepts for the sake of argument the hypothesis that much of the time series correlation between tax and profit rates is spurious, and shows how nonetheless time series for profit rates, tax rates, and consumption can be organized, compared and interpreted using Fisher's (1930) theory of consumption in order to understand the incidence of capital taxes. Capital taxation is associated with a wedge between anticipated aggregate consumption growth and capital rental rates, suggesting that in one way or another capital owner behavior adjusts in the direction needed for some "passing" of the capital tax. Conversely, most of the medium and low frequency deviations between anticipated aggregate consumption growth and capital rental rates are associated with capital taxation, as implied by aggregate time-separable Fisherian consumption theories in which time preference, non-tax capital market distortions, aggregation biases, and other determinants of aggregate consumption growth vary little over time.

Casey B. Mulligan
Department of Economics
University of Chicago
1126 East 59th Street, #506
Chicago, IL 60637
and NBER
c-mulligan@uchicago.edu

## Table of Contents

## I. Introduction

Who bears the burden of capital income taxes? This is an important question because capital income tax rates have increased so much over time, and vary a lot across countries. The U.S., for example, introduced federal corporate taxation in 1909, and rates reached as high as 52% during the 1950's (Cummins et al 1994), and now stand at 35%. Europeans have been cutting their corporate tax rates – for example, the 20 percentage point cuts in Germany and Ireland between 1995 and 2001 (American Council for Capital Formation 2001, citing PricewaterhouseCoopers) – to the point where most Western European countries have lower rates than does the U.S. Estimates of capital tax incidence may also tell us something about the market for capital, and capital's place in a full model of the economy.

One approach to calculating tax incidence follows Harberger (1962), building a general equilibrium model of the supply and demand for capital, choosing numerical values for its parameters, and then simulating pre- and post-tax interest rates under various policy options. My paper uses instead measurements of pre- and post-tax interest rates, compares their evolution over time to the time pattern of tax rates, and organizes and interprets those comparisons using Fisher's (1930) theory of consumption as modernized by Hall (1978). I find that capital taxation drives a wedge between anticipated aggregate consumption growth and capital rental rates, so that in one way or another capital owner behavior adjusts in the direction needed for some "passing" of the capital tax. Conversely, most of the deviations between anticipated aggregate consumption growth and capital rental rates are associated with capital taxation, as implied by aggregate time-separable Fisherian consumption theories in which time preference, non-tax capital market distortions, aggregation biases, and other determinants of aggregate consumption growth vary little over time.

A related approach – namely looking at time series correlations between a price and a tax rate – has been used to study the incidence of excise taxes (eg., Due 1954, Evans et al 1999 and the papers referenced therein), payroll taxes (Mitrusi and Poterba 2000), and retail sales taxes (Haig and Shoup 1934, Poterba 1986, Besley and Rosen 1999). This approach also appeared 40 years ago in the capital tax incidence literature, but quickly fell into disrepute for reasons that can be seen in a simple scatter diagram like Figure 1. Each observation in the diagram is one of the five-year intervals 1931-35, .... The vertical axis measures the log of the economy-wide capital rental rate $\rho$ (gross of capital taxes and net of depreciation), while the horizontal axis measures the log of one minus the economy-wide rate $\tau$ of capital taxation (both of these measures are explained in detail below).[1] There is a clear negative correlation. Since the after-tax rental rate is $(1-\tau)\rho$, the magnitude of the regression slope (1.0, or 0.5 if the years prior to 1946 are excluded) is an estimate of the fraction of capital taxes paid by factors other than capital. If the regression slope were closer to -1.0 than 0, one might conclude as Krzyzaniak and Musgrave (1963) did that capital taxation increases pre-tax profits more than it decreases after-tax profits. However, we also see, as Goode (1966), Slitor (1966), Cragg, Harberger, and Mieszkowski (1967) did, that capital tax rates seem to be correlated with non-tax determinants of economic activity. For example, tax rates were high during the war and low during the Depression, and we doubt that tax policy alone was responsible for the high and low capital rental rates, respectively. Even if capital taxation increases pre-tax profits there is still the question, raised by Goode (1966) and Gordon (1970), of whether capital taxation does so by increasing markups, discouraging investment, or some combination.

Comparisons of investment and capital tax rate time series show zero or positive correlation (eg., Cummins et al 1994), but are equally hard to interpret. Does, say, a zero correlation mean that investment is unresponsive to tax rates, or that tax rates are correlated with non-tax determinants of investment? Irving Fisher's (1930) theory of consumption suggests that progress can be made by *simultaneously* comparing the time series for capital rental rates, capital tax rates, and consumption growth (ie, investment behavior). In particular, the theoretical relation between these series can be summarized by a consumption "Euler equation":

$$E_{t-1}\left[\frac{1 + (1-\tau_t) r_t}{IMRS_t}\right] = 1 \qquad \textbf{(1)}$$

[1]Krzyzaniak and Musgrave's famous 1963 study used data like this except they exclude the 1940's and early 1930's, and, of course, excluded years since 1960. They also confined their attention to the corporate sector but, as I show below, much of the economy-wide time variation is driven by the corporate sector.

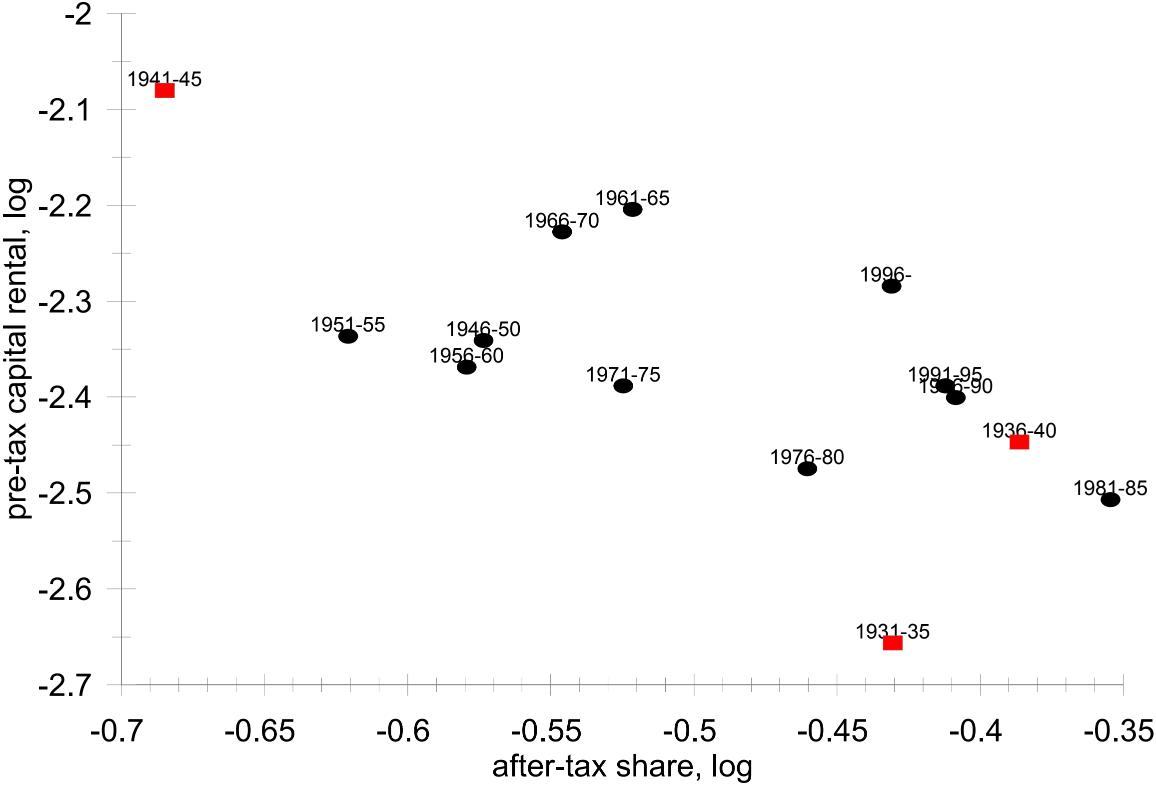


Figure 1 Capital Tax and Rental Rates

where $r_t$ is the year $t$ return on a representative piece of capital accumulated in year $t$-1, $IMRS_t$ is the marginal rate of substitution between consumption at dates $t$-1 and $t$, and $E_{t-1}[\cdot]$ denotes expectations as of date $t$-1. $\tau_t$ represents a distortion between the return on capital and the utility cost of investment. In some theories, the year $t$ capital income tax rate is a prime example of such a distortion, so that $r_t(1-\tau_t)$ is the after-tax return. There maybe other distortions between savers and investors, but for the moment I suppose that capital taxation is the main intertemporal distortion, or at least uncorrelated with the other distortions.

It has been suggested by Fisher (1930), and more recently Hall (1978), that the *IMRS* may be a fairly stable function of aggregate consumption at dates $t$ and $t$-1. With this extension, the Euler equation (1) gives us a testable prediction: that anticipated capital taxation drives a wedge between capital's expected return and expected consumption growth. This wedge appears in theory regardless of whether or not capital taxation is determined by profit rates, or whether capital taxation and profit rates are determined by non-tax factors – possibilities which were so hotly debated in the follow up to Krzyzaniak and Musgrave's book. In other words, if capital taxation increases profit rates or decreases consumption growth, or some combination of these, then we have good reason to believe that some other factor shares the burden of capital income taxation in the long run, or the short run, or both.[2]

In summary, previous time series studies of tax incidence are hard to interpret if the tax rate series is correlated with the state of demand for the taxed good. This is true in principle for any tax, such as an excise or payroll tax and, as demonstrated in Figure 1, obviously true for capital taxes. My proposal is to consider the tax rate and pre-tax price series *jointly* with independently measured behavioral series, and to apply this method to the study of capital income taxation over time. The results of this application are insights into the incidence of capital taxation, and empirical evaluations of various theories of the utility cost of investment.

This empirical approach has the advantage that it does not require a numerical model of the entire economy, or a struggle with interpreting the results of such a model when it is known to have some important inconsistencies with observation. It also does not depend on the degree to which

---

[2]A full computation, of course, requires estimates of the elasticity of capital demand. If it were perfectly elastic in the long run, then even a sustained consumption growth response to capital income taxation is consistent with no "passing on" of the tax. Estimating capital's demand elasticity is beyond the scope of this paper.

tax rate fluctuations over time may be a reaction to, or just coincident with, the state of demand for capital. On the other hand, the reader will notice that my calculations are hard to interpret if tax rate fluctuations over time are possibly correlated with the state of capital supply (in Fisherian terms, with the "rate of time preference").

Section II presents my capital rental and tax rate data. Section III presents the main empirical result, followed by some sensitivity analysis. Section IV discusses some of the theories which are ruled out by the main empirical result, and which need further evidence in order to be distinguished from the simple Fisherian model. Section V concludes.

## II. Measures of Pre- and Post-Tax Returns on Capital

### *II.A. Capital Returns as Measured in the National Accounts*

One empirical proxy for the pre-tax capital return is the pre-tax "capital rental rate": capital income net of depreciation per dollar of capital in place at the beginning of the year. Capital is measured as proportional to the BEA's (2000) fixed assets valued at current cost, and is aggregated for private residential and nonresidential sectors.[3] Note that the capital measured is employed domestically (including foreign-owned capital), includes owner-occupied housing, excludes consumer durables, and excludes the government sector. Current cost capital is not the same as book value, because the former aggregates real investment flows, and the latter aggregates investment expenditure flows. Capital income is measured accordingly, in three steps. First, income accruing to agents with their factors domestically and privately employed is calculated by subtracting net government product[4] and net factor income from abroad from national income. Second, this income is multiplied by one minus labor's share of non-proprietors' private national income, in order to obtain an estimate of the income pre-direct-taxes going to domestically

[3]Data sources are detailed in the Appendix.

[4]Government net product is equal to the compensation of government employees, because, as explained by Parker et al (1995, p. 36), the national accounts assume that government assets (other than those used by government enterprises selling their output in the marketplace) yield no services in production beyond their depreciation.

employed capital.[5] Third, property income tax revenue is added back into capital income, as suggested by Feldstein, Dicks-Mireaux, and Poterba (1983). Figure 2 displays this series as a solid line; the log of this series was aggregated for five-year intervals in order to measure the vertical distances in Figure 1.

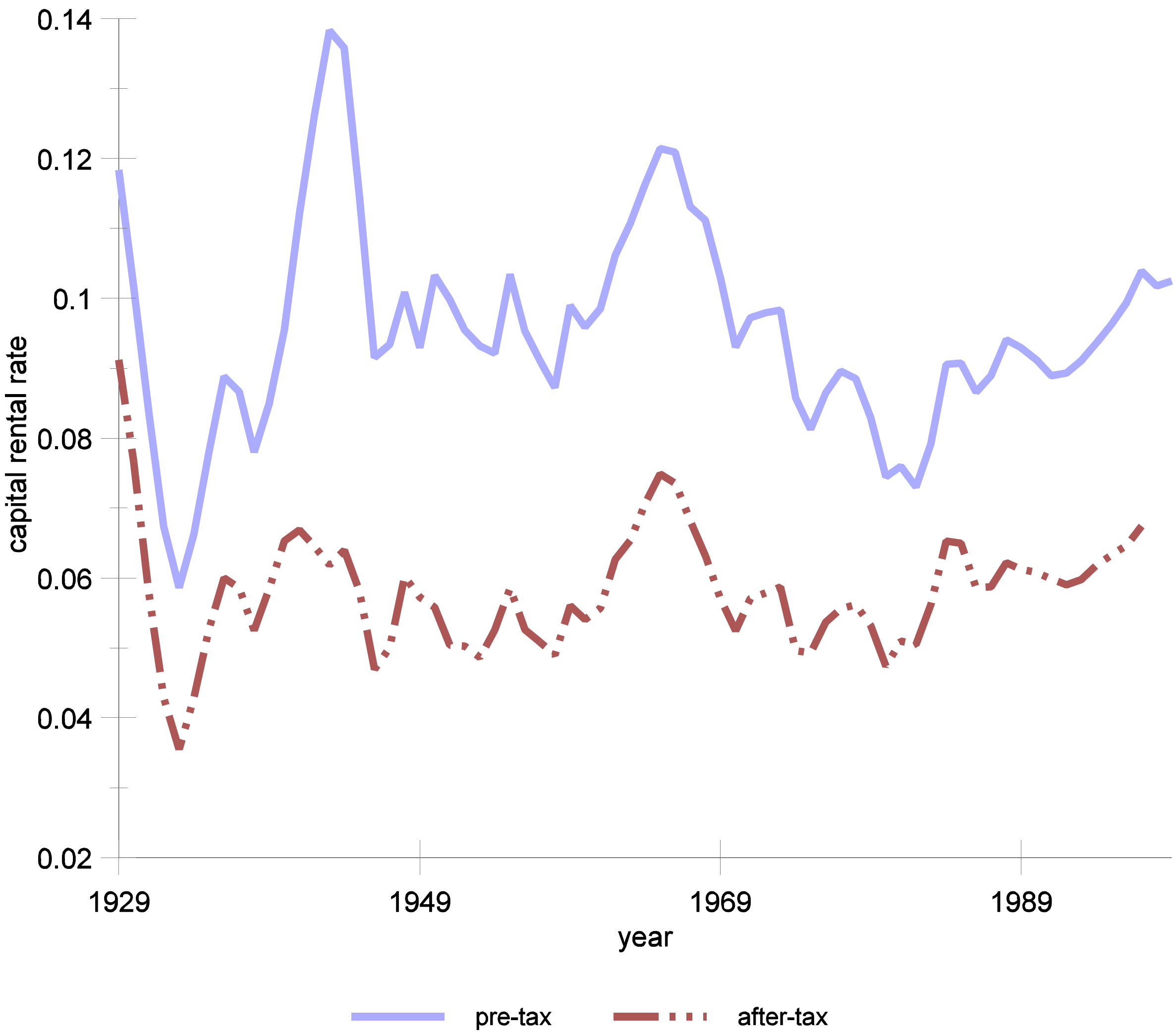


**Figure 2** Capital Rental Rates

[5]These two steps implicitly assume that capital and labor income accrue in the same shares in three sectors – the nonproprietary sector, the proprietary sector, and the foreign sector. My formula for pre-direct-tax private sector capital income is $(NI\text{-}Y_g\text{-}NFI)[1\text{-}W_p/(NI\text{-}W_g\text{-}Y_s)]$, where $Y_s$ is proprietors' income, $NI$ is national income, $NFI$ is net factor income from abroad, $W_p$ is the private employee compensation of domestic residents, and $W_g$ is the labor compensation of domestic government employees.

The return on capital $r$ can be decomposed into a rental rate $\rho$ and a capital gain. Capital gains might result from a variety of forces, including aging, obsolescence, changes in the rate of consumption taxation, and changes in the demand for the asset's services. To the extent that these gains are unanticipated, and have a time-invariant covariance with consumption innovations, they could be excluded from Euler equation estimates without affecting my results. Perhaps one advantage of the national accounts (for my purposes) is that their concept of depreciation includes expected aging and obsolescence,[6] and hence may provide an estimate of a big component of the expected capital gains. In principle, one could test the hypothesis that, other than BEA's estimate of depreciation, aggregate capital gains are unforecastable, although perhaps the BEA's estimate of the prices of equipment, housing, and other assets are not good enough for such a test.[7] For the purposes of this paper, I presume that aggregate capital gains, net of BEA depreciation, are unforecastable and have a constant covariance with consumption innovations, so that capital's pre-tax expected return might be measured according to the amount $\rho$ of capital income net-of-depreciation that is earned per dollar of capital.

---

[6]"Expected obsolescence implicitly enters into BEA estimates of depreciation through shorter asset lifetimes and through the retirement pattern previously used." (Fraumeni 1997, p. 9). The BEA does not estimate asset-and-year-specific depreciation rates (the aggregate depreciation rate does change over time according to composition of the capital stock); several econometric studies have failed (eg., those cited by Fraumeni 1997, p. 13) to reject the hypothesis that asset-specific depreciation rates are constant over time.

[7]Appendix III provides some evidence on this point by adding to the capital rental rate $\rho$ the log growth of the BEA investment price index relative to the consumption price index, evn though this addition double counts the expected economic obsolescence already included in BEA depreciation. The Appendix shows how the "simulated capital income tax rate" is not significantly affected by this addition, except in the 1980's when the BEA index began a sharp downward trend.

At least for the postwar years, Gordon (1990) and question the accuracy of the BEA index. Also, Cochrane (1991) and others in the finance literature have shown how capital gains on financial assets like the NYSE portfolio are much more volatile than the returns on investment implied by the national accounts. Perhaps this is a weakness of the national accounts (eg., they may exclude the "adjustment costs" emphasized in Cochrane's study), or perhaps the financial capital gains derive from the kinds of "preference" changes modeled by Mulligan (2002b), and hence should be ignored in a study of the timing of aggregate consumption.

Financial asset returns may also be related to capital returns, although it is hard to say for sure whether, for example, the commercial paper return is tied to the pre-tax, or the post-tax capital return. I argue elsewhere (Mulligan 2002b) that the consumption-asset-pricing and production-asset-pricing literature suggest that financial asset returns are much noisier measures of the return on capital (pre- or post-tax) than capital's rental rate. This noise may only widen confidence intervals on tax incidence estimates derived from financial asset returns or, to the extent that departures between financial asset and capital returns are correlated with capital's return or with capital tax rates, the incidence estimates may be biased. In this paper I therefore confine attention to national-accounts-based measures of capital returns.

*II.C. Capital Tax Rates*

There are many kinds of capital, and many forms of capital taxation. One approach might be to explicitly model this complexity, but we[8] follow Griliches and Jorgenson (1966, p. 58), Feldstein, Dicks-Mireaux, and Poterba (1983), Lucas (1990), and Mendoza et al (1994) and attempt to construct annual measures of the rate $\tau_t$ of taxation of a representative piece of capital's date $t$ income. Readers not interested in the details of this construction, and the legislative changes creating fluctuations in the measured series may want to skip ahead to Section III. Our construction begins with the formula:

$$\tau_t = \frac{T_t + P_{t+1}}{R_t + P_t}$$

$$\begin{aligned} T_t &\equiv \text{(tax year } t \text{ corporate inc tax revenue)} \\ &\quad + \text{(tax year } t \text{ estimated personal capital inc tax revenue)} \\ P_t &\equiv \text{(treasury year } t \text{ property tax revenue)} \end{aligned}$$

$$\text{(estimated personal capital inc tax revenue)} \equiv \text{(nonlabor inc share of AGI)(total IIT revenue)}$$

where $R_t$ is date $t$ aggregate capital income before direct taxes and after indirect taxes, and $P_t$ is

[8]The estimates in this section were made possible by ongoing research with Justin G. Marion. Some of those results are reported in Mulligan and Marion (2000).

property tax revenue received by the government in year *t*. These are similar to Mendoza et al's measures, with four exceptions (i) our definition of capital income is slightly different, (ii) we added property taxes back into the aggregate capital income (see the denominator, and also Feldstein, Dicks-Mireaux, and Poterba 1983), and (iii) we count tax revenue according to the tax year.[9] On point (iii), we have used IRS records to measure personal and corporate tax liabilities by tax year. On point (iv), we assume that property tax liabilities accrue in the year prior to their arrival at the treasury, as indicated in the formula above. I refer to this measure as the "aggregate effective tax rate series."

Figure 3 displays my measure of capital income tax rates, decomposed into the corporate, personal, and property tax components. The middle series is the sum of personal capital income and proporty taxes. The top series the sum of all three, and fluctuates more over time. Hence, the corporate income tax accounts for most of the combined tax rate fluctuations, with the exception of the 1930's when corporate and personal income tax revenues were few and property tax revenues were substantial relative to capital income.[10]

[9]Lucas (1990) uses a similar method to measure the capital tax rate for 1985 (0.36). Mendoza et al (1994) and Lucas (1990) apparently count revenue according to the year it arrives in the Treasury and therefore in the government budget. For example, a personal income tax payment made April 15, 1985 for the 1984 tax year would count as 1984 in my calculations and as 1985 in the Mendoza et al/Lucas calculations.

[10]We conjecture that property tax assessors did not adjust the dollar value of their assessment during the 1930's, when the overall price level and dollar incomes were falling, which is why aggregate property tax revenue was pretty stable in dollar terms and such a large fraction of aggregate capital income.

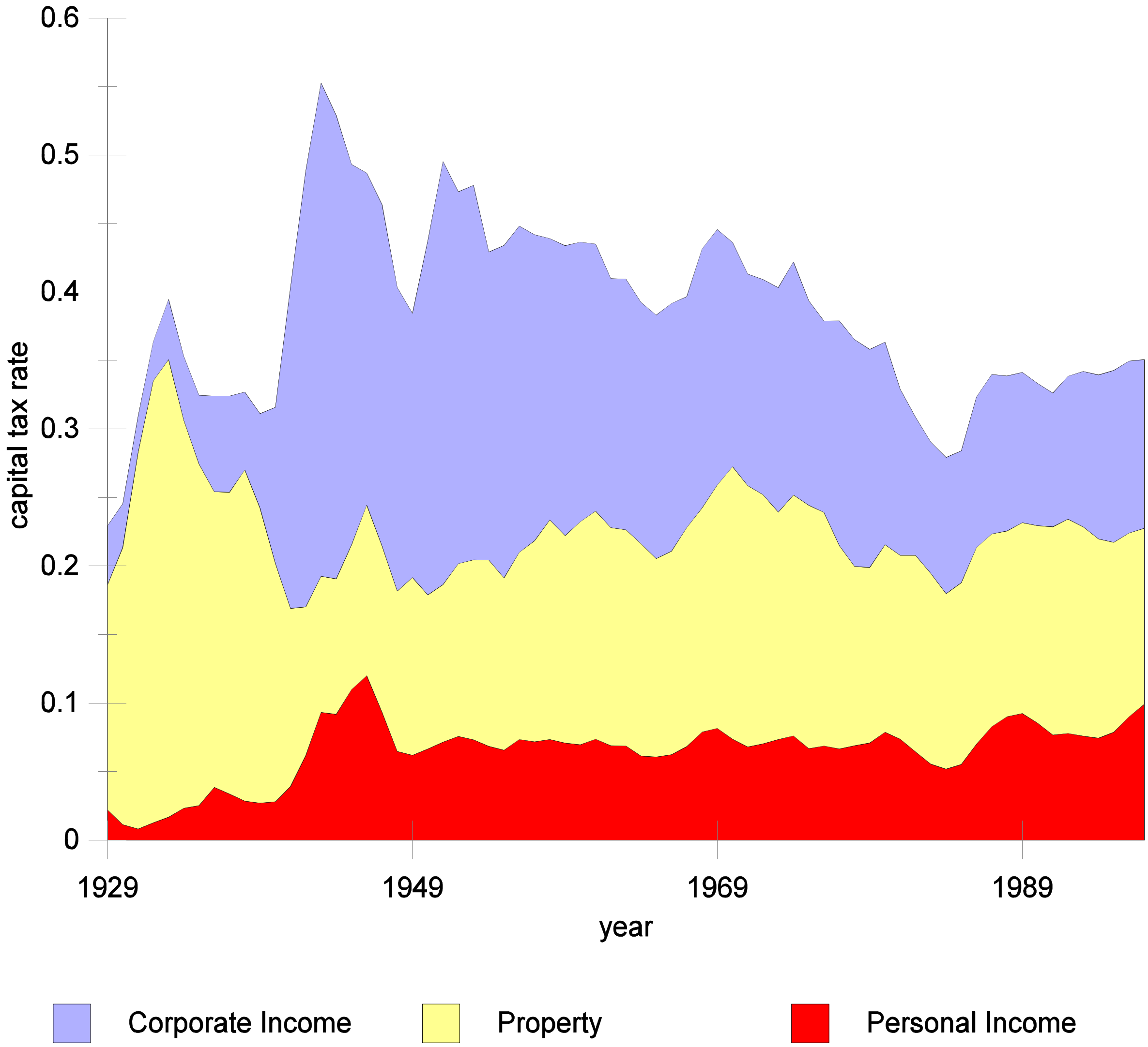


**Figure 3** Capital Income Tax Revenues by Major Type, 1929-97
(as a share of aggregate capital income, before direct and property tax)

Since the postwar measured tax changes are a very important ingredient in my analysis, it is worth understanding some of the legislative history of those tax changes. When discussing those changes, it is helpful to organize them using Hall and Jorgenson's (1967) famous statutory "user cost" formula for the distortion $\tau_t^u$ between the year *t* marginal product of new corporate capital (installed in year *t*-1) and the year *t*-1 corporate cost of funds:

$$\tau_t^u = \frac{\tau_t^s - ITC_{t-1} - z_{t-1}}{1 - ITC_{t-1} - z_{t-1}} \qquad \textbf{(2)}$$

where $\tau_t^s$ is the statutory rate at which year *t* taxable corporation income is taxed, $ITC_{t\text{-}1}$ is the credit rate for investment in year *t*-1, and $z_{t\text{-}1}$ is the present value of tax savings) from depreciation allowances permitted for capital installed in year *t*-1. Federal values for the formula (2)'s ingredients are available from Cummins et al's (1994) paper for *t* = 1954, ..., 1989, for equipment and structures in manufacturing industries. I calculated equipment and structures tax rates using the formula (2), and averaged them weighting by the relative amounts of equipment and structures in the manufacturing sector; this average rate $\tau_t^u$ based on the statutory user cost is displayed together with my aggregate effective rate in Figure 4. The levels of these series are different because the aggregate effective series includes property and personal income taxes, as well as state corporate income taxes. Interestingly, the two series have similar fluctuations.

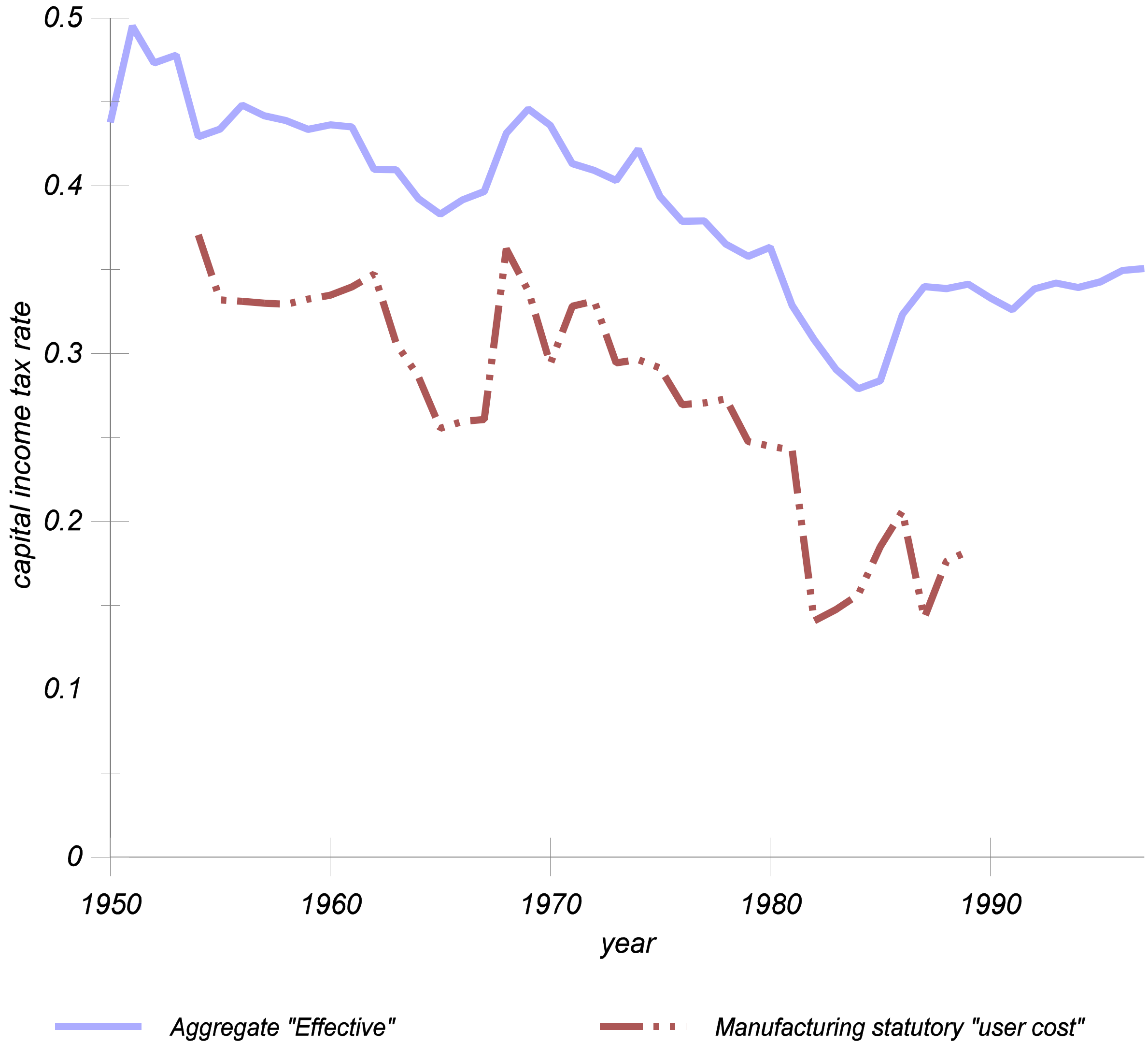


**Figure 4** Two Capital Income Tax Rate Measures:
Aggregate "Effective" and Manufacturing Statutory "User Cost"

The measured effective tax rate series has five characteristics that are important for my conclusions: the lack of a trend 1947-62, JFK's cuts, increases during the Johnson administration, declines 1968-82,[11] and increases since 1982. For the period 1947-62, I have relatively little legislative information except that the statutory corporate tax rate increased 14 percentage points during the Korean War, and that depreciation allowances were accelerated ($z_t$ increased) in 1953.

[11]The tax rates shown in Figure 3 are dated according to the year the capital income is earned.

It is hard to tell whether these were offsetting as suggested by the effective tax rate series. Kennedy cut the corporate tax rate and introduced an ITC, capital income tax cuts which can be seen in both my effective rate series and Cummins et al's series based on the statutory user cost. During the Johnson administration, the corporate rate increased from 48 to 52.8%, an increase which appears obviously in both the effective rate and statutory user cost series.

Capital income tax rates fell between 1968 and 1982, in large part because of five legislative changes in the federal corporate income tax.[12] These rate cuts have been widely discussed in the literature (see, for example, Auerbach 1983), and appear in both of Figure 4's series. Feldstein and Summers (1978) and Auerbach (1983) explain how high inflation generated higher corporate income tax revenues in the 1970's relative to the 1980's, and how this increase is indeed a tax on the returns to investment. This was important 1968-71, but according to both series in Figure 4 more than offset by the corporate rate cut (totaling 5.8 percentage points). Between 1971 and 1975, the ITC was reinstated, and depreciation allowances were accelerated. Although not necessarily a response to new legislation, corporations increasingly took advantage of high nominal interest deductions during the 1970's (Auerbach 1983, p. 458). ITC's were further increased 1975-78, and the corporate rate was cut two percentage points after 1978. The 1981 law changes accelerated depreciation, while at the same time inflation was falling and making depreciation allowances more valuable.[13]

Since 1982 capital income tax rates increased one or two times. First, Cummins et al's examination of rates based on statutory user cost show that depreciation deductions were worth less prior to the 1986 tax reform than they were after the 1981 reform, although I'm not sure whether this results from a legislative change (including phase-ins of the 1981 law), or a change of the composition of investment within the manufacturing equipment and manufacturing structures categories studied. Second, the 1986 tax reform eliminated the ITC and made depreciation

[12]Feldstein, Dicks-Mireaux, and Poterba (1983) tax rate series for the nonfinancial corporate sector suggest that capital tax rates were greater in the 1970's than in the 1960's (which explains why they do not find (p. 154) the negative relation seen in my Figure 1 or in the 1960's studies), mainly because they measure more property tax revenue per dollar of profits for that sector in the 1970's, and because they have relatively high estimates for the rate of interest income taxation in the 1970's.

[13]This was reinforced by personal marginal income tax rate cuts which, as explained above, is included in my aggregate effective tax rate series but not the series derived from Cummins et al's manufacturing corporate study.

allowances less generous – changes which, according to both series in Figure 4, were roughly offset by the cut in the corporate income tax rate from 46 to 34%.[14] Third, the corporate rate was increased to 35% beginning in 1993.

*II.D. Potential Biases in Measured Tax Rates*

There are a number of reasons to expect that the anticipated capital tax rate might be measured with error (when measured as my aggregate "effective" capital tax rate), and that those errors would affect incidence estimates. One important issue in this regard is whether the *rate* of capital taxation is anticipated at the time that investment occurs and consumption is foregone. The typical legislative calendar is informative in this regard, since tax laws (ie, schedules relating capital income of various types to tax liabilities) are usually debated and passed prior to the tax year during which they are in force, we can reasonably suppose that investors have a good idea of the one-year-ahead relation between capital income and capital income tax liability. If capital income taxes were literally proportional, then this would imply that marginal tax *rates* are also well anticipated one year ahead. Marginal corporate and personal income tax rates are, in the relevant range, fairly constant with income.

Related is the question of whether average and marginal capital income tax rates are the same. Again the proportionality of tax rules is relevant. Also relevant is whether old and new capital are treated symmetrically. For example, we could imagine a policy that heavily taxes old capital, thereby generating substantial revenue (measured as a ratio to the capital stock at the time of the levy), and the appearance of a high rate of capital taxation, but did not discourage investment in the year prior to the levy. However, one conclusion we draw from Figure 4 is that, in terms of time fluctuations, my effective tax rate series is similar to the tax rate on new investment measured by Cummins et al (1994).

Another bias may derive from the composition of capital income taxes and the differential

[14]Personal income taxation was changed in 1986 as well, although Barro and Sahasakul's (1986) series on average marginal federal personal income tax rates, as updated by Stephenson (1998) and Mulligan and Marion (2000), only show about a 3 percentage point decline 1986-89, and my effective tax rate series does not show any decline during those years. Some of the personal capital income tax reforms in 1986 may also have changed the personal-corporate composition of capital income tax revenues than they changed the overall amount of capital income tax revenue (Auerbach and Slemrod 1997).

cyclicality of their tax bases.[15] Suppose for the sake of illustration that property taxes are zero, and that all capital income falls either under the corporate tax or the personal tax but not both. Then my capital tax rate measure is the weighted average of the corporate and personal tax rates $\tau_t^c, \tau_t^p$, respectively:

$$\tau_t = \theta_t \tau_t^c + (1 - \theta_t)\tau_t^p$$

$$\theta_t \equiv \frac{R_t^c}{R_t^c + R_t^p}$$

where the $R$'s are the personal and corporate components of capital income. The formula above shows that, if the composition of capital income were cyclical, then non-tax determinants of economic activity may cause fluctuations in my measured tax rate even when the personal and corporate rates are constant. In particular, if $\tau_t^c > \tau_t^p$ and the corporate tax base were the more cyclical, then my tax rate measure would be procyclical even when personal and corporate rates are not. However, Figures 3 and 4 suggest that my aggregate effective tax rate series has a similar time pattern as corporate series by themselves.

## III. Intertemporal "Distortions" Compared with Measured Capital Income Tax Rates

### *III.A. Calculating an Intertemporal Distortion from the National Accounts*

The hypothesis of this paper is that capital income taxes drive a wedge between pre-tax capital rental rates and *simple* proxies for the IMRS, exactly as described by equation (1) and, conversely, most of the deviations between capital rental rates and simple proxies for the IMRS are associated with capital taxation – at least at medium and low frequencies. To demonstrate this I use the method of Mulligan (2001, 2002a) – namely to use national accounts data to calculate a wedge between IMRS and a capital rental rate, and then compare that wedge with measured capital income tax rates. The first step is to rearrange equation (1) to calculate the tax rate $\tau_t^*$ that makes the Euler equation hold exactly:

---

[15] I owe this point to Marty Feldstein.

$$\tau_t^* = \frac{E_{t-1}\left[\frac{r_t}{IMRS_t}\right] + E_{t-1}\left[\frac{1}{IMRS_t}\right] - 1}{E_{t-1}\left[\frac{r_t}{IMRS_t}\right]} \qquad \textbf{(1)}'$$

where, as explained above, I assume that the capital income tax rate is known one year ahead. Following Mulligan (2001, 2002a), I refer to the tax rates $\{\tau_t^*\}$ calculated according to (1)′ as "simulated tax rates", to be distinguished from the aggregate effective capital income tax rates $\{\tau_t\}$ *measured* using IRS data as explained above. As argued above, perhaps the best NIPA proxy for capital's return $r$ is the "profit" or rental rate $\rho$ net of depreciation shown in Figure 1 and used in the 1960's time series studies of tax incidence.

Of course, equation (1)′ is of limited utility unless we have ways of measuring *IMRS* and expectations. On the first point, I follow the familiar practice of supposing that $IMRS_t = (\beta^{-1} c_t / c_{t-1})^{1/\sigma}$, where $\beta$ and $\sigma$ sigma are constants representing the "rate of time preference" and "intertemporal elasticity of substitution" respectively. This is a very simple model of the aggregate *IMRS*, ignoring aggregation biases, time preference shifts, etc., so it would be especially notable if this model could be used to match *IMRS* and after-tax capital returns.

Even with measures of *IMRS*, the Euler equation has no empirical content unless there are empirical proxies for expectations. I follow the familiar practice of supposing that the full model of the economy (most of which is not spelled out in this paper) is Markov with a sufficiently short state vector, so that expectations can be well proxied with fitted values from VAR's. The elements in the VAR's are: 1/*IMRS*, $\rho$/*IMRS*, $\rho$ (remember that capital's return is measured as the capital rental rate net of BEA depreciation), the nominal commercial paper rate, the gap in promised yields on BAA and AAA corporate bonds, and inflation. Note that tax data is not used to calculate the simulated tax rate, aside from the property tax adjustment of pre-direct-tax capital income as proposed by Feldstein, Dicks-Mireaux, and Poterba (1983).

Figure 5 displays 5-year moving averages of measured and simulated tax rates for the years 1949-95. An intertemporal elasticity of substitution of 2.5 is used,[16] and consumption is measured

[16]See below for a sensitivity analysis. The rate of time preference is calibrated differently for each value of $\sigma$ so that the levels of $\tau$ and $\tau^*$ are similar.

as real nondurable and services expenditures per person age 15+. We see that the simulated tax rate is fairly constant – i.e., that consumption growth roughly followed the pre-tax rental rate – prior to the Kennedy tax cut, very much like the measured tax rate. The Kennedy tax cut does not seem to fit the theory, because pre-tax rental rates and consumption growth moved apart rather than moving together. Since then the two tax rate series are very similar – both decline about 13 percentage points 1970-83, and both increase since 1983, although the simulated rate increases more since 1988. It is also interesting that both series show the tax rate trough in almost exactly the same year (1982 for the simulated rate and 1983 for the measured rate). Both series also move in a range with similar breadth – both have a maximum about 15-20 percentage points above its minimum.

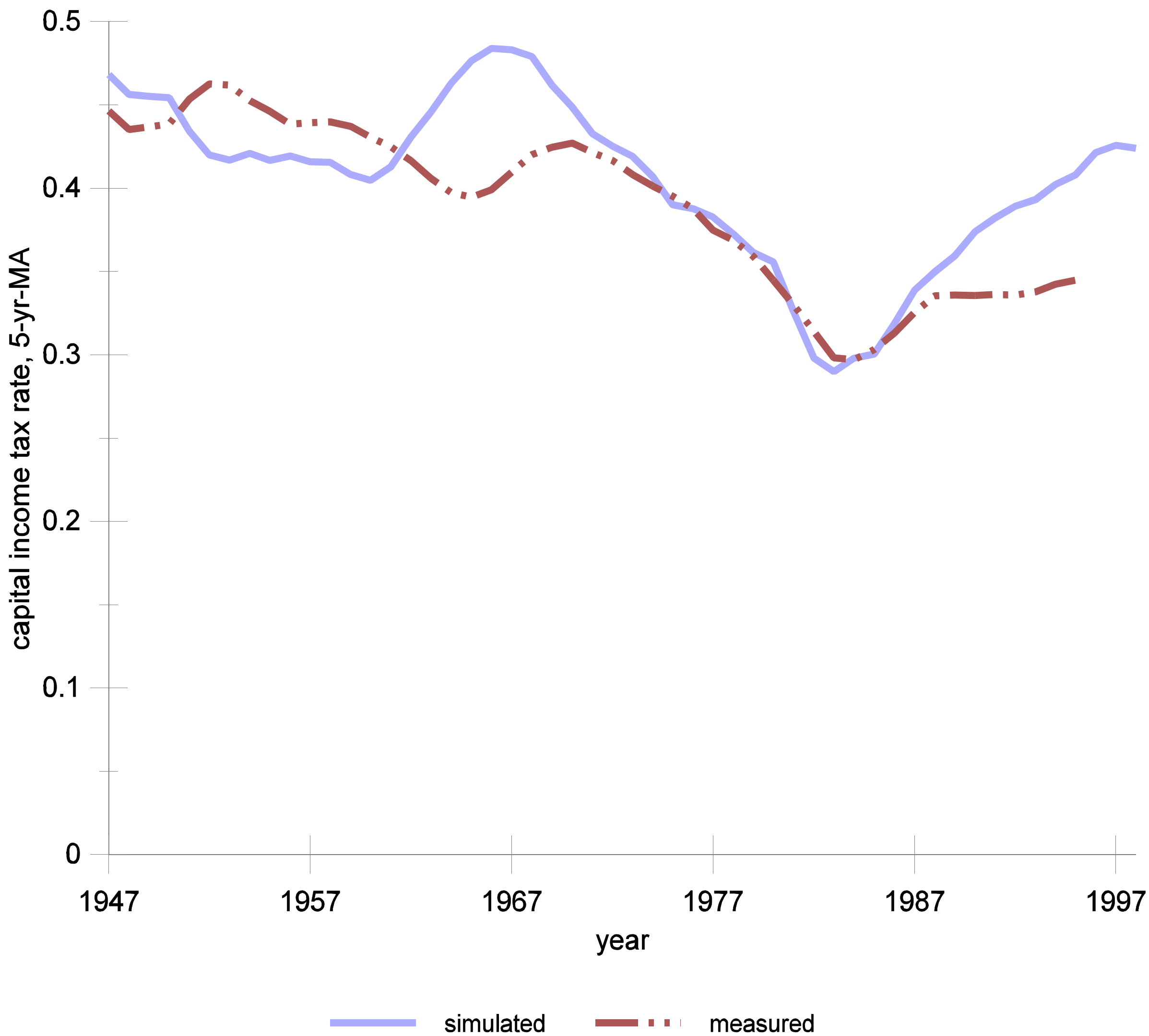


**Figure 5** Capital Income Tax Rates: Simulated ($\sigma = 2.5$) and Measured

*III.B. Sensitivity Analysis: "Intertemporal Substitution Elasticities"*

My first calculation (Figure 5) depends on the intertemporal substitution elasticity σ, although it is not particularly sensitive to that parameter. In order to see how σ would have some impact on the results, notice that an infinite intertemporal substitution elasticity means that *IMRS* is constant over time, so that my analysis of the Euler equation (1) boils down to a comparison of tax rates and expected capital rental rates – which might be very much like my Figure 1 and the 1960's time series studies of capital tax incidence.[17] But remember that my departure from the 1960's literature is to suppose that *whatever* creates spurious comovement between capital income tax rates and capital rental rates also affects consumption growth through the capital rental rate. So the appropriate "intertemporal substitution elasticity" should reflect the elasticity of expected consumption growth and expected capital rental rates, which I have argued elsewhere (Mulligan 2002b) is at least one and probably somewhat greater than two.[18] Figure 6 displays simulated tax rates based on various values of σ. By comparing the series derived from my preferred σ value of 2.5 (solid line) and a value of 200 (ie close to infinity, shown as a long-dashed line), we see that adding consumption growth to the analysis makes some important differences. For example, the σ = 200 series shows tax rates rising immediately after the 1981 tax reform, rather than falling, because consumption growth (essentially ignored by the σ = 200 series) was rising faster than expected pre-tax rental rates. The rate decline between 1966 and 1981 is seven percentage points greater with the σ = 200 series because consumption growth was declining together with pre-tax

[17] One important difference between my Figures 1 and 5 is that the latter forecasts (functions of) $r$ and *IMRS*, and the important forecasting variables are not especially the lags of $r$ and *IMRS*. Appendix II shows the VARS, and how the important forecasting variables are the nominal commercial paper rate, the gap in promised yields on BAA and AAA corporate bonds, and inflation.

[18] Mulligan (2002b) emphasizes that the consumption growth-rental rate correlation is very different than the consumption growth-bond return correlation because bond returns are much more variable and are uncorrelated with capital rental rates. Hence a large elasticity of consumption growth with respect to capital rental rates is consistent with a small elasticity (like that found by Hall 1988) of consumption growth with respect to bond returns.

The issue in the current paper is not what is the right intertemporal substitution elasticity, but what is the right elasticity of consumption growth with respect to measured capital rental rates. If, for example, measured capital rental rates were too smooth and thereby creating exaggerated estimates of the intertemporal substitution elasticity, these exaggerated estimates should be used here in order to excessively smooth consumption growth by the same amount.

rental rates. In other words, the consumption growth series suggests that some of the comovments between tax and pre-tax rental rates is spurious – for example, pre-tax rental rates would have declined in the 1970's even without tax rate cuts.

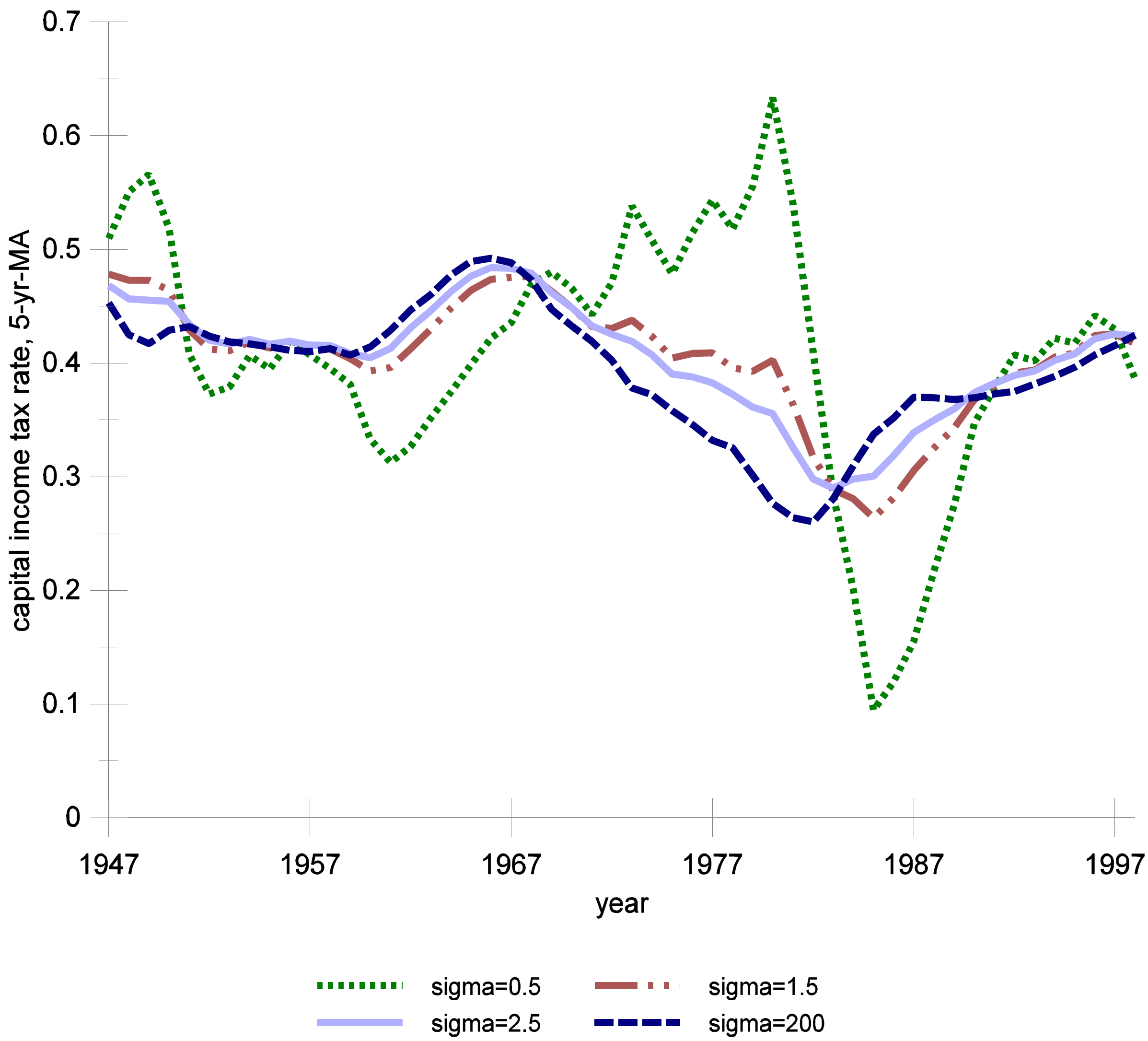


**Figure 6** Capital Income Tax Rates: Simulated For Various Intertemporal Elasticities

Even though the value of σ has some effect on the calculations, it is easy to see why its effect is limited. We know from Figure 1 that pre-tax rental rates and capital income tax rates have moved together over time. But we also suspect from the investment literature that investment and consumption growth are not well correlated with capital income tax rates. The parameter σ tells us exactly what multiple of consumption growth to subtract from capital rental rates before a comparison with measured tax rates, but since the covariance between consumption growth and tax rates is weak, the covariance of the rental rate-consumption growth difference will be insensitive to the weight placed on consumption in constructing the difference. We see this in Figure 6 where four values of $\sigma$ are used. $\sigma$ only matters during the 1970's and early 1980's when consumption growth and tax rates move together. For example, both consumption growth and pre-tax rental rates are falling in the 1970's, and the $\sigma = 0.5$ series puts the most weight on consumption growth, so it appears that there is a growing distortion between $r$ and *IMRS*.

## IV. Interpretations

A Fisherian approach to consumption and savings, when combined with a simple, time-separable model of the *IMRS*, and the hypothesis that capital taxation is anticipated by investors, implies that capital income taxation causes a departure between consumption growth pre-tax capital rental rates. Furthermore, there appears to be exactly one percentage point departure between pre-tax capital rental rates and the IMRS for every percentage point of capital income taxation. That capital taxes create intertemporal wedges of the same magnitude is familiar from public finance theory, but this creation is by no means tautological. The purpose of this section is to discuss some of the theories which are ruled out by Figure 5, and which need further evidence in order to be distinguished from the simple Fisherian model.

### *IV.A. NonFisherian Savings Models*

Some theories of consumption are based on the hypothesis that savings rates, or consumption growth, are insensitive to capital rental and tax rates. To understand the first case, let all GDP be spent on consumption and gross investment, and suppose that year $t$ aggregate consumption is proportional to aggregate GDP with proportion $1\text{-}s$.[19] Suppose further that the capital rental rate plus depreciation is proportional to the GDP-capital ratio, with proportion $\alpha$. The formula for consumption growth is:

$$\frac{c_{t+1}}{c_t} = \frac{s}{\alpha}(\rho_{t+1} + \delta) + (1 - \delta)\frac{\rho_{t+1} + \delta}{\rho_t + \delta}$$

[19]In other words, there is no government consumption; revenue from capital taxation is transferred to consumers who save out of this income like they would out of other income.

where $\delta$ is the capital depreciation rate. In other words, capital taxation is correlated with consumption growth only to the extent it is correlated with pre-tax rental rates. We have already seen how capital tax rates are much less correlated with consumption growth and national savings rates than with pre-tax rental rates, which is consistent with the Fisher model but inconsistent with the formula above, which, holding constant the national savings rate, requires consumption growth to follow the *pre-tax* rental rate.

One way to theoretically interpret the quantitative relation between simulated and measured tax rate is to form a hybrid of the Fisherian and constant savings rate model:

$$\ln \frac{c_{t+1}}{c_t} = \sigma(1-\tau_{t+1})^{\gamma}\rho_{t+1} + \text{(constant)} \qquad \textbf{(3)}$$

where the constant exponent $\gamma$ allows for a potentially different sensitivity of consumption growth to the tax factor as to the pre-tax rental. $\gamma = 1$ in the pure Fisherian case, and $\gamma = 0$ in the constant savings rate case. If the long run demand for capital were less than perfectly elastic, and consumption constant in the long run, then $\gamma$ is also the fraction of the capital tax "passed on" in the long run.[20] Since Figure 5 shows that simulated and measured tax rates follow each other very closely, the Figure suggests that $\gamma$ is about one and, with neoclassical capital demand, essentially all of the capital tax is passed on in the long run.

*IV.B. Theories of Taxation*

Even if we accept the Fisherian model of consumption and the hypothesis that the *IMRS* is well proxied by the consumption growth rate, the findings in Figure 5 are informative. There are several Fisherian models in which effective capital tax rates would not necessarily be associated with a wedge between consumption growth and pre-tax rental rates. For example there would be

[20]To see this, notice that the long run pre-tax rental rate is proportional to $(1-\tau)^{-\gamma}$ and the long run after-tax rental is proportional to $(1-\tau)^{1-\gamma}$.

no wedge if the capital taxation were unanticipated by investors, or applied only to old capital.[21] Or perhaps the government manages to tax mainly those sectors where capital is inelastically supplied, or manages to offset capital tax distortions with regulatory distortions.

*IV.C. Time-Varying "Markups" or Intertemporal Specification Errors*

Measured capital tax rates are strongly correlated with the gap between pre-tax rental rates and consumption growth but, of course, this does not prove a causal link. The correlation would be spurious if capital tax rates happened to be correlated with other capital market distortions, or if rental rates and/or the *IMRS* were mis-measured with an error that is correlated with capital taxation. For example, time-varying efficiency in the financial intermediation process, or time-varying rates of time preference, might cause departures between pre-tax rental rates and consumption growth even if capital taxation were not present or were not distortionary. If rates of capital taxation were negatively correlated with financial intermediation efficiency, or positively correlated with the rate of time preference, then the evidence shown in Figure 5 need not indicate that capital taxation is distortionary. In other words, the consumption data is a helpful addition to the 1960's empirical incidence literature if the common determinants of capital tax rates and pre-tax rental rates are also, solely through the after-tax rental rate, determinants of consumption growth, but are not helpful if capital tax rates are determined by factors that have differential effects on rental rates and consumption growth. I leave it for future research to carefully formulate theories of this kind, and to obtain the data necessary to separate them from the explanation offered here.[22]

Krzyzaniak and Musgrave (1963) argue that corporations respond to capital taxes by marking up their prices. A related possibility is that the taxation of capital tends to be heavier when corporations are charging high markups. Either possibility is consistent with the data shown above, and with my interpretation of it, as long as national accounts nonlabor income accurately measures the capital rental income. The Fisherian model is about the relation between consumption growth and capital rental rates, regardless of whether capital rental rates are determined by markups rather

[21]A particular case of this is McGrattan and Prescott's (2001) model in which capital tax revenues are reduced over time without affecting consumption growth because the capital taxes that are cut are effectively taxing only old capital.

[22]Hwang and Mulligan (2003) have started in that direction.

than capital productivity. Namely, capital taxation reduces consumption growth, after-tax capital rental rates, and capital accumulation below what they would have been with the markup held constant and the tax eliminated. In both cases capital owner behavior serves to "pass on" capital taxation, although without knowledge of the causal link between taxes and markups, we cannot be sure whether capital income taxes are passed on because they cause higher markups or because they prevent consumption from growing in response to a high markup that would have occurred in the absence of taxation.

However, it is possible that, because of time-varying markups, nonlabor income inaccurately measures the capital rental rates to be enjoyed by the owners of new capital. This might occur because economic profits accrue mainly to old capital, or because they accrue to some factor other than capital. In these cases consumption growth may well follow the true capital rental rate, but the measured capital rental rate departs from the true rental rate according to the size of the markup. Even if capital taxation were not distortionary, any correlation between capital tax rates and markups would be associated with a *measured* wedge between consumption growth and pre-tax rental rates. Because markups can cause distortions on other margins as well, one way to test this hypothesis is to see whether capital taxation happens to be correlated with distortions on other margins. Hwang and Mulligan (2003) try this, and find a correlation between labor income's share of GDP[23] and the rate of capital taxation for the years 1954-95, but it is weak and of the wrong (positive) sign.

## V. Conclusions

Goode (1966), Slitor (1966), Cragg, Harberger, and Mieszkowski (1967) claim that capital income tax rates are procyclical because they are determined in part by profit rates or some other non-tax determinants of economic activity. The evidence presented here is consistent with their claim, because high tax rates are associated with high capital rental rates throughout the postwar period. However, the time series data is not as confusing as they suggest, because consumption growth can be used as another indicator of non-tax determinants of pre-tax capital rental rates. I find

[23]Under the hypothesis that aggregate GDP is a Cobb-Douglas function of labor income and the labor market it competitive, labor income's share of GDP fluctuates over time according to labor demand distortions, such as the labor demand distortion resulting from time-varying markups (see Rotemberg and Woodford 1999).

that high tax rates are associated with a gap between consumption growth and pre-tax capital rental rates. Furthermore, (fluctuations of) the gap between pre-tax capital rental rates and my proxy for the intertemporal marginal rate of substitution are of the same magnitude, which means that capital taxation is eventually fully "passed on" via a lower capital stock, at least if the long run demand for capital is less than perfectly elastic. Furthermore, the procyclicality of tax rates means that such passing on may occur even when tax rates are not correlated with investment and consumption growth, because heavy taxation happens to occur at times when investment and consumption growth would have been high.[24]

Most of the deviations between anticipated aggregate consumption growth and capital rental rates at low and medium frequencies are associated with capital taxation, as implied by aggregate time-separable Fisherian consumption theories in which time preference, non-tax capital market distortions, aggregation biases, and other determinants of aggregate consumption growth vary little over time. Perhaps this suggests that these other determinants of consumption growth are only important for high frequency analysis, or that by coincidence some have been offset by others at low and medium frequencies.

It is important to know whether the Euler equation (1) works nearly as well during the 1930's and 1940's as it does after WWII. After all, my calculations are alleged to deal with non-tax determinants of pre-tax capital rental rates that are correlated with capital tax rates, and those non-tax determinants seem abundant during this earlier period. Second, the 1940's was a time of large, and largely permanent, capital tax rate increases (see Figure 3) so it would be interesting to see whether a wedge appeared between pre-tax rental rates and consumption growth and, for the purposes of long-run tax incidence, whether that wedge persisted. Unfortunately, the Euler equation (1) requires calculation of expectations, and I highly doubt that the postwar VAR's are appropriate for calculating expectations 1930-46.[25] So I conclude the paper much like it began by calculating 5-year-interval time averages, and interpreting those time averages as expectations. I calculate a

[24]Perhaps the same possibility is relevant at frequencies lower than those examined here? Stokey and Rebelo (1995) look at U.S. taxes and GDP growth over the 20th Century, and Mulligan (2002c) at U.S. taxes, pre-tax rental rates, and consumption growth over the same period.

[25]Remember, for example, that the VAR's featured nominal magnitudes like inflation and bond yields.

simulated tax rate according to equation (1)′ and scatterplot it in Figure 7 versus (log of one minus) the measured aggregate effective capital income tax rate. The postwar data is distinguished from the earlier period by plotting with ovals and rectangles, respectively. Also shown in the Figure is the 45-degree line, which would contain all of the data if the theory and measures were flawless. In fact, the 1930's and earlier 1940's fit about as well as any time period since then! In particular, the theory predicts a tremendous wedge to appear between the late 1930's and the early 1940's (notice the large horizontal distance between the two corresponding rectangles), and one does appear in fact (notice the large vertical distance)!

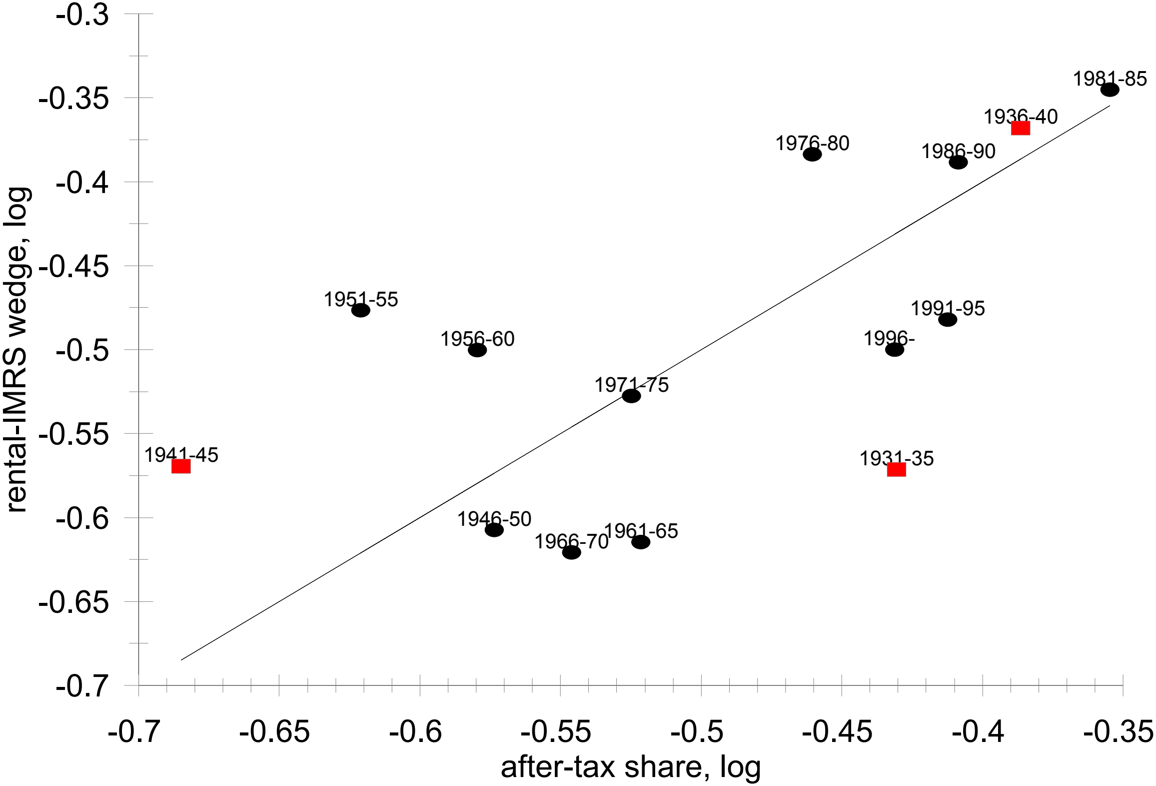


Fig 7: Simulated Tax Rates Calculated from Time-Averages, and Compared with Measured Rates

## VI. Appendix I: Data Sources

<u>capital, current cost</u> The current cost net stock of private fixed assets at the end of the previous year, as reported in BEA's Table 1.1 "Current Cost Net Stock of Fixed Assets and Consumer Durable Goods"(1926-99), and Kendrick's private domestic capital stock (1961, Table A-XV, 1900-25). The Kendrick series is merged with the BEA series by multiplying the former by 0.771 in order to make the levels of the two series identical in 1925. "Capital" as referenced in the text is current cost capital, unless noted otherwise.

<u>capital income</u> Real income to domestically employed private capital, calculated as $(Y-Y_g)[1-W_p/(NI-W_g-Y_s)]$, where $Y$ is real net domestic product, $Y_g$ is the real net product of the government sector, $Y_s$ is proprietors' income, $NI$ is national income, $W_p$ is the private employee compensation of domestic residents, and $W_g$ is the labor compensation of domestic government employees. Capital income after-tax is calculated by subtracting real capital tax revenue (deflated with the GDP deflator) in the corresponding tax year.

<u>capital rental rate</u> capital income/capital. The after-tax rental rate is real capital income after-tax per dollar of capital. "Capital" is measured at current cost, unless noted otherwise in the text.

<u>capital tax revenue</u> Federal, state, and local personal capital income, corporate income, property, excess profit, capital stock, and document & stock transfer tax revenue. Federal personal income, corporate income, and excess profits tax revenues are dated by tax year as reported by IRS (various issues). State and local revenues are dated by the year in which they arrive in the state treasuries from U.S. Council of Economic Advisers (1996, 1999). Personal capital income tax revenue is calculated as the product of personal income tax revenue and one minus labor's share of AGI (1916-99). Before 1916, the latter is assumed to change proportionally with labor's share of national income.

<u>capital tax rate</u> Capital tax revenue/capital income. see also the formula in the text.

<u>consumption</u> Nominal expenditure from Kenrick (1961, Table A-IIb, 1899-1928) and BEA NIPA Table 1.01, line 2 (1929-99) plus$2b for alcohol (1929-32, $1.335b for 1933). Since 1929, BEA decomposes consumption into expenditures on nondurables, durables, and services. Real expenditure per person aged 15+ calculated by dividing by the GDP implicit price deflator and Population aged 15+. In order to increase comparability with Hall (1988), I report results in the body of the paper derived from the nondurables-only consumption measure. Appendix I explores alternative specifications.

domestic product Gross from Kendrick (1961, Table A-III, 1900-28) and BEA NIPA Table 1.1, line 1 (1929-99). Net from Gross minus Kendrick's (1961, Table A-III, 1900-28) National Capital Consumption Allowances and directly from BEA NIPA Table 1.12, line 1 (1929-99). Net product of the government sector from Kendrick (1961, Table A-III, 1900-29) and BEA NIPA Table 1.12, line 10 (1929-99). Labor's share of nonproprietor's income from Kendrick (1961, Table 28, 1900-28, missing years linearly interpolated). Since 1929, employee compensation of domestic residents from BEA NIPA Table 1.15, line 53 and compensation of government employees from BEA NIPA Table 1.15, line 44. Proprietor's income from BEA NIPA Table 1.15, line 54.

GDP implicit price deflator Kendrick (1961, 1899-1928) and BEA NIPA Table 701, line 4 (1929-99).

long-term bond yields Moody's AAA corporate bond yield as reported by Citibase series FYAAC (1919-99) and spliced with Census Bureau series HS X-490 by adding 50 basis points to the latter. Moody's AAA corporate bond yield is an annual average of monthly yields reported on by St. Louis Fed (1919-99).

national income, and components National income from BEA NIPA Table 1.14, line 1 (1929-) and Census Bureau HS F-7 (-1928). Employee compensation and proprietors' income with inventory valuation and capital consumption allowance from BEA NIPA Table 1.14, lines 2 and 9 (1929-). As shares of national income, employee compensation and proprietors' income are reported by Johnson (1954, Table 1) at 5 year intervals prior to 1929; I linearly interpolate in between years.

population aged 15+ Calculated as the product of total population and the fraction of the population that is aged 15+. Both series are from the Census Bureau (1975, series HS A-29, 1899-1969 and April 2000 Internet Release, 1970-99), except that the fraction aged 15+ is not always measured directly, and in these cases interpolated between Census years.

real paper yield For year $t$, the nominal yield promised in year $t$-1 on 4-6 month prime commercial paper, as recorded by the Census Bureau (1975, series HS X-445, 1899-1969) and U.S. Council of Economic Advisers (1999, Table B-73), minus the GDP deflator log change from $t$-1 to $t$.

Table 1 Summary Statistics, 1947-96

| variable | mean | std dev | min | max |
|---|---|---|---|---|
| pre-tax capital rental rate | 0.095 | 0.011 | 0.073 | 0.121 |
| capital tax rate, aggregate effective | 0.388 | 0.053 | 0.279 | 0.495 |
| capital tax rate, manufacturing, based on statutory user cost (1954-89 only) | 0.273 | 0.067 | 0.141 | 0.371 |
| nondur & serv. cons. gr. | 0.020 | 0.013 | -0.013 | 0.037 |
| BAA-AAA bond yield premium*100 | 0.919 | 0.411 | 0.372 | 2.326 |
| nominal paper yield | 0.055 | 0.032 | 0.008 | 0.148 |
| inflation | 0.038 | 0.025 | -0.001 | 0.102 |

## VII. Appendix II: VAR's used to Calculate Expectations

Table 2: VARs used to Calculate Simulated Tax Rates
($t$ = 1947, ..., 1996)

| independent variables | | | | |
|---|---|---|---|---|
| intertemporal elas. σ: | 2.5 | 1.5 | 2.5 | 1.5 |
| dependent variable: | $1/IMRS_t$ | | $\rho_t/IMRS_t$ | |
| $1/IMRS_{t-1}$ | 0.38<br>(0.97) | 0.38<br>(0.97) | -0.02<br>(0.18) | 0.42<br>(0.66) |
| $\rho_{t-1}/IMRS_{t-1}$ | -1.79<br>(10.42) | -1.80<br>(10.42) | 2.68<br>(2.86) | -2.95<br>(7.13) |
| nominal paper yield (promised year $t$-1 for maturity in $t$) | 0.07<br>(0.03) | 0.11<br>(0.05) | -0.09<br>(0.04) | -0.09<br>(0.03) |
| inflation ($t$-2 to $t$-1) | 0.08<br>(0.03) | 0.14<br>(0.04) | -0.07<br>(0.03) | -0.07<br>(0.03) |
| yield gap, as promised year $t$-1, between BAA and AAA corporate bonds/100 | -1.04<br>(0.23) | –1.73<br>(0.44) | 0.66<br>(0.30) | 0.56<br>(0.30) |
| $\rho_{t-1}$ | 1.56<br>(9.83) | 1.48<br>(9.82) | -1.73<br>(2.71) | 3.56<br>(6.71) |
| adj-$R^2$ | .42 | .42 | .81 | .82 |
| regression standard error | .004 | .006 | .004 | .004 |

Notes: (1) A constant term is included in all specifications.
(2) $IMRS_t = (\beta^{-1} c_t/c_{t-1})^{1/\sigma}$, where $c_t$ is year $t$ real nondurable and services expenditures per person age 15+

## VIII. Appendix III: The NIPA Investment Price Index and Capital Tax Incidence

The return on capital $r$ can be decomposed into a rental rate ρ and a capital gain. It is the entire return $r$, and not just one of its components, that enters the Euler equation. However, there are two reasons why the entire return $r$ is difficult to measure in the national accounts. First, Gordon (1990) and others have questioned the accuracy of BEA investment price series. Second, even if BEA investment prices measured exactly what they are supposed to measure, it is important to recognize that investment prices are partly incorporated into BEA depreciation because the latter is intended to measure anticipated aging and economic obsolescence.[26] Hence, if we took capital income gross of depreciation, subtracted BEA depreciation, and then added the rate of appreciation of investment prices, we would be counting some investment price depreciation twice. For example, if the aggregate capital stock became more computer-intensive (computer prices are expected to fall more rapidly than those of most other investment goods) BEA would record more depreciation for the aggregate capital stock and record a lower (more negative) rate of price appreciation for the representative investment good. The three part calculation cited above would thereby double count the effect of computers' economic obsolescence on the return to capital. The "rental rate" calculated as capital income net of BEA depreciation would correctly measure the return.

On the other hand, if there were an unanticipated investment price appreciation that was not associated with a change in the composition of the capital stock, then the three part calculation cited above would correctly measure capital's return. An alternative three-part calculation would avoid the double-counting by replacing BEA depreciation with 0.04* the BEA capital stock, although this would miss any changes in depreciation due to a change in the capital stock to investment goods with shorter lifetimes.

Both the 1960's time series approach to capital tax incidence are somewhat different if either three part calculation is used. Each observation in Figure 8 is one of the five-year intervals 1931-35, .... The vertical axis measures the log of the economy-wide capital return $r$ (gross of capital taxes and net of depreciation) measured as the sum of the three parts cited above (including BEA depreciation), while the horizontal axis measures the log of one minus the economy-wide rate $\tau$ of capital taxation (both of these measures are explained in detail below). The negative relation is steeper than in Figure 1 (which uses the rental rate on the vertical axis), especially during the postwar period. Figure 8's postwar regression slope is -2.0!

When using the Euler equation approach, it is important to recognize that BEA investment prices begin a sudden downward trend beginning about 1980. Should a dummy variable for year>=1980 be included in the VARs? I try it both ways, and in either case the simulated tax rate

[26]"Expected obsolescence implicitly enters into BEA estimates of depreciation through shorter asset lifetimes and through the retirement pattern previously used." (Fraumeni 1997, p. 9).

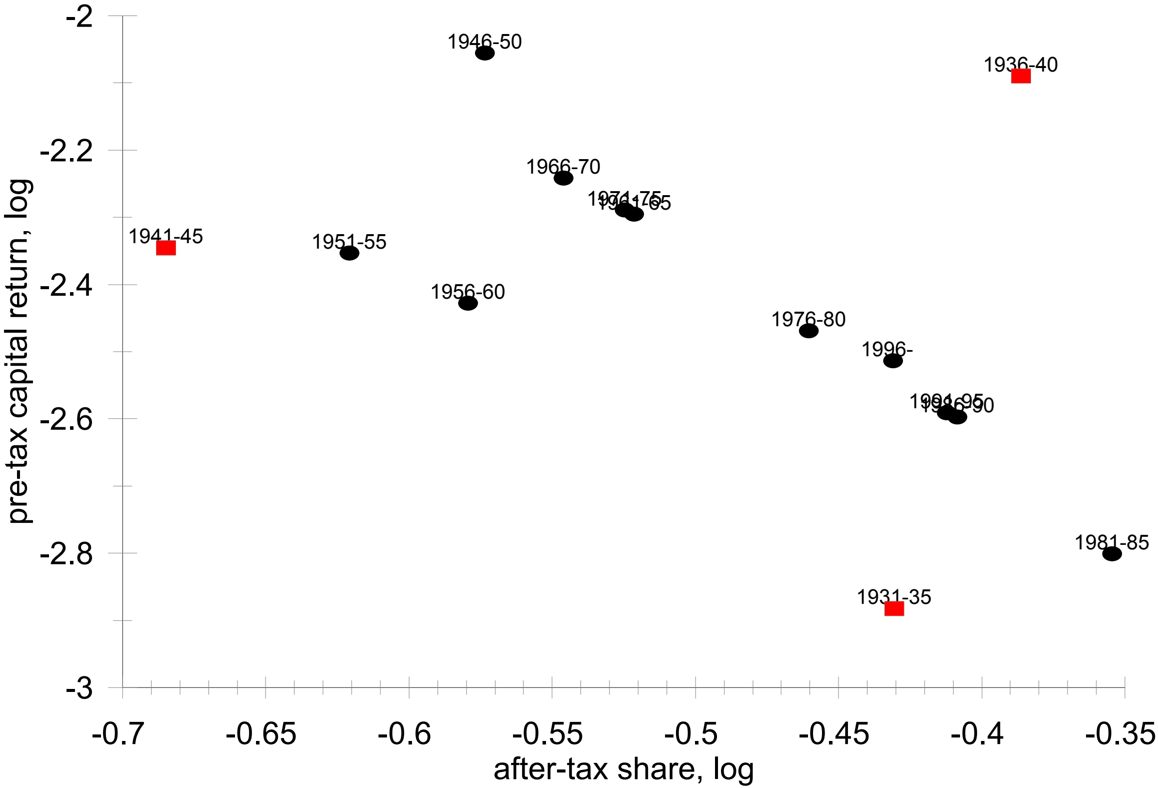


Fig 8: pre-tax "return" (rental rate + inv price appreciation) vs tax rates

is quite similar to that shown in Figure 5 prior to 1980. The simulated tax rate dips from 34% to 11% 1980-84, rather than the 35% to 30% dip shown in Figure 5. By 1995 the simulated tax rate is much closer to the measured tax rate than shown in Figure 5. Hence, by comparison with the pre-1980 period, the simulated tax rate matches measured tax rates better in the 1990's if BEA investment price appreciation is included in the capital return, and better in the 1980's if excluded.

## IX. References


Altig, David, et al. "Simulating Fundamental Tax Reform in the United States." *American Economic Review*. 91(3), June 2001: 574-95.

American Council for Capital Formation. "The Role of Federal Tax Policy and Regulatory Reform in Promoting Economic Recovery and Long-Term Growth" Congressional Testimony, November 28, 2001.

Auerbach, Alan J. "Corporate Taxation in the United States." *Brookings Papers on Economic Activity*. 2, 1983: 451-505.

Auerbach, Alan J. and Laurence J. Kotlikoff. *Dynamic Fiscal Policy*. Cambridge: Cambridge University Press, 1987.

Auerbach, Alan J., and Joel Slemrod. "The Economic Effects of the Tax Reform Act of 1986." *Journal of Economic Literature*. 35(2). June 1997: 589-632.

Barro, Robert J. and Chaipat Sahasakul. "Measuring the Average Marginal Tax Rate from the Individual Income Tax." *Journal of Business*. 56, October 1983: 419-52.

Besley, Timothy J., and Harvey S. Rosen. "Sales Taxes and Prices: An Empirical Analysis." *National Tax Journal*. 52(2), June 1999: 157-78.

Bureau of Economic Analysis. "Fixed Assets and Consumer Durable Goods: Estimates for 1925-98." *Survey of Current Business*. 80(4), April 2000. 17-30.

Cochrane, John H. "Production-Based Asset Pricing and the Link between Stock Returns and Economic Fluctuations." *Journal of Finance*. 46(1), March 1991: 209-37.

Cragg, John G. Arnold C. Harberger, and Peter Mieszkowski. "Empirical Evidence on the Incidence of the Corporation Income Tax." *Journal of Political Economy*. 75(6), December 1967: 811-821.

Cummins, Jason G., Kevin A. Hassett, and R. Glenn Hubbard. "A Reconsideration of Investment

Behavior Using Tax Reforms as Natural Experiments." *Brookings Papers on Economic Activity*. 2, 1994: 1-59.

Due, John F. "The Effect of the 1954 Reduction in Federal Excise Taxes on the List Prices of Electrical Appliances." *National Tax Journal*. 7(3), September 1954: 222-6.

Evans, William N. Jeanne S. Ringel, and Diana Stech. "Tobacco Taxes and Public Policy to Discourage Smoking." *Tax Policy and the Economy*. 13, 1999: 1-55.

Feldstein, Martin S, Louis Dicks-Mireaux, and James Poterba. "The Effective Tax Rate and the Pretax Rate of Return." *Journal of Public Economics*. 21(2), July 1983: 129-58.

Feldstein, Martin S. and Lawrence Summers. "Inflation, Tax Rules, and the Long-Term Interest Rate." *Brookings Papers on Economic Activity*. 1, 1978: 61-99.

Fisher, Irving. *The Theory of Interest*. New York: Macmillan, 1930.

Goode, Richard. "Rates of Return, Income Shares, and Corporate Tax Incidence." in Marian Krzyzaniak, ed. *Effects of Corporation Income Tax*. Detroit: Wayne State University Press, 1966.

Gordon, Robert J. "Specification Bias and Corporate Tax Incidence." *National Tax Journal*. 23(4), December 1970: 373-78.

Gordon, Robert J. *The Measurement of Durable Goods Prices*. Chicago: University of Chicago Press (for NBER), 1990.

Griliches, Zvi and Dale W. Jorgenson. "Sources of Measured Productivity Change: Capital Input." *American Economic Review*. 56(1), March 1966: 50-61.

Haig, Robert M. and Carl Shoup. *The Sales Tax in the American States*. New York: Columbia University Press, 1934.

Hall, Robert E. "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence." *Journal of Political Economy*. 86(6), December 1978: 971-87.

Hall, Robert E. "Intertemporal Substitution in Consumption." *Journal of Political Economy*. 96(2), April 1988: 339-57.

Hall, Robert E. and Dale W. Jorgenson. "Tax Policy and Investment Behavior." *American Economic Review*. 57(3), June 1967: 391-414.

Harberger, Arnold C. "The Incidence of the Corporation Income Tax." *Journal of Political Economy*. 70, 1962: 215-40.

Hwang, Jason and Casey B. Mulligan. "Macroeconomic Distortions and Specification Errors: Some

Descriptive Statistics." working paper, Harvard University, February 2003.

Johnson, D. Gale. "The Functional Distribution of Income in the United States, 1850-1952." *Review of Economics and Statistics*. 36(2), May 1954: 175-82.

Kendrick, John W. *Productivity Trends in the United States*. Princeton: Princeton University Press, 1961.

Krzyzaniak, Marian, and Richard A. Musgrave. *The Shifting of the Corporation Income Tax*. Baltimore, MD: Johns Hopkins Press, 1963.

Lucas, Robert E., Jr. "Supply-Side Economics: An Analytical Review." *Oxford Economic Papers*. 42(2), April 1990: 293-316.

McGrattan, Ellen R. and Edward C. Prescott. "Taxes, Regulations, and Asset Prices." NBER working paper #8623, December 2001.

Mendoza, Enrique G. Assaf Razin and Linda L. Tesar. "Effective Tax Rates in Macroeconomics: Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption." *Journal of Monetary Economics*. 34(3), December 1994: 297-323.

Mitrusi, Andrew and James Poterba. "The Distribution of Payroll and Income Tax Burdens, 1979-99." *National Tax Journal*. 53(3), Part 2 Sept. 2000: 765-94.

Mulligan, Casey B. "A Dual Method of Empirically Evaluating Dynamic Competitive Equilibrium Models with Distortionary Taxes: Evaluating the Stochastic Margins." Manuscript, University of Chicago, January 2001.

Mulligan, Casey B. "A Dual Method of Empirically Evaluating Dynamic Competitive Equilibrium Models with Market Distortions, Applied to the Great Depression and World War II." NBER working paper no. 8775, February 2002a.

Mulligan, Casey B. "Capital, Interest, and Aggregate Intertemporal Substitution." NBER Working paper #9373, December 2002b.

Mulligan, Casey B. "Capital Tax Incidence: First Impressions from the Time Series." NBER Working paper #9374, December 2002c.

Mulligan, Casey B. and Justin G. Marion. "Average Marginal Tax Rates Revisited: Comment." Working paper, University of Chicago, August 2000.

Parker, Robert P., et al. "Preview of the Comprehensive Revision of the National Income and Product Accounts: Recognition of Government Investment and Incorporation of a New Methodology for Calculating Depreciation." *Survey of Current Business*. 75(9), September

1995: 33-41.

Poterba, James M. "Retail Price Reactions to Changes in State and Local Sales Taxes." *National Tax Journal*. 49, June 1996: 165-76.

Rotemberg, Julio and Michael Woodford. "The Cyclical Behavior of Prices and Costs." *Handbook of Macroeconomics*. Amsterdam: North Holland, 1999.

Sidhu, Nancy D. "The Effects of Changes in Sales Tax Rates on Retail Prices." in *Proceedings of the Sixth-Fourth Annual Conference on Taxation*. 720-33. Columbus: National Tax Association – Tax Institute of America, 1971.

Slitor, Richard E. "Corporate Tax Incidence: Economic Adjustments to Differentials under a Two-Tier Tax Structure." in Marian Krzyzaniak, ed. *Effects of Corporation Income Tax*. Detroit: Wayne State University Press, 1966.

Stephenson, E.F. "Average Marginal Tax Rates Revisited." *Journal of Monetary Economics*. 41, 1998: 389-409.

Stokey, Nancy L. and Sergio Rebelo. "Growth Effects of Flat-Rate Taxes." *Journal of Political Economy*. 103(3), June 1995: 519-50.

United States Council of Economic Advisers. *Economic Report of the President*. Washington, DC: Government Printing Office, various issues.