Journal of Public Economics 84 (2002) 1–32
JOURNAL OF PUBLIC ECONOMICS
www.elsevier.com/locate/econbase

The elasticity of taxable income: evidence and implications

Jon Gruber[a,c,*], Emmanuel Saez[b,c]

[a]*Department of Economics, Massachusetts Institute of Technology, MIT E52-355, 50 Memorial Drive, Cambridge, MA 021432-1347, USA*
[b]*Department of Economics, Harvard University, Littauer Center, 1575 Cambridge Street, Cambridge, MA 02138, USA*
[c]*NBER: National Bureau of Economic Research, 1050 Massachusetts Avenue, Cambridge, MA 02138, USA*

Received 31 March 2000; received in revised form 6 September 2000; accepted 3 January 2001

Abstract

A central tax policy parameter that has recently received much attention, but about which there is substantial uncertainty, is the overall elasticity of taxable income. We provide new estimates of this elasticity which address identification problems with previous work, by exploiting a long panel of tax returns to study a series of tax reforms throughout the 1980s. This identification strategy also allows us to provide new evidence on both the income effects of tax changes on taxable income, and on variation in the elasticity of taxable income by income group. We find that the overall elasticity of taxable income is approximately 0.4; the elasticity of real income, not including tax preferences, is much lower. We estimate small income effects of tax changes on reported income, implying that the compensated and uncompensated elasticities of taxable income are very similar. We estimate that this overall elasticity is primarily due to a very elastic response of taxable income for taxpayers who have incomes above $100 000 per year, who have an elasticity of 0.57, while for those with incomes below $100 000 per year the elasticity is less than one-third as large. Moreover, high income taxpayers who itemize are particularly responsive to taxation. Our estimates suggest that optimal tax structures may feature tightly targeted transfers to lower income taxpayers and a flat or even declining marginal rate structure for middle and high income taxpayers.

JEL classification: H21; H31; J22

*Corresponding author. Tel.: +1-617-253-8892; fax: +1-617-253-1330.
E-mail address: gruberj@mit.edu (J. Gruber).

0047-2727/02/$ – see front matter
PII: S0047-2727(01)00085-8

One of the most important features of economic policy-making during the 1980s were a series of tax reforms which dramatically lowered marginal income tax rates in the US, particularly for higher income families. The top marginal income tax rate at the federal level fell from 70% in 1980 to 28% by 1988, as the income tax schedule was reduced from 15 brackets to four. There were parallel changes in state income tax systems over this decade as well; New York, for example, moved from a system in 1980 with 13 brackets and a top marginal rate of 14% to one in 1989 with five brackets and a top marginal rate of 7.875%.

The intellectual weight behind this dramatic reduction in marginal tax rates was the logic of supply side economics. A number of influential articles, such as Hausman (1981) and Boskin (1978), argued that behaviors such as labor supply and savings were very elastic with respect to their prices, and as a result lower tax rates could generate important increases in economic activity. A large body of subsequent literature, however, suggested that these behavioral elasticities were actually rather modest (Slemrod, 1990). While this subsequent literature may not be a driving factor, it is noticeable that the 1990s have seen a reversal of the tax reductions of the 1980s, with marginal rates rising to 39.6% at the top today.

Over the past few years, however, a new literature has emerged which has pointed out that these standard behavioral responses are only one component of what drives taxable income; other responses such as the form of compensation, unmeasured effort, and compliance also ultimately determine taxable income income, and these may be more elastic with respect to taxation. Feldstein (1995) in particular observed that it is the overall elasticity of taxable income which is relevant for assessing the implications of tax changes for revenue raising. His seminal article found that this elasticity was very high for the Tax Reform Act of 1986 (TRA86), in excess of one for his central estimates.

This striking conclusion has generated a substantial body of work on this central parameter. Unfortunately, this subsequent work has generated a wide range of estimated elasticities, ranging from Feldstein's estimate at the high end to close to zero at the low end. This extreme variation reflects a variety of differences between the approaches in these papers, along dimensions such as the definition of income (ranging from broad Haig-Simons type definitions to narrower taxable income definitions), the samples used (ranging from just focusing on high income taxpayers to using a full range of incomes), and, perhaps most importantly, the source of identification. As emphasized by Slemrod (1996) and Goolsbee (2000a,b), many of the studies have essentially shown that high income taxpayers, whose marginal rates were falling in the 1980s, increased their taxable income during this era. But there was a general widening of the income distribution during the 1980s, and disentangling the role of taxation, as opposed to other factors such as international trade and skill-biased demand shocks, is quite difficult.

Our paper makes three contributions to this empirical literature. First, we draw on the entire set of state and federal tax reforms during the 1980s to estimate the elasticity of taxable income. The use of multiple years of changes allows us to address the identification problem faced by previous work by controlling in a rich way for the relationship between income changes and lagged income levels. That is, since for every income group over this time period there are different changes in tax policy in different years, we can control for any general tendencies towards (for example) a widening income distribution over this period while identifying the impact of tax policy changes. Second, while the previous literature has, in most cases, ignored the decomposition of behavioral responses into substitution and income effects, our empirical framework allows us to make this decomposition.[1] Third, by using this broad set of reforms, which affected not just taxpayers at the top of the income distribution, we can extend the literature by exploring the variation in this critical parameter along the income distribution. Since we have variation not just at the top of the distribution but throughout, we can examine the heterogeneity by income class in how taxpayers respond to tax changes.

These advances generate a number of important findings. We find that the overall elasticity of taxable income is 0.4, well below the original estimates of Feldstein but roughly at the mid-point of the subsequent literature. This response is much lower, however, for a broader definition of total income that does not exclude tax preferences such as exemptions and itemized deductions; this partly arises from the mechanical effect that the base for calculating the elasticity is larger, and partly from responsiveness of tax preferences to tax rates. We estimate small income effects of tax changes on reported income, implying that the compensated and uncompensated elasticities of taxable income are very similar. We also find that this response is driven largely by the behavior of high income taxpayers; the elasticity of taxable income for those with incomes above $100 000 is 0.57, while it is less than one-third that for other income groups. High income taxpayers who itemize appear to be particularly responsive to tax changes. Finally, we draw on the framework of Saez (2000a) to show that our estimates suggest that the optimal system for most redistributional preferences consists of a large demogrant that is rapidly taxed away for low income taxpayers, with lower marginal rates at higher income levels.

Our paper proceeds as follows. Section 1 provides a review of the literature on the elasticity of taxable income, highlighting the variation in the estimates, and the differences in approach across these papers. Section 2 discusses our data and methodology. Section 3 presents our basic results. Section 4 considers heterogeneity by income and itemizing status. Section 5 briefly discusses the implications of our finding for optimal tax structures. Section 6 concludes.

[1] Feldstein (1995) argues that he estimates compensated elasticities because the TRA of 1986 was a broadly revenue neutral tax reform. However, this argument is correct only when the reform is neutral for all income classes. This is very unlikely to be the case with the TRA of 1986. See Footnote 12.

1. Previous work

As noted in the introduction, there is a long tradition of work on the behavioral elasticities of labor supply and savings which determine the responsiveness of real behavior to taxation. The literature on labor supply has recently been reviewed in Blundell and MaCurdy (1999), and they conclude that the responsiveness of male labor supply to after-tax wages is low, although it is higher (and perhaps much higher) for female/secondary earner labor supply. There is less consensus on the responsiveness of savings to taxation, but Hall (1988) concludes that there is little evidence from time series data to suggest an important correlation between savings and rates of return. There is also a large literature on the responsiveness of other elements of taxable income to taxation, such as charitable giving and the form of compensation (as well as tax evasion), which suggests that these elements are fairly sensitive to taxation (Slemrod, 1990). But these literatures had proceeded in piecemeal fashion, each paper considering the response of a particular real or reporting behavior, but with little effort to integrate the findings.

The first article to attempt such an integration was Lindsey's (1987) study of the response of taxable income to the Economic Reform Tax Act of 1981 (ERTA 81), which significantly reduced tax rates on high income earners. He used a series of cross-sections of taxpayers to project what the distribution of earnings would have been like in 1982 had there been no change from 1979, other than uniform overall income growth. He then interpreted a change in the distribution of incomes towards the wealthy as evidence of a responsiveness to taxation, estimating an elasticity of taxable income with respect to taxation of 1.6–1.8. But, as highlighted by Navratil (1995), a critical problem with this approach is that the income distribution is not static, and if there is any growing skewness of incomes for other reasons, then the use of a constant real income cutoff will naturally lead to a finding that tax cuts for the wealthy are leading to higher taxable incomes in that group.

Feldstein's (1995) influential article addressed this problem by turning to panel data, allowing him to assess whether given individuals actually saw income changes, rather than simply whether income changed on average in a given income group. He studied the experience of the Tax Reform Act of 1986 (TRA 86), which further reduced tax rates at the top of the income distribution. He examined groups of taxpayers based on their pre-TRA income levels, and found that for those taxpayers for whom rates fell the most, taxable income increased the most. He estimated elasticities of taxable income with respect to taxation ranging from 1 to over 3, with a central estimate of 2.14.

Feldstein's article generated a significant amount of interest in this question, and led to the series of additional studies reviewed in Table 1. As is immediately apparent, there is significant disagreement among these studies about the appropriate elasticity estimate, with results ranging from zero to 0.8. But as is also

Table 1
Previous studies

Author (date) (1)	Data (years) (2)	Tax change (3)	Sample (4)	Controls for mean reversion and income distribution (5)	Income definitions (6)	Elasticity results (7)
Lindsey (1987)	Repeated tax cross-sections (1980–1984)	ERTA 81	AGI>$5K	None	Taxable income	Elast.: 1.05–2.75 Central estimate: 1.6
Feldstein (1995)	NBER tax panel (1985 and 1988)	TRA 86	Married, non-aged non-S corp creating Income>$30K	None	AGI Taxable income	Elast. of AGI: 0.75–1.3 Elast. of taxable income: 1.1–3.05
Navratil (1995)	NBER tax panel (1980 and 1983)	ERTA 81	Married, income>$25K	Use Average Income	Taxable Income	Elast. of taxable income: 0.8
Auten and Carroll (1997)	Treasury tax panel (1985 and 1989)	TRA 86	Single and married age 25–55, inc.>$15K Non-S corp creating	Include Log Income in base year	Gross Income Taxable Income	Elast. of gross inc.: 0.66 Elast. of taxable income: 0.75
Sammartino and Weiner (1997)	Treasury tax panel (1985–1994)	OBRA 1993	Less than 62 years old	None	AGI	Close to zero permanent response of AGI
Goolsbee (1998)	Panel of corp. exec. (1991–1994)	OBRA 1993	Corporate executives 95% with income>$150 K	Use Average Income	Wages, Bonus and Stock Options	Short run elast.: 1 Long run elast.: 0.1
Carroll (1998)	Treasury tax panel (1987 and 1996)	OBRA 1993	Married aged 25–55 Income>$50 K	Use Average Income	Taxable Income	Elast.: 0.5
Saez (1999)	NBER tax panel (1979–1981)	Bracket Creep	Married and singles only	Include Log Income and Polynomials in Income	AGI Taxable Income	Elast. of AGI: 0.25 Elast. of taxable income 0.4
Moffitt and Wilhelm (2000)	SCF panel (1983 and 1989)	TRA 86	High incomes oversampled	Use various Sets of Instruments	AGI	Elast. of AGI: 0 to 2 depends on instruments
Goolsbee (1999)	Tax statistics tables (1922–1989)	Various tax ref.	Incomes>$30 K	None	Taxable Income	Elast. from −1.3 to 2 depending on tax reform

apparent, there is significant difference across the studies in how the question is approached, along at least two important dimensions.

The first, and most important difference, is whether the studies attempt to control for mean reversion and, relatedly, for other trends in the income distribution which might confound the results. While panel data reduces the problem noted above with the Lindsey (1987) study, it introduces a new problem: if there is a mean-reverting transitory component to income in a given year, then it can cause high income taxpayers in 1 year to appear low income in the next, aside from any true behavioral response. At the same time, a countervailing factor is the fact that the distribution of income has been continually widening since the mid-1970s, with particularly large gains at the very top of the income distribution in the 1980s and 1990s. This corresponds to a series of tax reforms which have targeted their tax cuts (ERTA 81 and TRA 86) and increases (the 1993 tax increases studied by Goolsbee (2000a) and Carroll (1998)) at the top of the income distribution. It is possible that these tax policies are themselves causally related to this widening of the pre-tax income distribution, but there are a variety of alternative explanations as well, ranging from the impacts of international trade to skill-biased technological change (see Katz and Murphy (1992)). While several of the studies reviewed here recognized the mean reversion problem, only Auten and Carroll (1997) and Saez (1999) dealt with it in a manner that also potentially addressed concerns about omitted determinants of the income distribution (by including explicit controls in the regression for base year income group).

A second major issue is the definition of income used. Most studies reviewed here use taxable income as the income definition, in many cases excluding capital gains income. Whether this is the right definition depends very much on the question being asked; for local reforms, this is probably appropriate, but for thinking about larger reforms or optimal tax systems, it would be more appropriate to use a more comprehensive income definition. There is some suggestion in the literature of sensitivity to the income definition; Feldstein's estimate is significantly lower (although still above most of the subsequent literature) when a broader definition of income is used.

2. Data and methodology

2.1. Data

Our data source for this exercise is the NBER panel of tax returns over the 1979–1990 period. This panel, known as the Continuous Work History File, contains most of the individual line items from form 1040, as well as numerous other items from the other forms and schedules. The panel is constructed from all tax returns filed in a given year by selecting certain four-digit endings of the social security number of the primary taxpayer listed on the form. From 1979 to 1981, five such endings were chosen, and the panel is quite large, with roughly 46 000 observations. However, in 1982 and 1984, only one ending was chosen, and in other years only two, so that the size of the panel was drastically reduced. Appendix A describes in more detail this data source and the definitions of our key variables.

The empirical strategy is to relate changes in income between pairs of years to the change in marginal rates between the same pairs of years. This pair of years are called year 1 and year 2. The time length between year 1 and year 2 can be of 1, 2 or 3 years. In our basic specification, the time length is 3 years, following Feldstein (1995). In that case, we relate year 1982 to year 1979, year 1983 to year 1980, ... and year 1990 to year 1987. These nine differences are stacked to obtain a single dataset of about 100 000 observations. We then exclude taxpayers whose marital status changes from year 1 to year 2, for whom we expect large reported taxable income changes unrelated to tax policy. It is unlikely that tax changes affected specifically marriage strategies and therefore discarding those observations should not bias the results.

We use two different types or definitions of income: broad income and taxable income. Broad income is an extensive definition of gross income that is consistent across the years 1979–1990. It includes most of the items that are summed to arrive at Total Income on Form 1040: wage income, interest income, dividends, business income, etc. The precise definition of broad income is given in Appendix A. Broad income is a grosser income definition than Adjusted Gross Income (AGI) because Broad Income does not incorporate the various adjustments such as IRA or retirement plans deductions that are substracted from Total Income to obtain AGI. Capital gains are excluded because their tax treatment is special. Before the TRA of 1986, only 40% of capital gains were included in taxable income and thus the marginal rate on capital gains was much lower than on other income. After the TRA, full capital gains were included in taxable income but the top rate for capital gains was limited to 28%. Because of these special rules for capital gains, most previous studies have also excluded capital gains from their analysis (see Table 1).

The Taxable Income definition we use is close to the actual definition of taxable income. Our definition is consistent over the years 1979–1990. It includes all the items and adjustments that can be computed from the data for all the years 1979–1990. For example, the secondary earner deduction that was in place from 1982 to 1986 is not included because it cannot be computed for the other years. As for Broad Income, Capital Gains have also been excluded from our Taxable Income definition. See the appendix for the precise definition of Taxable Income; this definition is similar to what has been used in previous work.[2] Using a constant definition of taxable income can be seen as a natural counterpart of what previous studies have done using only 2 years of data.

[2] Contrary to Feldstein and Auten and Caroll, we do not add back losses to our income definitions because we find that adding back losses does not affect the results.

As our definition of taxable income is similar to the definition in place in 1990, our estimates can be viewed as the impact of taxes on a 1990-style taxable income definition. A limitation of this constant-definition approach is that we potentially understate the responsiveness of taxable income to taxation, even from the perspective of 1990. This is because if the 1990 definition were in place in earlier years, individuals may have undertaken different activities to avoid taxes that would have shown up in this definition; that is, if the avoidance avenues available in earlier years were made unavailable, other avenues might have been used instead that would have shown up in our data. Slemrod (1998) describes this point in detail. Offsetting this, however, is the problem that, like all other papers in this literature, we focus solely on the individual income tax base. A growing wedge between the individual and corporate tax rate could lead some individuals to shift their income generation from the non-corporate to corporate sectors; see Gordon and MacKie-Mason (1994) and Gordon and Slemrod (2000) for evidence of this type of shifting. Thus, we are overstating the total cost to the tax system from rising tax rates, since some of the reduced individual income that we estimate will show up in rising corporate sector income.

We also exclude taxpayers whose income is below $10 000 in year 1, to avoid very serious mean reversion at the bottom of the income distribution. In fact, as our elasticity results are weighted by income, including taxpayers with lower incomes does not significantly affect the results. We select taxpayers according to their *Broad Income* in year 1, even when looking at Taxable Income. Therefore, potential differences between Broad Income and Taxable Income estimates do not come from selection.

In Table 2, we present the means of the data for the 3-year difference case; the table shows that average Broad Income is equal to about $43 000 and average

Table 2
Summary statistics[a]

	Mean (1)	S.D. (2)
Broad income	$43 334	55 104
Taxable income	$25 873	45 508
Married dummy	0.645	
Single dummy	0.28	
Itemizer status	0.41	
Federal tax rate	23	8.8
State tax rate	4	3.5
Average net-of-tax rate	73	10.6
Federal tax liability	$6737	23 555
State tax liability	$1072	1694
Number of observations	69 202	

[a] Summary statistics given for all observations with Broad income above $10 000. All dollar values are expressed in 1992 dollars.

Taxable Income equal to $25 000. Sixty-four percent of our sample consist of married taxpayers and 28% of singles. All our dollar figures are expressed in terms of 1992 dollars.

2.2. Empirical strategy

Our goal is to measure the impact of a change in the tax schedule faced by a given individual on his income. To do so, we use the basic micro-economic framework with two goods (consumption and income). From this basic model, we derive a regression specification and we then discuss the identification assumptions.

2.2.1. The model

The budget constraint of a taxpayer on a linear part of the tax schedule is given by $c = z(1-\tau) + R$, where z is before tax income, τ is the marginal rate and R is virtual income. Utility maximization leads to an income supply function which depends on the slope of the budget line and on virtual income: $z = z(1-\tau, R)$. As depicted in Fig. 1, for a given individual, a tax change can be seen as a change in both virtual income R and marginal rate τ. Changes in R and τ affect income supply z as follows,

$$\mathrm{d}z = -\frac{\partial z}{\partial(1-\tau)}\,\mathrm{d}\tau + \frac{\partial z}{\partial R}\,\mathrm{d}R.$$

Introducing the (uncompensated) elasticity of income with respect to the net-of-tax rate $\zeta^u = [(1-\tau)/z]\partial z/\partial(1-\tau)$ and the income effect parameter $\eta = (1-\tau)\partial z/\partial R$, we get,

$$\mathrm{d}z = -\zeta^u z\,\frac{\mathrm{d}\tau}{1-\tau} + \eta\,\frac{\mathrm{d}R}{1-\tau}.$$

Using the compensated elasticity of income $\zeta^c = [(1-\tau)/z]\partial z/\partial(1-\tau)\big|_u$ and the Slutsky equation $\zeta^c = \zeta^u - \eta$, we obtain finally,

$$\frac{\mathrm{d}z}{z} = -\zeta^c\,\frac{\mathrm{d}\tau}{1-\tau} + \eta\,\frac{\mathrm{d}R - z\,\mathrm{d}\tau}{z(1-\tau)}. \tag{1}$$

$\mathrm{d}R - z\,\mathrm{d}\tau$ is the change in after-tax income due to the tax change for a given before tax income z. It is thus also equal to the change in tax liability for taxpayers with income z. This is illustrated by the vertical segment between the two schedules on Fig. 1.

2.2.2. Regression specification

Eq. (1) displays the behavioral response in income induced by the small tax change ($\mathrm{d}\tau$, $\mathrm{d}R$). This equation could be estimated by replacing z by z_1 (year 1

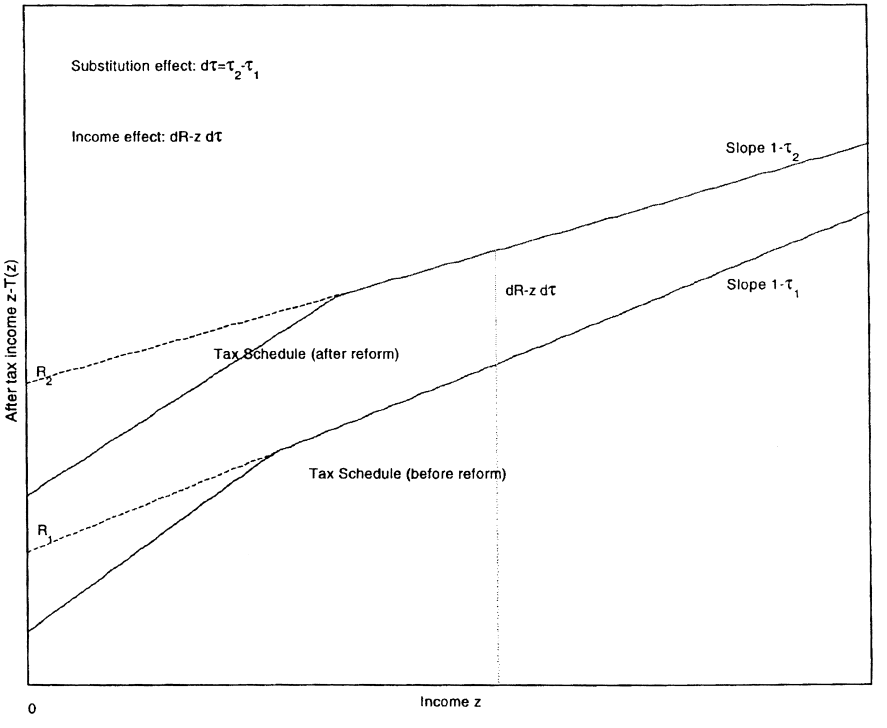

Fig. 1. Income and substitution effects of a tax change.

income), dz by $z_2 - z_1$ (change in income between year 1 and year 2), $d\tau$ by $T_2'(z_2) - T_1'(z_1)$ (change in marginal tax rates), and $dR - z\ d\tau$ by $[z_2 - T_2(z_2)] - [z_1 - T_1(z_1)]$ (change in after-tax income). However, for large tax changes, it is perhaps more natural to use a log–log specification that is also closer to previous studies' specifications. Therefore using (1) and replacing dz/z by $\log(z_2/z_1)$, $-d\tau/(1-\tau)$ by $\log[(1-T_2')/(1-T_1')]$ and $(dR - z\ d\tau)/(z(1-\tau))$ by $\log[(z_2 - T_2(z_2))/(z_1 - T_1(z_1))]$[3], we obtain the following specification,

$$\log(z_2/z_1) = \zeta \log[(1-T_2')/(1-T_1')] + \eta \log[(z_2 - T_2(z_2))/(z_1 - T_1(z_1))] + \epsilon, \quad (2)$$

where ζ is the compensated elasticity parameter and η is the income effects parameter. z_i is *real* income in year i, T_i' is the marginal tax rate in year i and $T_i(z_i)$ is the tax liability in year i. This specification resembles that used in previous studies, with an important difference: the inclusion of income effects. Fig. 1 illustrates empirically how one can decompose a tax change into a tax rate

[3]Here, we use the approximation $z(1-\tau) \simeq z - T(z)$.

effect (change in the slope of the budget constraint) and an income effect (change in tax liability). Any tax change generates both shifts in the slope of the income/tax relationship, as well as changes in after-tax income. In principle, since the shift in the slope affects equally all those on a segment of tax/income relationship, but the income effect varies by how far one is from a tax kink, and both income and substitution effects can be separately identified.

In order to simplify the discussion, let us assume first that there are no income effects ($\eta = 0$). The term capturing the tax rate change $\log[(1 - T_2')/(1 - T_1')]$ is correlated with ϵ because if there is a positive shock to income ($\epsilon > 0$) then, due to progressivity, the tax rate increases mechanically. Therefore, an OLS regression of Eq. (2) would lead to a biased estimate of the behavioral elasticity. The strategy to build instruments for this variable is to compute T_p' which is the marginal tax rate that the individual would face in year 2 if his real income did not change from year 1 to year 2; that is, to just use changes in tax laws to provide identification of the parameter of interest. The natural instrument for $\log[(1 - T_2')/(1 - T_1')]$ is thus $\log[(1 - T_p')/(1 - T_1')]$ which is the predicted log net-of-tax rate change if real income does not change from year 1 to year 2.

Running the IV regression of Eq. (2) might also lead to a biased estimate of the elasticity if ϵ is correlated with z_1. There are two different reasons why individuals at different points in the income distribution might experience different income growth rates, aside from tax changes. The first is mean reversion: high incomes in year 1 tend to be lower in the following years, producing a negative correlation between ϵ and first period income. The second is a change in the distribution of income. For example, if the income distribution widens, there will be a positive correlation between ϵ and z_1. As noted in the introduction, these opposing forces are both very likely to operate in the 1980s, and there is no reason to expect that they will cancel.

If ϵ depends on z_1, then the instrument (which is also a function of z_1) will be correlated with the error term, producing biased estimates. It is for this reason that Auten and Carroll (forthcoming) and Saez (1999) include lagged income as a control in their regression models. Auten and Carroll show that there is a significant increase to their coefficient when this control is added. But the problem with this solution is that the two effects do not necessarily operate linearly, particularly in combination with each other. Thus, in principle, richer controls for period 1 income might be called for. But, in practice, with only 2 years of data (and therefore only one tax change), a much richer set of controls for period 1 income may destroy identification. This problem is especially acute when the size of the tax rate change is directly correlated with the income level as in the TRA of 1986.[4]

As highlighted by Goolsbee (2000b), what is required is a number of years of

[4]Note that the Auten and Carroll results are in principle also identified by state tax changes around TRA86, by the non-linearity introduced by the 33% ‘bubble rate’ under TRA86, and by changes in deduction rules.

data, where there are different changes in after-tax shares over time. In this framework, one can control in a very rich way for lagged income and still identify tax effects. As we will demonstrate below, we use a variety of reforms that affected different points in the income distribution in different ways over time. As a result, we can add, in addition to log income, a 10-piece spline in log first period income (and our results are not sensitive to even richer splines in first period income). We also control for time (by including year dummies) and marital status.[5]

Of course, even in this richer framework, we still rely on an identifying assumption: that mean reversion or changes in inequality are not changing year-to-year in a way that is correlated with year-specific changes in tax policy. In other words, we are allowing the relationship between ϵ and z_1 to be non-linear, but we are imposing that it is constant over time. Given the steadily widening income distribution over the time period we study, this identification assumption is likely to be innocuous. We present specification tests below that show that this assumption is robust to allowing in limited ways for year-specific variation in the relationship between ϵ and z_1.

Following this same discussion, the term $\log[(z_2 - T_2(z_2))/(z_1 - T_1(z_1))]$ in Eq. (2) which captures the income shock, is mechanically correlated with ϵ and needs to be instrumented. A natural instrument is the log change in real after-tax income if there were no behavioral response: $\log[(z_1 - T_p))/(z_1 - T_1(z_1))]$ where T_p is the real tax liability in year 2 that the taxpayer would face if his income did not change in real terms from year 1 to year 2. Additional income controls also remove the residual correlation between the error term ϵ and the income effect instrument.

Once again, for identifying the income effect it is important to control for base year income. In practice, rich controls for base year income make it very difficult to separately identify income and substitution effects with only one tax change. But since we are using many tax reforms, the two effects can be separately identified, as we show below.

The regression setting is thus the following,

$$\log(z_2/z_1) = \alpha_0 + \zeta \log[(1-T'_2)/(1-T'_1)] + \eta \log[(z_2 - T_2(z_2))/(z_1 - T_1(z_1))] + \alpha_1 \log(z_1) + \sum_k \alpha_{2k} mars_k + \sum_j \alpha_{3j} YEAR_j + + \sum_{i=1}^{10} \alpha_{4i} SPLINE_i(z_1) + \epsilon. \tag{3}$$

[5]Another approach to controlling for mean reversion is to control for average income, rather than simply using base period income, as in Carroll (1998). While this may help with mean reversion, however, it does not address our joint concern with omitted variables bias through income distribution changes. Moreover, if average incomes from only the years before the tax change are used, then slowly moving mean reversion is still a problem; if averages that include the years after the tax change are used, then the income control becomes endogenous to the response of incomes to taxation. We have estimated models using income averaging in place of our richer income controls, and the results are much weaker than those reported below.

$YEAR_j$ denote base year dummies and $mars_k$ dummies for marital status in base year. This equation is estimated by 2SLS using $\log[(1-T'_p)/(1-T'_1)]$ and $\log[(z_1-T_2(z_1))/(z_1-T_1(z_1))]$ as instruments. The first stage of this regression is very strong. The F statistics for the coefficient of the tax rate instrument in the first stage regression are always above 20 and often around 100. The F statistics for the coefficient of the income effect instrument in the first stage regression are weaker but always above 6 and often around 20.

Since we stack observations from nine pairs of years to form our estimates, we are using multiple observations on many of the same individuals. If there is individual-specific correlation in how income changes over time, then standard 2SLS will understate our associated standard errors. We therefore present estimates that correct the standard errors for intra-personal correlation.

2.2.3. Computation issues and sources of variations

All tax rate and tax liability variables are computed using the TAXSIM calculator developed at the NBER.[6] The tax computation includes federal and state tax rates. At the federal level, the Earned Income Tax Credit and various other characteristics of the tax rules are taken into account when computing the tax rates. In order to compute the predicted tax rate T'_p and predicted tax liability T_p, all sources of incomes in year 1 are first inflated using a nominal growth deflator (see Appendix A for more details). Then, the TAXSIM calculator applies the income tax law of year 2 to this inflated observation. All income levels are expressed in real terms in 1992 dollars.

During the decade there have been two major tax reforms, ERTA 1981 and TRA 1986. In 1981, the Economic Recovery Tax Act (ERTA) decreased marginal rates in 3 years from 1982 to 1984. The top-rate was reduced from 70 to 50%. In 1986, the Tax Reform Act (TRA) introduced the largest changes in the income tax since World War II. The number of brackets was drastically reduced and the top-rate was further reduced to 28%. The TRA also increased substantially the standard deduction and personal exemption levels in order to be roughly redistributionally neutral (see Slemrod (1990) for a more detailed description of the TRA). In 1987, the Earned Income Tax Credit was also significantly expanded, producing significant changes in the tax rates faced by low income households with children.

There have also been numerous state tax reforms during that decade, with many states decreasing the number of brackets and reducing the top tax rates. At the same time, a few states increased their income tax rates. And about half of the states have experienced very little variation in their tax rules.[7]

---

[6] Feenberg and Coutts (1993) provide an overview of the TAXSIM calculator.

[7] The biggest tax cuts have been in Alaska (from a top rate equal to 14.5% to no taxation at all), Delaware (top rate decreased from 16.7 to 7.7%), Minnesota (from 17 to 8%), New York (from 14 to 7.8%) and Wisconsin (from 10 to 6.9%). Ohio and North Dakota experienced the biggest tax increases.

Table 3 shows the extent of variation in our data. We provide information for each year in our sample on the value of our instrument for the elasticity of taxable income, the predicted log change in the net-of-tax rate, for the full sample and for three different income groups, defined by broad income: $10 000–50 000; $50 000–100 000; and $100 000 and above. The instrument is negative for a tax rate increase and positive for a tax rate cut. We show the results for a 3-year difference between years; we discuss further below the implications of different lengths of differences. We show both the average value of the instrument, and, in square brackets, the standard deviation in this value.

As the results show, there is substantial variation in the mean values of this instrument, over time, across income group, and within group over time. Over the 1979–1982 period, the values are negative (except for the top group), due to the bracket creep explored by Saez (1999). Then, from 1980 to 1983, the first effects of ERTA 1981 are felt, with a large rise in the after-tax share at the very top of the

Table 3
Variation in after-tax shares $\log(1 - T'p/1 - T'1)$[a]

Year (1)	$10 K and above (2)	$10 K to $50 K (3)	$50 K to $100 K (4)	$100 K and above (5)
1979–1982	−0.019	−0.015	−0.039	0.043
	[0.058]	[0.055]	[0.045]	[0.118]
	5465	3846	1411	208
1980–1983	0.026	0.020	0.026	0.132
	[0.059]	[0.050]	[0.052]	[0.111]
	10 864	7762	2660	442
1981–1984	0.042	0.032	0.056	0.158
	[0.063]	[0.052]	[0.060]	[0.109]
	5720	4059	1428	233
1982–1985	0.029	0.021	0.045	0.071
	[0.050]	[0.047]	[0.053]	[0.057]
	5794	4160	1294	240
1983–1986	0.001	0.004	−0.004	−0.033
	[0.082]	[0.041]	[0.115]	[0.210]
	5.180	3598	1327	255
1984–1987	0.037	0.028	0.053	0.102
	[0.077]	[0.074]	[0.070]	[0.108]
	5969	4296	1418	255
1985–1988	0.042	0.025	0.068	0.183
	[0.092]	[0.085]	[0.076]	[0.113]
	11,918	8,589	2,780	548
1986–1989	0.042	0.024	0.067	0.186
	[0.091]	[0.084]	[0.075]	[0.105]
	6122	4385	1444	293
1987–1989	0.009	−0.001	0.022	0.084
	[0.057]	[0.053]	[0.052]	[0.060]
	12 091	8663	2826	602

[a] Mean, standard deviation and number of observations reported. Income cuts based on Broad income definition.

income distribution, while it is close to zero at the bottom due to continued bracket creep. By the next year, there are increases in the after-tax share for most of the income distribution, and they persist to 1982–1985. Then, in 1983–86, the values become small again, before rising in 1984–1987 and 1986–1989 as a result of TRA 1986. Once again, these increases are largest at the top of the income distribution. By 1987–1990, the instrument values are small once again (except at the very top because of the phasing in of the TRA 86).

Clearly, the most sizeable variation in the means is at the top of the income distribution. But there are non-trivial movements in many years at the bottom and middle income levels as well. Moreover, there is enormous heterogeneity within groups, as is illustrated by the standard deviations. This heterogeneity arises from numerous federal and state tax reforms during the period.

3. Overall results

3.1. Basic results

Since the focus of the previous literature has been solely on the elasticity of taxable income, we first estimate (3) without income effect controls; we return to a discussion of income effects in the next section. We include in all models controls for base period marital status, and dummies for each base year; the latter are not reported.

Our basic results from doing so are reported in Table 4. The table has six columns, expressing three alternative methods for dealing with the issue of mean reversion/income distribution changes, for our two income concepts. In the first two columns, we do not include any control. In the second two columns, we control for log income, as in Auten and Carroll (forthcoming). Finally, in the third set of columns, we further include a 10-piece spline in income, to allow for non-linearities in the widening of the income distribution; our results are insensitive to higher order spline terms. We show the results for both definitions of income, broad and taxable. All estimates are weighted by income to reflect the relative contribution to total revenues. As sketched in Section 5, the important parameters for optimal taxation or deadweight burden computations are the elasticities weighted by income because the income response to a change in marginal rates is proportional to the elasticity times the income level.[8] However, to avoid the undue influence of a few very high income observations, we censor our weights at $1 million; this affects only 13 observations. We also censor the change in log income at 7, so that the 11 observations who report changes income ratios across the 2 years of more than 1000 or less than 1/1000 are censored at those

[8]It should be noticed that, if one assumes that elasticities are constant across income levels, weighted estimates are less efficient than unweighted estimates. However, as we will see, the assumption of constant elasticities is rejected by the data.

Table 4
Basic elasticity results[a]

Income controls	None		Log income		Log income 10-piece spline	
	Broad income (1)	Taxable income (2)	Broad income (3)	Taxable income (4)	Broad income (5)	Taxable income (6)
Elasticity	−0.300	−0.462	0.170	0.611	0.120	0.400
	(0.120)	(0.194)	(0.106)	(0.144)	(0.106)	(0.144)
Dummy for marrieds	−0.008	−0.062	0.045	0.049	0.050	0.055
	(0.010)	(0.018)	(0.014)	(0.023)	(0.012)	(0.021)
Dummy for singles	−0.037	−0.053	−0.034	−0.032	−0.036	−0.027
	(0.012)	(0.019)	(0.013)	(0.022)	(0.013)	(0.021)
Log(income) control			−0.083	−0.167		
			(0.015)	(0.021)		
Spline 1st decile control					0.225	−0.884
					(0.086)	(0.039)
Spline 2nd decile control					−2.74	−0.538
					(1.13)	(0.047)
Spline 3rd decile control					−0.317	−0.279
					(0.055)	(0.057)
Spline 4th decile control					−0.071	−0.445
					(0.051)	(0.069)
Spline 5th decile control					−0.197	−0.003
					(0.054)	(0.075)
Spline 6th decile control					−0.074	−0.253
					(0.053)	(0.081)
Spline 7th decile control					−0.127	−0.124
					(0.056)	(0.083)
Spline 8th decile control					−0.061	−0.0172
					(0.057)	(0.083)
Spline 9th decile control					−0.027	−0.057
					(0.076)	(0.125)
Spline 10th decile control					−0.072	−0.126
					(0.041)	(0.064)
Observations:	69 129	59 199	69 129	59 199	69 129	59 199

[a] Estimates from 2SLS regressions. Income range is $10 000 and above. Regressions weighted by income. All regressions include dummies for marital status and dummies for each base year.

endpoints. In practice, the results are fairly sensitive to the first restriction; our overall elasticity is only about three-quarters as large when we use an uncapped weight, and the elasticity at the top of the income distribution is only about 60% as large.[9] The results are not very sensitive to the second restriction.

[9]We have decided to censor these observations because we did not want to allow a few outliers to drive our main estimates. Moreover, when we allow for income-specific time trends in our specification check section, we obtain the same elasticity as in Table 4 both with and without this censoring, as the influence of these outliers is captured by these additional time trend terms. So we feel that the estimate in Table 4 is the best estimate of the true responsiveness of taxable income to taxation.

Our findings reflect substantial sensitivity to controlling for income, and to the form of the controls. For the models in the first column that exclude any control for mean reversion and income distribution changes, we obtain large wrong-signed elasticities for both broad and taxable income.

Once log income is included in the model; however, the results change quite radically. For broad income, the elasticity becomes a positive 0.17, and for taxable income, the effect is dramatic, with the elasticity rising to 0.61. This estimate lies in the upper end of the post-Feldstein literature discussed above. Log income itself has a highly significant negative coefficient, suggesting that on average mean reversion dominates income dispersion in our sample period.

As noted earlier, the problem with this specification is that it assumes that any changes in the income distribution are a (log) function of lagged income. It is difficult to effectively weaken this assumption with only one change, as in most previous work, since it destroys identification of the tax effects. But, since we have a number of tax changes over this period, we can weaken this assumption in the third column, by including as well a 10-piece spline in lagged income. In fact, we find that adding this spline significantly decreases our taxable income estimate, with the elasticity falling to 0.4, and lowers slightly our broad income estimate, with the elasticity falling to 0.12. As noted earlier, this estimate is robust to the inclusion of additional splines, cubics, or other forms of income controls.

The coefficients on the splines themselves support the contention that base period income should not be entered in a simple log-linear fashion. For broad income, there is a positive coefficient on the first spline, presumably reflecting mean reversion, and then a sizeable negative coefficient on the second spline, perhaps reflecting worsening income prospects for low income groups over this time period. The coefficients then demonstrate significant non-linearities throughout the rest of the income distribution. For taxable income, the splines are highly negative at the bottom of the income distribution, and then once again vary non-linearly as income rises. In all specifications except with no controls, we find positive coefficients on dummies for marrieds and negative coefficients on dummies for singles implying that married households experience increases in income from year to year relative to single taxpayers.

The large difference between our broad and taxable income elasticities is striking. There are two sources of difference here. The first is mechanical; broad income has a larger base, so that a given dollar response will result in a smaller elasticity.[10] The second is behavioral; taxable income includes itemized deductions, which might respond to changes in taxes (as well as exemptions, which could respond if family size is endogenous to taxation).

To decompose these effects, we have estimated some models with 'pseudo-

[10] Another form of mechanical effect here is that with taxable income, higher state tax rates will result in a larger deduction on federal income taxes, leading to an mechanical negative correlation between state taxes and federal taxable income. We are grateful to Gary Engelhardt for pointing this out to us.

taxable' income, created by subtracting from both period 1 and period 2 incomes the period 1 level of exemptions and deductions. Doing so normalizes the income change for the magnitude of the exemptions and deductions, but does not allow them to respond to taxation, and thereby captures the mechanical but not the behavioral effect of taxation. We have estimated models using pseudo-taxable income, using splines in both broad and taxable incomes as controls. Doing so, we find that the pseudo-taxable income elasticity is 33–45% of the way between our broad and taxable income elasticities, depending on which controls we use. This is sensible, given that, as shown in Table 3, the mean of taxable income is only 60% as large as the mean of broad income. Thus, the mechanical effect appears to explain about two-fifths of the gap between broad and taxable income. The remainder is behavioral responses through changing itemization (and possibly exemption) behavior.[11]

To summarize, our most complete specification suggests that there is a sizeable response of taxable income to tax changes, with an elasticity of 0.4. This is well below Feldstein's estimates but is within the range of the subsequent literature, despite our ability to include much richer controls for changes in the income distribution. On the other hand, we find that the responsiveness of broad income is much lower than that of taxable income. Roughly 40% of that gap is explained by the mechanical effect that broad income has a larger base so that elasticities will be calculated to be smaller for a given dollar response to taxation; the remainder arises through changes in itemization and exemption behavior.

3.2. Income effects

As noted above, one advantage of our empirical framework is that we can separately identify the income effects of taxation on taxable income. To obtain income effects, we run the regression specification (3) including the income effect term and the full set of control variables. In fact, it is theoretically unclear what sign to expect for the income effect estimates for constructs such as broad or taxable income. For the labor component of total income, we might expect relatively small negative estimates, following on the findings of the labor supply literature (e.g., Pencavel (1986) and more recently Blundell and MaCurdy (1999)). But it is feasible that capital income reacts positively to a positive income shock if savings (and thus future capital income) increase. And it is even more difficult to conceive of how activities such as tax evasion or shifts in the form of compensation react to income increases.

In contrast to the estimates in Table 4, our estimates of this equation are

[11] It is impossible to examine more directly itemization behavior using our methodology, since we would only be able to include taxpayers with itemized deductions in both periods, leading to a substantial sample selection bias. Note however that there is a large independent literature on the response of items such as charitable contributions to taxation (see, e.g., Clotfelter (1985)).

unweighted. This is because the income effect coefficient $\eta = (1 - \tau)\partial z/\partial R$ gives the direct (and not the percentage) change in reported income due a change in tax liability. Therefore, the tax revenue effect due to income effects should not be weighted by income. For low taxable income levels, the right-hand side variable corresponding to the income effect parameter becomes noisy. As a result, when we estimate responses of taxable income, we restrict the sample to taxable incomes above \$10 000 in year 1 (instead of restricting the sample to broad income above \$10 000 as we did in Table 4 and as we will do subsequently).

Table 5 presents our results. We first show our unweighted overall elasticities.[12] The unweighted taxable income elasticity is very similar to the weighted taxable income elasticity in Table 4, while the unweighted broad income elasticity is substantially lower than the weighted elasticity in Table 4. As we will discuss below, this reflects the fact that most of the response of income to taxation comes from those with high broad but not necessarily high taxable incomes, due to the central role of itemization.

Table 5
Substitution and income effects[a]

	Broad income (1)	Taxable income (2)
(A) No income effect included		
Elasticity	0.071	0.396
	(0.066)	(0.114)
	69 129	45 765
(B) Income effect included		
Substitution effect	0.072	0.430
	(0.069)	(0.121)
Income effect	−0.071	−0.135
	(0.096)	(0.108)
N. Obs	69 089	45 728

[a] Estimates from 2SLS regressions. Regressions are unweighted. Income range: broad income above \$10 000 in column (1) and taxable income above \$10 000 in column (2). Regressions include 10 splines in log(income). All regressions include dummies for marital status and dummies for each base year.

[12] It is worth noting that the elasticities estimated in this model are not necessarily uncompensated elasticities, since with a non-linear tax schedule the tax changes that we study may change both the after-tax share and after-tax incomes. For example, when the tax schedule is a flat tax with constant rate and the tax reform is a simple change in the tax rate with no change in the intercept then the response is given by the uncompensated elasticity. On the other hand, if the tax change changes tax rates without changing the tax liability then the response is given by the compensated elasticity. Fig. 1 illustrates this point. Feldstein (1995) argues that the TRA of 1986 was broadly neutral for redistribution and thus the response was a compensated elasticity. This is only a crude approximation because a tax change cannot affect tax rates while keeping tax liabilities constant for everybody.

We then show substitution and income effects from full estimation of Eq. (3). The income effects are negative, but they are highly insignificant in both cases, and they are quite small. The Slutsky equation states that the difference between the compensated and uncompensated income elasticities is $-\eta$, which is thus approximately equal to our empirical estimate. Our empirical results show therefore that the difference between uncompensated and compensated elasticities is 0.135 for taxable income. This is small relative to the magnitude of the elasticities that are presented in Table 4. These small income effects are perhaps unsurprising, given that income effects on labor earnings are generally found to be small, at least for primary earners, and income effects on other forms of income could perhaps even be positive.

Therefore, we can safely assume that compensated and uncompensated elasticity are identical and drop the income effect variable (and instrument) in specification (3). We thus present the remainder of our results, and our optimal tax simulations, without including income effects.

3.3. Variations in timing

Following the previous literature, we have used a 3-year difference in computing our measures of both the change in taxable income and the change in after-tax shares. But our framework allows us to explore the sensitivity of our finding to the length of this differencing ‘window’. The implications of changing the window of observation are not clear. If, on the one hand, individuals react slowly to tax changes, then using a longer difference might increase the estimated elasticity. If, however, as suggested by Goolsbee (2000a) and Sammartino and Weiner (1997), responses to tax changes are largely through the timing of income reporting, then a longer difference might reduce the elasticity.

We explore these issues of timing in Table 6. In this and all subsequent tables, we use our richest specification from Table 4, including the splines in first period

Table 6
Variations in timing[a]

	3-Year lag (1)	2-Year lag (2)	1-Year lag (3)
Broad income	0.120	0.085	0.192
	(0.106)	(0.104)	(0.105)
Number of obs.	69 129	116 250	145 550
Taxable income	0.400	0.331	0.410
	(0.144)	(0.138)	(0.164)
Number of obs.	59 199	100 385	127 644

[a] Estimates from 2SLS regressions. Income range is $10 000 and above. Regressions weighted by income. Regressions include 10 splines in log(income). All regressions include dummies for marital status and dummies for each base year.

income. The Table proceeds by narrowing the window used first to 2 and then to 1 year. In fact, we find that the estimate of the elasticity of taxable income to the window length is fairly robust; the estimate falls significantly for a 2-year window but then rises for a 1-year window almost back to its level in Table 4. The timing impacts on broad income are similar, although the elasticity with a 1-year window is now higher than the elasticity with a 3-year window. Thus, overall, the estimated impacts of taxation are not particularly sensitive to the window over which the response is observed; the response of real income is slightly lower, and the response of taxable income is virtually identical, over a 3-year window relative to a 1-year window. Since a long run response seems of most interest, and since this is the focus of most previous work, we continue to use a 3-year window for the remainder of the paper.

3.4. Controlling for time-varying income distribution changes

As noted earlier, our identifying assumption in these data is that there were no differences in the relationship between first period income and the change in income over time that are correlated with differences in tax policy. While we believe that this is a reasonable assumption, we can assess our sensitivity to alternatives which modestly weaken our assumption.

We consider two such alternatives in Table 7. The first is to allow for a linear time trend in the splines in income that form our central controls. This allows for a general trend in the widening of the income distribution over time. The second is to interact log income with a full set of year dummies. This allows for year-specific changes in the income distribution, but only in a way that is linearly related to base-period income. Both of these alternatives, and particularly the

Table 7
Adding year-specific income controls[a]

	Broad income (1)	Taxable income (2)
(A) Time trend × splines included		
Elasticity estimate	0.125	0.477
	(0.109)	(0.149)
Number of obs.	69 129	69 155
(B) Year dummies × log(income) included		
Elasticity estimate	0.095	0.459
	(0.137)	(0.218)
Number of obs.	69 129	59 199

[a] Estimates from 2SLS regressions. Income range is $10 000 and above. Regressions weighted by income. All regressions include 10 splines in log (income). All regressions include dummies for marital status and dummies for each base year. Regressions in panel A include additional time trend × splines interactions. Regressions in panel B include additional year dummies × log(income) interactions.

second, remove some of the variation from the large federal reforms in our sample, much as including log income in a pre-post 1986 comparison (as in Auten and Carroll) removes much of the variation of that reform. But if our results are robust to these controls, it suggests that changes in the relationship between lagged income and income changes are not driving our results.

In fact, as Table 7 shows, our results are robust to these two sets of controls. Our standard errors rise somewhat, but in both cases the key coefficients are similar to those in Table 4. Thus, while we cannot rule out year-specific non-linear changes in the relationship between lagged income and income changes, it seems unlikely that these would occur in precisely the same way as tax changes and therefore unlikely that they can explain our results.

3.5. State versus federal taxes

One question of particular interest is the relative responsiveness of income to state and federal taxation. Previous studies of the elasticity of taxable income have either focused on federal taxation only (e.g., Feldstein, 1995), or have combined the impacts of state and federal taxes (e.g., Auten and Caroll, forthcoming). But research by Feldstein and Wrobel (1998) suggests that the responsiveness to incomes to state taxation may be particularly strong, due to the additional margin of response afforded by residential mobility. Our regression framework allows for a natural decomposition of effects into federal and state tax effects, by simply splitting our key regressor into its federal and state components.

We do so in Table 8, for both broad and taxable income. Consistent with

Table 8
Federal versus state tax rates responses[a]

	Broad income (1)	Taxable income (2)
(A) Federal tax rate		
Elasticity estimate	0.099	0.405
	(0.122)	(0.163)
Number of obs.	69 129	59 199
(B) State tax rate		
Elasticity estimate	0.292	0.632
	(0.199)	(0.320)
Number of obs.	69 129	59 199

[a] Estimates from 2SLS regressions. Income range is $10 000 and above. Regressions weighted by income. All regressions include 10 splines in log (income). All regressions include dummies for marital status and dummies for each base year. Each column reports the elasticity coefficients on the log change of (one minus) federal tax rates (panel A) and on the log change of (one minus) state tax rates (Panel B). These two variables are instrumented with the predicted log change in (one minus) federal rates and the predicted log change in (one minus) state rates.

Feldstein and Wrobel (1998), we also find that there is a more elastic response of incomes to state than to federal taxation. In particular, for broad income in column (1), we now estimate a non-trivial 0.29 elasticity with respect to state taxation, although it is not significant; the elasticity for federal taxation is only 0.1. For taxable income, the elasticity with respect to state taxation is 0.63, while it remains 0.4 for federal taxation. The differences between the state and federal tax elasticities is not significant, so it is hard to draw strong conclusions from these findings. But the findings are suggestive of more responsiveness to state than to federal tax changes.

4. Heterogeneity

An important feature of the US tax system is that taxes are not linear and do not apply equally to all population subgroups. Tax rates differ both over the income range and between groups such as itemizers and non-itemizers. We explore in this Section whether there is significant heterogeneity in the response to taxation among these groups.

We first consider heterogeneity across income groups. There is significant reason to believe that the responsiveness of taxable income to taxes might be higher for higher income groups, since more of their income comes in forms that are more readily manipulable for tax purposes. That is, most of the income to lower income groups is labor income, which is withheld for tax purposes, so the only way to manipulate income earning is to work more or less. But with higher income families, capital income will be more prominent, and this is more readily manipulated through, for example, asset allocation decisions.

A key advantage of our framework is that it allows us to explore heterogeneous responses by income groups. With only one change, as in most previous papers, most of the variation comes across income groups, so it is very hard to identify group-specific responses. But, by exploiting the series of reforms that we have at our disposal, which impacted different points in the distribution at different times, we are able to identify group-specific effects.

In Table 9 we show the results by income group. An interesting question in this context is which income concept to use when dividing the sample for analyzing the responsiveness of taxable income. On the one hand, it seems natural to divide the sample by taxable income, to replicate the tax bracket structure of the income tax. On the other hand, this makes it quite difficult to compare the estimated elasticities of broad and taxable income. Thus, we split the sample by income both ways in Table 9. In the second column, we divide the sample into those with broad incomes from \$10 000 to 50 000; incomes from \$50 000 to 100 000; and incomes above \$100 000. In the third column, we cut the sample by taxable incomes that correspond to roughly the same division of sample size: \$10 000–32 000; \$32 000–75 000; and above \$75 000.

Table 9
Elasticity results by heterogeneous groups[a]

	Broad income (1)	Taxable income (2)	Taxable income (using taxable income cuts) (3)
Panel A: income range			
Income range	−0.044	0.180	0.284
$10K to $50 K	(0.085)	(0.164)	(0.180)
($10 K to $32 K col. (3))			
N. Obs	49 364	39 902	26 635
Income range	−0.065	0.106	0.265
$50K to $100 K	(0.154)	(0.219)	(0.192)
($32 K to $75 K col. (3))			
N. Obs	16 688	16 293	16 338
Income range	0.171	0.567	0.484
$100 K and above	(0.240)	(0.298)	(0.316)
(above $75 K col. (3))			
N. Obs	3076	3004	2792
Panel B: itemizing status			
Itemizers	0.266	0.647	
$10 K and above	(0.068)	(0.099)	
N. Obs	28 117	25 746	
Non-Itemizers	−0.210	−0.179	
$10 K and above	(0.079)	(0.122)	
N. Obs	41 012	33 569	

[a] Estimates from 2SLS regressions. Regressions weighted by income. Income ranges in columns (1) and (2) based on broad income in base year. Income ranges in column (3) based on taxable income in base year. All regressions include dummies for marital status and dummies for each base year and 10 income control splines.

The results in the second column, where the sample is divided by base period broad income, provide strong evidence that the responsiveness to taxable income that we have seen is driven by the highest income taxpayers. There are modest elasticities of taxable income of 0.18 for those in the $10 000–50 000 income range, and of only 0.11 in the $50 000–100 000 range. But there is a much larger elasticity of 0.57 for those in the very top income category. For broad income, the estimates are actually negative (but smaller than their standard errors) for those below $100 000, but positive (although still insignificant) for those above $100 000.

This finding explains to some extent the difference between our overall elasticity estimates and those of Feldstein and Auten and Carroll, which are higher. The TRA 1986 reform on which they focus almost provided tax variation mostly at the top of the income scale, so that their overall estimates are identified primarily by reactions of high income taxpayers. If this is the most responsive group, as our findings suggest, then it is not surprising that their estimates are higher. On the other hand, our estimates by income group are disappointingly imprecise. While the coefficients for the elasticities of the highest income taxpayers are much larger than for those lower in the income distribution, the estimates are not statistically distinguishable from each other. Thus, these findings are suggestive of much more responsiveness by the highest income taxpayers, but not definitely conclusive.

The results in the third column, however, paint a somewhat different story. When taxpayers are ordered by base period taxable income, there is a much flatter response along the income distribution. This interesting finding arises because the most responsive taxpayers are those taxpayers with high real incomes, but lower taxable incomes, through itemization. Indeed, while $75 000 of taxable income corresponds to roughly the same cutoff in the sample as does $100 000 of broad income, 15% of taxpayers with broad incomes above $100 000 have taxable incomes below $75 000. These taxpayers have large amounts itemized on their taxes, and they are the ones who appear particularly responsive to taxation. As a result of large base period itemization, they are more equally distributed in the base period taxable income distribution than in the base period broad income distribution, and this results in a more equal distribution of responsiveness of taxable income.

To illustrate this further, the next panel of Table 9 shows the responsiveness of taxable income by itemizers and non-itemizers. The elasticity of both taxable and broad income is much higher for itemizers, and they are in fact negative (but insignificant) for non-itemizers. Here, the differences between groups are in fact quite significant. Moreover, we estimate that for itemizers, the elasticity of taxable income of those with broad income above $100 000 in the base period is 0.66 (0.33). It is these itemizers with very high real incomes, but not necessarily as high taxable incomes, who are most responsive to taxation.

Given the imprecision of these estimates by income group, the patterns can only be taken as suggestive. But the findings do confirm the standard intuition that the highest income taxpayers are the ones that are most responsive to taxation, as well as further confirming the important role played by itemization in determining the elasticity of taxable income.[13]

[13] Another relevant source of heterogeneity, in the context of current debates over the 'marriage penalty' in the US tax code, is heterogeneity by marital status in the base year. In Gruber and Saez (2000), we show that there is no evidence that married taxpayers are more responsive than single taxpayers in terms of taxable income. This result appears to contradict Eissa's (1995) evidence of the responsiveness of high income wives to the tax rates on their husband's income. We have obtained some suggestive evidence that Eissa's results may not apply to the full income distribution: the responsiveness of married taxpayers is much higher in the $100 000 and upwards range. This would be consistent with the notion that it is very high income wives that are the most elastic; but the comparison is imprecise because there are very few high income single taxpayers.

5. Optimal taxation

Though economic evidence supporting (or disputing) the importance of supply side incentives for labor supply and savings has been central in the debates over the tax structure, economists have been peculiarly absent in the normative discussion of the optimal progressivity of our tax system. In this section, we attempt to draw on our empirical framework to provide a computation of the optimal income tax system that is both theoretically rigorous, and empirically based. To do so, we draw on Saez (2000a), who showed how the optimal income tax formulas of the Mirrlees (1971) model could be expressed in terms of income and substitution effects. This section is a summary of the more extended discussion in the working paper version of the paper (Gruber and Saez (2000)).

5.1. Revenue maximizing constant rate

Before discussing optimal tax results, it is worth considering a more straightforward application of our estimated elasticities: the revenue maximizing constant linear tax rate. This rate is the maximum rate that the government can set before starting to lose revenue. As is well known, the revenue maximizing flat rate is equal to $\tau^* = 1/(1+\bar{\zeta})$, where $\bar{\zeta}$ is the average elasticity weighted by incomes. Using our results in Table 4 (columns (5) and (6)), we obtain a tax revenue maximizing rate equal to 71% for Taxable Income (elasticity 0.400) and equal to 89% for Broad Income (elasticity 0.120).[14]

5.2. Optimal tax results

In Gruber and Saez (2000), we consider four brackets income tax schedules corresponding the three income ranges ($10 000–50 000, $50 000–100 000 and above $100 000) we have examined. We add a bottom bracket (incomes between $0 and 10 000) in order to complete the optimal tax structure.[15] We present two sets of numerical implementation results, one for Broad Income and another one for Taxable Income. Which is relevant depends on the underlying thought exercise. If the social planner is free to reshape the tax system and remove all the deductions and exemptions embodied in the current law, then the Broad Income simulation is most appropriate. But, if the planner is constrained to operate within the basic exemption and deduction structure of the existing income tax, then the Taxable Income simulation is most relevant.

In Gruber and Saez (2000), we show that the optimal tax rate in each bracket

[14] Though our estimates are computed only for incomes above $10 000, the estimates are hardly affected when including lower incomes because the elasticity $\bar{\zeta}$ is weighted by income.

[15] Using results from the literature on behavioral responses of the low income population to welfare program parameters (see Moffitt (1992)), we posit an elasticity of 0.4 in the bottom bracket.

can be simply expressed in terms of the density distribution of taxpayers in each bracket, the average income in each bracket, the average elasticity in each bracket (which we estimated in Table 9), and the redistributive tastes of the government.[16] The optimal tax structure is defined by the marginal tax rates in each bracket and by a lump sum transfer that is redistributed to everybody. The tax rates on the lowest income group are best thought of as phaseout rates for the lump sum transfer amount. The optimal income schedules we compute are calibrated to raise as much net revenue as the current income tax. We make a number of different assumptions for the redistributive tastes of the government, from the Rawlsian objective where the government cares only about the poorest members of society, to redistributive objectives where the weights are decreasing with income, and to the extreme case where the government minimizes deadweight burden with no regard for redistribution.

This exercise yields a number of interesting findings. If there are at all redistributive tastes, the optimal tax policy combines a fairly large lump sum demogrant that is rapidly taxed away, with generally flat or even declining marginal rates for middle and high income taxpayers. For example, for redistributive tastes where social weights are decreasing with income, we find that for broad income there is a $22 000 lump sum demogrant, a 66% marginal rate on the lowest income taxpayers, an 84–88% rate on middle income taxpayers, and a 73% rate on the highest income taxpayers; for the same case for taxable income we find a $11 000 demogrant, a 68% rate on the lowest income taxpayers, a 56–66% rate on middle income taxpayers, and a 49% rate on the highest income taxpayers.[17] While the system is flat or even regressive on the margin, it is highly progressive on average, due to the large lump sum demogrant. The key point is that since tax responsiveness is concentrated in the highest income taxpayers, it is appropriate to have highly targeted redistribution by having large lump sum grants that are rapidly clawed back as income rises; once middle incomes are reached, it is undesirable to have rising marginal rates unless there are very low social weights on the highest income taxpayers, since they are more responsive to taxation. Another important point is that the optimal system is much more redistributive if a broader definition of income is used, since there is less distortion to redistributing resources at these smaller elasticities.

These optimal tax simulations are subject to an important caveat. We are relying on differences in estimated elasticities across income groups that are imprecise, producing optimal tax rates with large standard errors. Therefore, the results should regarded as mostly suggestive. The main goal of these simulations is to

[16]These tastes are summarized by weights attached to each bracket which represent how much the government values a marginal dollar of consumption for taxpayers in a given bracket relative to a marginal dollar to the average taxpayer.

[17]With no redistributive tastes, the tax rates are highest at the bottom because (almost) everybody pay those rates but the distortion is borne only by the low income people who contribute little to tax revenue. Therefore, the tax structure is regressive and the top rate is extremely low (3–5%).

show that it is fairly easy to apply the optimal income tax framework to a simple multi-bracket setting using elasticities estimated by brackets. As long as elasticities are higher at the top of the income distribution, a contention which is consistently supported by our estimates, redistribution should not take place through an increasing pattern of marginal rates but rather through adding a large negative income tax component to the tax system that is taxed at fairly high rates at the bottom of the income distribution.

6. Conclusion

Over the last few years, economists have recognized the centrality of the elasticity of taxable income as a parameter of interest for evaluating tax policy. But the substantial variability in the estimates of this central parameter have made it difficult to draw conclusions about the role that taxes play in determining income generation. Moreover, the fact that we have a non-linear tax system implies that it is critical to estimate not just an overall elasticity, but how that elasticity varies along the income distribution.

We have presented a framework that provides new estimates of the elasticity of taxable income that surmounts some problems with previous work. We find that the elasticity is 0.4, which is large but well below early estimates of its value; it is roughly at the midpoint of the post-Feldstein literature on the elasticity of taxable income. We also find much lower elasticities for real, broadly defined, income; about two-fifths of the difference between these results arises from the mechanical effect that the base of broad income is smaller, but the majority arises from the fact that tax preferences are sensitive to tax rates. And we find that the income effects of tax changes on taxable income are small, implying little difference between compensated and uncompensated elasticities.

Moreover, this framework allows us to explore the variation in this elasticity along the income distribution, and we find that it is primarily driven by the response of very high real income taxpayers to changes in tax rules. In our final section, and in more detail in Gruber and Saez (2000), we show that these findings may have important implications for the optimal tax structure, suggesting a tax system which is progressive on average but not on the margin, with a large demogrant that is rapidly taxed away at the bottom of the income distribution, but with marginal rates that are flat or falling with income. These results are highly speculative given the imprecision of our income group-specific elasticities, but they can serve as a stepping stone for further work that explores these important issues.

One important difference between our study and previous work is the size of the tax changes being studied. Most of the previous literature has focused on the Tax Reform Act of 1986, which imposed large changes in tax rates on upper income taxpayers, whereas our variation comes in addition from bracket creep, state tax changes, and changes through ERTA and TRA on other groups which were more modest. If individuals react more strongly to large, and presumably as a result better understood, changes, then by 'muddying the waters' with these smaller change we may be reducing the estimated elasticity relative to the previous literature. Of course, it is not at all obvious why the reaction to the large changes of TRA 86 only are more relevant for projection purposes than are the reactions to all tax changes in the 1980s; TRA was more dissimilar than it was similar to the modal post-war tax reform. Thus, our estimates are probably the preferred ones for the types of modest (relative to TRA 86) reforms that are currently contemplated by Congress.

These findings have two potentially important implications for tax policy. First, they highlight the value of having low tax rates on a broad tax base, a position long advocated by economists. The large elasticities that we observe are driven by 'holes' in the tax base that allow taxpayers, particularly at higher income levels, to reduce their tax burdens. With a broader tax base we would distort behavior less and could therefore raise revenues more efficiently.

Second, they suggest that the substantial concern currently expressed about the distorting impact of high implicit tax rates at the bottom of the income distribution may be overblown. Most of the concern is focused on the $10 000–50 000 income range that we examine where the EITC is phased out. But we find no evidence that, at least for the explicit taxes that arise through the federal and state income tax system, taxpayers in this range are substantially changing either their real incomes or reported taxes in response to tax policy. This suggests that the distributional advantages of tightly income targeted tax subsidies may outweigh the efficiency costs of high implicit tax rates on the lower middle income taxpayers, as is illustrated by the high optimal rates in this bracket in our simulations.

Of course, our study does not consider non-filers and individuals who move into filing status between a pair of years. If these individuals are particularly responsive, then there still may be concern about the high implicit rates arising through transfer programs. This type of responsiveness is indeed suggested by the high elasticities of labor force participation with respect to taxation estimated in Meyer and Rosenbaum (1999). This potential dichotomy between the responsiveness of those inside and outside of the tax system suggests that attention be paid to incentives that reward work per-se rather than marginal increments to hours worked, as is highlighted by Saez (2000b).

Acknowledgements

We are grateful to Gerald Auten, David Cutler, Peter Diamond, Esther Duflo, Gary Engelhardt, Dan Feenberg, Austan Goolsbee, Roger Gordon, Joel Slemrod, and two anonymous referees for helpful comments, and in particular to Dan Feenberg for his patience and help with the TAXSIM calculator. Gruber acknowledges financial support from the National Science Foundation.

Appendix A

A.1. Income definitions

Broad Income is defined as the sum of all the items that compose Total Income less Capital Gains, Social Security Benefits. Capital Gains are excluded because their tax treatment is special and thus the relevant marginal rate is not the same as for other income. Social Security benefits are also excluded because they were fully exempted from taxation before 1984 and thus are not present in the data for the years 1979–1983. Broad Income includes Wages, salaries and tips, Interest Income (taxable and exempted), Dividends (taxable and exempted), Alimony received, Business income (or loss), Total IRA distributions, Total Pensions and Annuities, Income reported on Schedule E (Partnerships, Trusts, etc.), Farm Income, full Unemployment Compensation and Other income. The definition of Broad Income is therefore constant over the period 1979–1990 that we study.

Taxable Income is a definition consistent over the years and closest to the 1990 definition of taxable income. Taxable Income is defined as our Broad Income definition minus the adjustments that are made to arrive at taxable income. Because the definition of taxable income changes from year to year due to the numerous tax reforms, we have included in the our Taxable Income definition only the adjustments that can be computed in all the years from 1979 to 1990. We do not include the adjustments such as moving expenses, IRA deductions, Student loan interests, secondary earners deductions because they are not in the tax code every year and thus cannot be computed for every year. Therefore, our definition of Taxable Income is simply equal to our Broad Income definition less exemptions, standard deduction and itemized deductions (Schedule A). In order to get a consistent definition, exemptions are fixed in real value at the 1990 level before being substracted from Broad Income. The standard deduction (also fixed at the real level of 1990 standard deduction) is also deducted. Finally, real itemized deductions in excess of the real 1990 standard deduction are deducted to arrive at our definition of Taxable Income. Note that taxpayers who change their itemizing status between year 1 and year 2 are included in our regression sample.[18]

As described in the text, the size of the sample varies from year to year. Our regression data links observations from year to year which are not necessarily of the same size and therefore many individual-year observations cannot be linked. As a result, the size of our final sample (around 100 000) is much reduced relative to the original number of year-individuals observations (around 300 000).

A.2. Inflation parameters

The inflation parameters are applied to all income and deductions definitions to obtain real income definitions over the period and to impute lagged tax rates using

[18] Our computer programs are available upon request.

the TAXSIM calculator. These inflation parameters were computed as the average income growth of Broad Income for each of the years 1980–1990 using our tax return data. Taking year 1992 as base year index 100), the incomes for years 1979–1990 have been deflated using the following indices: 50.3, 55.1, 59.9, 63.7, 66.3, 70.4, 73.9, 76.6, 79.7, 86.0, 89.0, 92.9. Our results are not sensitive to small changes in those inflation parameters.

A.3. Tax rates computations

All marginal tax rates and tax liabilities, both at the federal and state level, have been computed using the TAXSIM calculator developed at the NBER. The TAXSIM calculator takes into account the deduction of state taxes from taxable income for itemizers. Virtually all the characteristics of the tax code, such as state and federal Earned Income Tax Credits, Child Credits, Special Rules for Deductions, are included in the calculator. A key advantage of TAXSIM is that the definitions of all variables have been standardized over all the years. As a result, for any individual-year observation, it is straightforward to compute the tax liabilities and marginal tax rates for *any* year after having used a suitable deflator. Obviously, when a special provision such as the Secondary earner deduction does not appear in a given year, TAXSIM assumes a zero value. That is why, as described above, we had to leave out from our broad and taxable income definitions all the items that are not included in every year.[19]

References

Auten, G., Carroll, R., 1997. The Effect of Income Taxes on Household Behavior. Office of Tax Analysis, US Department of the Treasury, forthcoming Review of Economics and Statistics.

Blundell, R., MaCurdy, T., 1999. Labor supply: a review of alternative approaches. In: Ashenfelter, O., Card, D. (Eds.), Handbook of Labor Economics, Vol. 3.

Boskin, M.J., 1978. Taxation, saving and the rate of interest. Journal of Political Economy 86, S3–S27.

Carroll, R., 1998. Tax Rates, Taxpayer Behavior, and the 1993 Tax Act. Office of Tax Analysis, US Department of the Treasury, mimeograph.

Clotfelter, C.T., 1985. In: Federal Tax Policy and Charitable Giving. The University of Chicago Press, Chicago.

Eissa, N., 1995. Taxation and Labor Supply of Married Women: the Tax Reform Act of 1986 as a Natural Experiment. NBER Working Paper No. 5023.

Feenberg, D., Coutts, E., 1993. An introduction to the TAXSIM model. Journal of Policy Analysis and Management 12 (1), 189–194.

Feldstein, M., 1995. The effect of marginal tax rates on taxable income: a panel study of the 1986 Tax Reform Act. Journal of Political Economy 103 (3), 551–572.

Feldstein, M., Wrobel, M.V., 1998. Can state taxes redistribute income? Journal of Public Economics 68, 369–396.

[19] The fortran programs that perform our computations using TAXSIM are available upon request. The help of Dan Feenberg has been invaluable to develop our programs.

Goolsbee, A., 1999. Evidence on the high-income Laffer curve from six decades of tax reform. Brookings Papers on Economic Activity.

Goolsbee, A., 2000a. What happens when you tax the rich? Evidence from executive compensation. Journal of Political Economy 108 (2), 352–378.

Goolsbee, A., 2000b. It's not about the money: why natural experiments don't work on the rich. In: Slemrod, J. (Ed.), Does Atlas Shrug? The Economic Consequences of Taxing the Rich. Cambridge University Press, Cambridge.

Gordon, R.H., MacKie-Mason, J.K., 1994. Tax distortions to the choice of organizational form. Journal of Public Economics 55 (2), 279–306.

Gordon, R., Slemrod, J., 2000. Are 'real' responses to taxes simply income shifting between corporate and personal tax bases. In: Slemrod, J. (Ed.), Does Atlas Shrug? The Economic Consequences of Taxing the Rich. Cambridge University Press, Cambridge.

Gruber, J., Saez, E., 2000. The Elasticity of Taxable Income: Evidence and Implications., NBER Working Paper No. 7512.

Hall, R., 1988. Intertemporal substitution in consumption. Journal of Political Economy 96, 339–357.

Hausman, J., 1981. Labor supply. In: Aaron, H., Pechman, J. (Eds.), How Taxes Affect Economic Behavior. Brookings Institution, Washington, DC.

Katz, L., Murphy, K., 1992. Changes in relative wages, 1963–1987: supply and demand factors. Quarterly Journal of Economics 107, 35–78.

Lindsey, L., 1987. Individual taxpayer response to tax cuts: 1982–1984, with implications for the revenue maximizing tax rate. Journal of Public Economics 33, 173–206.

Meyer, B., Rosenbaum, D., 1999. Welfare, the Earned Income Tax Credit, and the Labor Supply of Single Mothers. NBER Working Paper No. 7363.

Mirrlees, J.A., 1971. An exploration in the theory of optimal income taxation. Review of Economic studies 38, 175–208.

Moffitt, R., 1992. Incentive effects of the US welfare system: a review. Journal of Economic Literature 30, 1–61.

Moffitt, R., Wilhelm, M., 2000. Taxation and the labor supply decisions of the affluent. In: Slemrod, J. (Ed.), Does Atlas Shrug? The Economic Consequences of Taxing the Rich. Cambridge University Press, Cambridge.

Navratil, J., 1995. The Economic Recovery Tax Act of 1981: Evidence on Individual Taxpayer Behavior from Panel Tax Return Data. Unpublished Harvard Thesis.

Pencavel, J., 1986. Labor supply of men. In: Ashenfelter, O., Layard, R. (Eds.), Handbook of Labor Economics, 1986. North-Holland, Amsterdam, pp. 3–102.

Saez, E., 1999. The Effect of Marginal Tax Rates on Income: A Panel Study of 'Bracket Creep'. NBER Working Paper No. 7367.

Saez, E., 2000a. Using Elasticities to Derive Optimal Income Tax Rates. NBER Working Paper No. 7628.

Saez, E., 2000b. Optimal Income Transfer Programs: Intensive Versus Extensive Labor Supply Responses. NBER Working Paper No. 7708.

Sammartino, F., Weiner, D., 1997. Recent evidence on taxpayers' response to the rate increases in the 1990's. National Tax Journal 50 (3), 683–705.

Slemrod, J., 1990. Do Taxes Matter. MIT Press, Cambridge, MA.

Slemrod, J., 1996. High income families and the tax changes of the 1980s: the anatomy of behavioral response. In: Feldstein, M., Poterba, J. (Eds.), Empirical Foundations of Household Taxation. University of Chicago, Chicago, MI.

Slemrod, J., 1998. Methodological issues in measuring and interpreting taxable income elasticities. National Tax Journal 51 (4), 773–788.