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Abstract

This paper applies the methods of Gruber and Saez (2002) to a panel of tax returns spanning 1979 through 2001 in order to examine the sensitivity of the elasticities of taxable and broad income to an array of factors. The paper finds that that Gruber and Saez's approach yields an estimated elasticity of taxable income (ETI) for the 1990s that is about half the size of this paper's corresponding estimate for the 1980s. In general, the addition of demographic information has little impact on elasticity estimates for the 1980s, but lowers the 1990s estimates, especially for broad income, which is a more encompassing income measure than is taxable income. Finally, the paper finds that weighting regression results by income not only has a substantial impact on the estimates, but also results in overall estimates that are influenced by a small number of predominately high-income filers. For example, excluding 100 of the most influential observations (just 0.2 percent of the sample) lowers the estimated ETI for the 1980s from 0.37 to 0.11.

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I. Introduction

The degree to which taxes alter economic activity and tax-reporting behavior is a subject of debate. Estimates of the effect range from extremely large to almost none. For even modest changes to tax rates, the range of estimates implies differences in deadweight loss and income-tax revenue of many tens of billions of dollars. A key variable at the center of recent research is the elasticity of taxable income (ETI), which measures the responsiveness of reported taxable income to changes in marginal tax rates.[1] The ETI, if accurately estimated, can be used to calculate both the change in deadweight loss[2] and the change in income-tax revenues resulting from a change in tax rates.[3] However, in practice, assessing both the efficiency and revenue implications of tax-rate changes is more complex than the formulas suggest. For example, if the ETI differs by income, an accurate assessment of either efficiency or revenue implications requires a breakdown of the responses by the level of income.[4]

Despite a great deal of variation in ETI estimates, both across papers and within studies that explore different specifications, several recent papers have reported an overall ETI of about 0.40. An often-cited study by Gruber and Saez (2002) examines responses to the tax cuts of 1981 and 1986, and finds an overall estimated ETI of 0.40. However, Kopczuk (2003) finds similarly estimated results to be quite sensitive to sample selection and model specification. It may also be the case that the results are not robust for the period examined or for the addition of a richer set of demographic variables.

The estimation portion of this paper first replicates Gruber and Saez's core results by applying their techniques to a dataset that is similar to the one that Gruber and Saez used. The paper's results for the

[1] Specifically, the ETI equals the percentage change in reported taxable income associated with a one-percent increase in the net-of-tax rate, where the net-of-tax rate equals one minus the marginal tax rate.
[2] Feldstein (1999) shows that $\textit{deadweight loss} = -0.5 \cdot \textit{tax\_rate}^2 \cdot (1 - \textit{tax\_rate})^{-1} \cdot \textit{ETI} \cdot \textit{taxable\_income}$.
[3] Income tax revenue equals $\textit{ETI} \cdot \textit{net-of-tax-rate} \cdot \textit{taxable\_income} \cdot \textit{tax\_rate}$.
[4] In addition, when external costs or benefits are present, assessing efficiency implications is also more complex. For example, suppose tax rates rise and, in response, taxable income falls, but a portion of that drop in taxable income comes from increased charitable contributions (and suppose those charities produce positive externalities). Or suppose that a tax increase is used to finance an underprovided public good. In such instances, the standard deadweight loss formula will overstate the efficiency cost of an increase in tax rates.

1980s closely parallel Gruber and Saez's results. Applying the same methodology to 1990s data and to data from both the 1980s and 1990s combined, however, yields estimated ETIs that are much smaller than corresponding estimates for the 1980s. In fact, using Gruber and Saez's preferred specification yields an estimated ETI for the 1990s that is a little more than half the corresponding estimate for the 1980s. The addition of demographic information, again using Gruber and Saez's preferred specification, has a negligible effect on the 1980s estimated ETI, but lowers the 1990s estimate by about one-quarter, from 0.20 to 0.15. For a more encompassing income measure (broad income), added demographics do little to the estimated elasticity for the 1980s, but cut it for the 1990s by half, from 0.15 to 0.07. Finally, weighting regression results by income not only has an enormous impact on the estimates, but yields overall estimates that are driven by a tiny fraction of high-income filers. For example, excluding the 100 most influential observations (just 0.2 percent of the sample), as measured by a *dfbeta* test, lowers the estimated ETI for the 1980s from 0.37 to 0.11.

II. Issues in the Analysis

Tax changes take place in a changing economic environment. Changes to that environment affect income growth. Controlling for non-tax-induced trends in taxable income is a major obstacle to accurately estimating elasticities. The issue of non-tax-related trends in income is given the most attention in this section because the approach used to control for those trends represents the most novel aspect of the model employed in this study—a model developed by Gruber and Saez (2002). The approach also takes into account other factors such as mean reversion, tax-rate endogeneity, institutional changes (which often coincide with changes in the rate structure), and differences between transitory (or temporary) fluctuations and permanent (or longer-term) responses.[5]

[5] See Giertz (2004).

Controlling for Exogenous Trends in Income

The centerpiece of Gruber and Saez's approach is its controls for non-tax-related heterogeneous shifts in income distribution and mean reversion. Over the past 30 years, the distribution of reported income has widened. In fact, that trend accelerated in the 1980s, especially at the top of the distribution.[6] Because people with the highest income pay a disproportionate share of taxes—the top 1 percent pay approximately one-third of all federal income taxes—their behavior is especially important.[7] Not fully accounting for the portion of that income growth that is unrelated to tax policy can result in large biases. For example, the 1980s cuts in marginal tax rates were greatest at the top of the income distribution and thus inversely correlated with the great income growth at the top of the distribution. If the exogenous (non-tax-related) portion of that income growth is not fully accounted for, that trend will bias ETI estimates upward. Although changes to the income distribution are widely documented and theories such as shifts in the returns to education and the market for superstars help explain the phenomenon,[8] the underlying driving factors are not well understood, nor are the year-to-year deviations from that trend. The fact that the exogenous-income trend has persisted through periods of both increases and decreases in the level and progressivity of tax rates suggests that it is, in large part, not a direct response to tax changes. In addition, because the trend has been irregular, distributional changes in years without tax changes may not provide useful measures of exogenous shifts that occur during periods with tax changes.

Controlling for Mean Reversion

Mean reversion also complicates estimation. Over a person's lifetime, income often follows a general path, with many fluctuations. After income has been particularly high or low, it will often revert to a more normal path. That reversion is especially pronounced at the tails of the distribution. People at the high end of the income distribution are often not there for long, and will likely have a substantial drop in income that is unrelated to tax policy. At the other extreme, students will often have large increases in income when they enter the workforce. Estimating the ETI without fully controlling for

[6] According to Piketty and Saez (2003), the share of income reported by the top 10 percent of filers rose by more than a third, from 32.9 percent in 1979 to 41.4 percent in 1998; two-thirds of that increase went to the top 1 percent of taxpayers. The share of income reported by the top one-half of one percent more than doubled, the share reported by the top one-tenth of one percent nearly tripled, and the share reported by the top one-hundredth of one percent more than quadrupled.

[7] See Internal Revenue Service (2004).

[8] See Rosen (1981).

mean reversion will erroneously count non-tax-related increases (by people below their lifetime path) and decreases (by those above their lifetime path) in taxable income as responses to changes in tax rates. Those factors bias ETI estimates in opposite directions, depending on whether tax rates are raised or lowered, but there is no reason to believe the biases will cancel each other out.

Research into the ETI is also complicated by the fact that the ETI appears to vary with income, rising as income increases.[9] If so, a single overall elasticity will not be applicable when considering the impact of rate changes that target only part of the income distribution or that differ across the distribution. In addition, a meaningful average overall estimated ETI must take into account the correlation between income and the elasticities. The average response of all filers may poorly assess how taxable income or tax revenue as a whole will respond. For example, suppose there are two types of people, that tax rates are the sole determinant of income, and that between the base and future years the net-of-tax rates rise by 10 percent for all filers. Now, suppose that half the population is in the first group and that each filer in that group has a base-year taxable income of $10,000 and a future-year taxable income of $10,100, while those in the second group have a base-year taxable income of $1,000,000 and a future-year taxable income of $1,090,000. In that instance, the low-income filers have an ETI of 0.1 and the high-income filers have an ETI of 0.9.[10] Under that scenario, the average person's elasticity equals 0.5. But the ETI that accurately reflects the change in overall taxable income equals 0.82 because the 0.9 applies to a base that is 100 times as large as the base for the group with the ETI of 0.1.

III. Data and Methods

This paper uses data from the Statistics of Income's (SOI) Continuous Work History Survey (CWHS) for 1979 through 2001. The basic SOI is a stratified random sample of tax filers, compiled by the

[9] People with higher incomes generally have more opportunities to respond to tax changes (see Saez, 2004). They generally itemize their tax returns, rely less on wage and salary income, and have more control over the timing and source of their income than do other groups. People with more modest incomes can alter their labor supply, but may have few other alternatives for altering their taxable income.

[10] The low-income filers' ETI is calculated by dividing their one-percent increase in taxable income by the 10-percent increase in the net-of-tax rate. The high-income filers' ETI is calculated by dividing their 9-percent increase in taxable income by the 10-percent increase in the net-of-tax rate.

Internal Revenue Service, and includes all information reported on the filers' tax returns, plus some additional demographic information. The CWHS, by contrast, is a subset of filers from the SOI who are followed from year to year. Although the CWHS contains detailed and accurate information, it is deficient in two important respects. First, although the overall sample is quite large (for some years, more than 20,000), relatively few returns come from the top of the income distribution. If high-income taxpayers dominate an estimate, that estimate using the CWHS will depend heavily on just a few filers. Second, the CWHS includes only people who file returns and are listed as the primary filers. Thus, attrition is an issue.

This paper follows Gruber and Saez (2002) in comparing behavior over three-year intervals, using only people who filed tax returns in both the base (or initial) year and the third subsequent year. The overall sample includes more than 218,000 paired observations. As with Gruber and Saez, income measures are adjusted by the growth in broad income, where broad income equals total income minus realized capital gains and Social Security benefits, using 1990 as the base.[11] The other income measure, taxable income, equals broad income less exemptions and standard and itemized deductions. Both measures are based on a 1990 constant-law definition of income. The sample includes only those with broad income greater than $10,000 in the base year and positive income in the future year (see Table 1). Without those restrictions, the sample is nearly twice as large. For the unrestricted sample, mean nominal reported taxable incomes range from $10,739 in 1979 to $25,308 in 1998; the corresponding means for broad income range from $17,442 to $43,289. Individual marginal tax rates (both state and federal) are imputed using the Congressional Budget Office's internal tax calculators.[12]

The data just described are very similar to those used by Gruber and Saez, but differ in several respects. First, Gruber and Saez use a publicly available version of the CWHS, which is slightly modified in order to protect the identity of taxpayers in the sample. Second, Gruber and Saez's sample ends in 1990, whereas this paper's sample extends to 2001. Third, Gruber and Saez use the National

[11] The adjustment for broad-income growth is analogous to adjustments that transform nominal dollars into real dollars. Thus, for this paper, each individual's reported income is divided by the ratio of average broad income in 1990 over the average broad income in the year of the observation.
[12] Jon Bakija of Williams College designed the state tax calculator used by CBO.

Bureau of Economic Research's (NBER) TAXSIM model to impute their federal and state marginal tax rates, but this paper's analysis uses CBO's internal tax calculators.

The methodology follows directly from Gruber and Saez (2002) and the model can be written such that the

$$\textit{income growth rate} = \alpha + \ln\left(\frac{income_{t+3}}{income_t}\right) = \xi \cdot \ln\left(\frac{1-taxrate_{t+3}}{1-taxrate_t}\right) + mars \cdot \beta_1 + year \cdot \beta_2 + spline(income_t) \cdot \beta_3 + demog \cdot \beta_4 + \varepsilon \cdot$$ [13]

The dependent variable is log of income in the future year ($income_{t+3}$) divided by income in the base year ($income_t$), where the future year is three years after the base. (The key independent variable equals the log of the net-of-tax rate in the future year divided by the net-of-tax rate in the base year.) To avoid endogeneity between the tax rate and income, an instrument is used in place of the actual log change in the net-of-tax rate.[14] The coefficient on that variable, ξ, represents the ETI. Control variables include year-fixed effects, dummies for marital status (*mars*), and a 10-piece spline of the log of base-year income. The spline is intended to control for mean reversion and for non-tax-related income trends that have differed across the reported income distribution in recent decades. Alternative specifications explored by Gruber and Saez and in this paper include a model with the log of base-year income in place of the spline and a specification that excludes the income control altogether. (In addition, Gruber and Saez include a variable to separate the income effect from the substitution effect. They conclude that the income effect is not important and thus exclude it from most of their analysis.) The only addition to the model from Gruber and Saez (besides extending the years of data) is the addition of richer demographic information (*demog*), including age, gender, itemization status, and state-fixed effects.

[13] Note that, for simplicity, subscripts denoting the individual are omitted here.
[14] The instrument is constructed by inflating base-year income by the growth in mean broad income over the three-year interval. Next, the tax calculator computes counterfactual tax rates based on the inflated income measure. Finally, two-stage least squares (2SLS) is employed, where, in the first stage, the log change in actual income is regressed against the counterfactual log change, along with the other independent variables.

The results from Gruber and Saez are weighted by income. Weighting is intended to produce estimates reflective of the change in total reported taxable (or broad) income, which relates directly to the change in income-tax revenues. If responses were homogeneous throughout the reported income distribution, weighting would not affect the results. But, as a number of studies, including Gruber and Saez, have found, the ETI varies by income and is generally much larger for highest-income filers. Weighting should produce estimates that are more indicative of overall responses, but, at the same time, the importance of weighting suggests that the model fit may be poor. In addition, although overall sample sizes are quite large, weighting could result in a small number of observations having a substantial impact on the overall results. A *dfbeta* test and re-estimated elasticities after excluding handfuls of the most influential observations suggest that results, in fact, depend heavily on just a few observations.

IV. Results

This section begins by replicating Gruber and Saez's approach for the 1980s and comparing the results. Next, the same methodology is applied to the 1990s and to the full sample, spanning 1979 to 2001. After a discussion of those results, demographics are added to the model, the importance of including state rates as opposed to using only federal tax rates is examined, and the ramifications of weighting regressions by income are explored in detail.

Replicating Gruber and Saez

Table 2 compares the results of Gruber and Saez (for broad income and taxable income, respectively) for the 1980s with this paper's comparable estimates. Each pair of the first six columns reports Gruber and Saez's results under these specifications: with no controls for exogenous income trends, with the log of base-year income as a control, and with a 10-piece spline of log income (Gruber and Saez's most preferred specification). The next six columns report comparable results from this paper's analysis of the same period. Despite using a slightly different core data set and different marginal tax rate calculators, the two sets of results are quite similar. Estimated with no control for base-year income, the elasticities are negative, which is inconsistent with theoretical predictions. Adding the log of base-year income to the model results in an estimated ETI of just above 0.6 and a substantially smaller broad-income elasticity of 0.17. Replacing the log of base-year income with the 10-piece spline yields an estimated ETI in the neighborhood of 0.4 and a corresponding estimated elasticity of broad income of 0.12. The fact that the estimated elasticities for broad income are so much lower than the corresponding ETI estimates suggests that a substantial portion of the taxable-income response may come via deductions and exemptions. Another contributing factor may be that the denominator for the broad-income calculation is larger, by definition; thus, for an identical dollar change, the estimated broad-income elasticity will be smaller than the corresponding ETI estimate. Smaller broad-income elasticities are consistent with Kopczuk's (2003) finding that income responses are a function of the tax base and that. the greater the availability of exemptions and deductions, the lower the cost of responding to tax changes, and hence the larger the response.

Results for the 1990s

The same methodology generates estimated ETIs for the 1990s that are much smaller than those for the 1980s and not statistically significant, despite a sample size of nearly 140,000 (see Panel 1 of Table 3). Gruber and Saez's preferred specification, which includes a 10-piece spline, yields an estimated ETI of 0.20, or slightly more than half the size of this paper's estimate for the 1980s. Likewise, the specification using the log of reported taxable income, in place of the spline, yields an estimated ETI of about 0.18, less than a third the size of the corresponding estimate for the 1980s. Replacing the log of base-year income with the spline has little impact on the estimated ETI for the 1990s, but it reduces the estimated ETI by over one-third for the 1980s.

Another interesting difference between the results from the 1980s and 1990s is that, without income controls, estimates for the 1980s are much smaller—in fact, well below zero—than with controls, but, for the 1990s, the estimates without income controls are much larger than those with controls. Those observations suggest that mean reversion at the top of the income distribution is important, even during a period of increasing concentration of income at the top of the distribution. People at the top of the income distribution have a relatively high probability of experiencing a substantial drop in income, but people with moderate incomes have only a small probability of experiencing tremendous income gains needed to push them to the top of the distribution. Thus, for the 1980s an inverse relationship exists between the mean reversion at the top of the distribution and changes to the net-of-tax rate. Without income controls, that relationship biases estimates downward. By contrast, for the 1990s, a direct relationship exists between mean reversion at the top of the distribution and changes to the net-of-tax rate, which is falling. Thus, without income controls, mean reversion at the top of the income distribution biases elasticity estimates upward for the 1990s.

Although the ETI estimates are much smaller for the 1990s than for the 1980s, the corresponding estimated broad-income elasticities are slightly larger. Including the spline yields an estimated broad-income elasticity for the 1990s of about 0.15, compared with 0.12 for the 1980s (see Panel 1 of Table 3). The specification using the log of base-year income yields estimated broad-income elasticities that are slightly larger.

Combined Results for the 1980s and 1990s

Not surprisingly, the same techniques applied to the full panel (from 1979 through 2001) generally result in estimated ETIs that are smaller than those for the 1980s and larger than those for the 1990s. The specification with the 10-piece spline yields an estimated ETI of 0.30, or slightly higher than the average of the estimates for the 1980s and 1990s. The specification with the log of base-year income produces an estimated ETI of 0.31, which is higher than the 1990s estimate of 0.18 but is only half the

1980s estimate of 0.63. One again, estimated broad-income elasticities are stable: 0.15 with the spline and 0.17 with the log of income control.

Why Do Estimates for the 1980s and 1990s Differ?

Three competing interpretations might explain the differences between the results from the 1980s and the 1990s:

1. The model does a good job of explaining overall behavior for both the 1980s and the 1990s, but differences in policy and economic factors caused the ETI to fall between the two periods. That hypothesis is consistent with the view of Slemrod and Kopczuk (2002), who argue that the ETI is not a structural parameter and is a function of more than preferences. In addition, the fact that the estimates of the ETI differ substantially but the estimates of the broad-income elasticity remain stable is also consistent with Kopczuk (2003), which shows that the availability of deductions and exemptions matters in determining the ETI. Broad income, which includes deductions and exemptions, should be smaller, because filers have fewer opportunities to alter that base, and should be more stable because the opportunities to alter that base are less likely to change over time.[15]
2. The model is misspecified and does a poor job of isolating the response of taxable income to tax rate changes in either period. During the 1980s, for example, reported taxable incomes were rising, and the share of taxable income reported by the top of the income distribution was growing rapidly. At the same time, marginal tax rates were falling, with the largest reductions at the high end of the income distribution. Thus, the larger estimated ETIs for the 1980s might occur not because the true response was greater, but because the model fails to fully control for the correlation between non-tax-related growth in income (especially at the top of the distribution) and falling tax rates. In the 1990s, the correlation between tax rates and income was reversed: The trend in income at the high end continued, and marginal tax

[15] Yet another interpretation in support of the model is that people simply respond differently to rate cuts than they do to rate increases.

rates were increasing as a result of the Omnibus Budget Reconciliation Acts of 1990 and 1993. For the 1990s, the failure to fully control for that correlation biases estimated ETIs downward, the opposite of the upward bias for the 1980s. Lending credence to that interpretation is the fact that the rate cuts of the 1990s applied only to upper-income groups, who are usually more responsive to tax rates than other groups are. Thus, it is somewhat surprising that the estimated ETI is lower for the 1990s, instead of higher.

3. The model works well for the 1980s, but breaks down in the 1990s (or vice versa). It is possible that the spline, for example, does a good job of tracking non-tax-related trends during one of the periods, but, for whatever reason, fails to do so in the other period.

The model can also be criticized in other respects. For example, measuring changes in behavior over three-year intervals is done in order to focus on permanent responses to tax-rate changes, as opposed to transitory fluctuations. But that comparison may not remove transitory influences from the elasticity estimates. Nearly every year of the 1980s (and of much of the 1990s) is likely to include some transitory behavior, in part because of multiyear phase-in periods. Thus, comparing observations three years apart is unlikely to avoid transitory fluctuations. If those transitory fluctuations severely contaminate measurement of the permanent responses, differences in ETI estimates for the two periods may result simply from noise.

Adding Demographics to the Model

The model discussed above excludes all demographic variables except marital status. Adding gender, age (as well as age squared and age cubed), itemization status, and geographic information (state dummies) to the model has only a small to moderate impact on the estimated elasticities, depending on the specification and time period. For the 1980s, the impact on the estimated ETIs is small (see Panel 2 and Panel 4 of Table 4). With the 10-piece spline, the estimated ETI rises from 0.37 to 0.39.

Using the log income control, the estimated ETI rises from 0.63 to 0.67. For the 1990s, the demographic variables have the opposite effect, lowering estimated ETIs. For example, with the 10-piece spline, adding demographic information reduces the estimated ETI from 0.20 to 0.15.

The impact of additional demographic information on estimated broad-income elasticities differs greatly between the periods. For the 1980s, the pattern is similar to that of taxable income, with estimated elasticities increasing slightly. For the 1990s, the added demographics lower estimated broad-income elasticities by about half. With the 10-piece spline, the estimated broad-income elasticity falls from 0.15 to 0.07. In contrast, adding demographics affects the results only slightly when the two decades are combined.

The effect of demographics on the estimates implies that those new variables are correlated with unobserved (and non-tax-related) factors that determine income changes and thus may help isolate the tax-related portion of changes in income. For example, suppose that, in the 1980s, a large number of filers nearing retirement age experienced drops in income that were correlated with the drops in marginal tax rates. Omitting the effect of age (or retirement) would lower estimated elasticities below their true values. For the 1990s, the same phenomenon (of incomes falling due to retirement) could bias elasticities upward, if the drop in income were correlated with increases in tax rates. Of course, that scenario is just one of many possible explanations for the results. And it fails to explain why demographics have a large impact on the estimated broad-income elasticities for the 1990s, but only a modest impact in most other instances (that is, for taxable income and for broad income during the 1980s).

Are State Tax Rates Important? Separately Estimated Responses for State and Federal Tax Rates

Excluding state tax rates from the model requires identification to come from variations in federal rates over time or from cross-sectional variation across income groups. But individuals from different income groups may respond differently to tax changes. The inclusion of state tax rates in the overall marginal rate calculation is potentially important because it adds a source of cross-sectional variation across individuals who may be very similar in other respects (such as income).[16] For the specification with limited demographic information, excluding state tax rates has only a minimal impact on estimated ETIs (see Panel 1 of Table 5). The estimated broad-income elasticity, in the model with the 10-piece spline, is slightly smaller in the 1990s when state rates are excluded: 0.13 when only the federal rate is included versus 0.15 when the tax rate includes both the state and federal components (see Panel 1 of Table 3). But, for the 1980s, that same estimate is much smaller, well less than half the estimate that includes state rates: 0.05 when only the federal rate is included versus 0.12 when the tax rate includes both state and federal components (see Panel 2 of Table 2).

Including only state net-of-tax rates (that is, one minus the filer's state marginal tax rate) raises estimated elasticities relative to specifications that include only federal rates or both federal and state rates (see Panel 2 of Table 5). The estimated ETI with only state rates is 0.59 for the 1980s, similar to Gruber and Saez's estimate of 0.63. In contrast to most of the other results, the estimated ETI when including only state rates is much larger for the 1990s (0.80) than for the 1980s (0.59). Likewise, when only state rates are included, the estimated broad-income elasticities are much larger than when the sum of state and federal rates is included (or when only federal rates are included), and, for the

[16] It is likely that, to some degree, state tax rates are endogenous because some people base their decision to live in a particular state, at least partially, on its tax system. As anecdotal evidence of that possibility, a number of high-paid celebrities have moved their primary residence from high-tax states, such as California, to low-tax states, such as Florida, Texas, and Nevada, which do not have state income taxes. The phenomenon is sometimes referred to as the "Tiger Woods Effect." Woods, who grew up in California and attended Stanford University, moved his primary residence from California to Florida shortly after turning professional. Woods recently remarked, "We're definitely residing in Florida and I don't see why we should leave—especially with zero income tax."

1980s, the estimated broad-income elasticities are actually larger than the corresponding ETI estimates, the opposite of Gruber and Saez's finding.

Weighting and Sensitivity to Sample Selection

A small number of outliers can dominate coefficients estimated using least squares, resulting in estimated coefficients that are not indicative of the behavior of much of the sample. That possibility seems remote when regressions are unweighted and include well over 50,000 observations. With income weighting, however, that is not necessarily the case.[17] With income weighting, large numbers of taxpayers with lower reported incomes might exert much less influence on the overall results than might a few very high-income filers. Also, the many paired observations that have no variation in marginal tax rates may do little to identify the model.

Three approaches are used to test the importance of those factors:

1. Excluding observations for which the base-year net-of-tax rate and the future-year counterfactual rate do not change;
2. Excluding as many as 100 observations that most affect the income-weighted estimates; and
3. Estimating an unweighted specification that includes quantile dummies interacted with the log change in the net-of-tax rate. That specification includes the 10-piece spline and other independent variables, but replaces the log change in the net-of-tax rate with 11 interacted variables, each representing a portion of the reported taxable-income distribution. If the ETI is uncorrelated with taxable income within each quantile, and the model is otherwise properly identified, then person-weighted estimated ETIs, by quantile, would represent a viable alternative to income-weighted 2SLS.

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[17] Table 4 reports both dollar-weighted and unweighted elasticity estimates. The unweighted estimates are often much smaller for the 1980s and much larger for the 1990s than the corresponding weighted estimates.

Excluding observations with no variation in tax rates[18] reduces the sample by less than 10 percent in the 1980s sample—but by more than 45 percent in the 1990s, when rate changes affected only high-income taxpayers. Even so, that exclusion of thousands of data points has little effect on the estimated elasticities for both broad and taxable income.

A *dfbeta* test run on the reduced 1980s sample measures the influence of each observation on the overall ETI estimate. For each observation, the *dfbeta* test calculates the difference between the estimated coefficient with and without that observation. Taxable-income elasticities for the 1980s are re-estimated based on the specification with the 10-piece spline and excluding the observations with the largest *dfbetas* (in absolute value).[19] Dropping cases with the same marginal tax rate in both the base year and the future year leaves 49,064 paired observations and yields an estimated ETI of 0.37, identical to the earlier estimate that included the approximately 5,000 dropped observations (see Table 6). Dropping the 10 most influential observations reduces the estimated ETI by more than 30 percent, to 0.25. Dropping the 25 most influential observations further lowers the estimated ETI to 0.20, 45 percent below the initial estimate. Excluding the 100 most influential observations (0.2 percent of the sample) lowers the estimated ETI to 0.11, 71 percent lower than the initial estimate. Thus, despite the large sample size, income weighting makes the results highly sensitive to just a few observations. For the most part, the most influential observations are taxpayers with very high taxable incomes who also report large changes in taxable income between the base year and the future year.

Finally, as an alternative to income-weighted 2SLS, person-weighted ETIs were estimated separately by quantile within a single equation framework and using the specification that includes the 10-piece spline. In addition, the log change in the net-of-tax rate was interacted with quantile dummies, using

[18] That is, observations are excluded if no variation exists between the base-year marginal tax rate and the corresponding rate from applying the rate schedule three years hence to base-year income inflated by the growth in broad income.
[19] Those observations are excluded not to improve the overall ETI estimate, but rather to test the model's robustness.

quantiles based on base-year taxable income.[20] The resulting estimated ETIs vary greatly (see Table 7 and Figure 1). For the first nine deciles, the coefficients are either not statistically different from zero or are the wrong sign (negative). Despite the lack of statistical significance, the coefficients are often quite different from zero (in terms of their economic importance). That lack of statistical significance is surprising, given that most quantiles have well over 5,000 observations. Especially surprising is the estimate of -1.0 for the third decile. That estimate has the wrong sign, is strongly significant, and is very large in absolute magnitude. The lack of statistical significance is consistent with studies that found minimal responses for the bulk of the distribution, but these results are inconclusive with estimated coefficients that are often much larger or smaller than zero. Those estimates (for the first nine deciles) suggest that the model is poorly identified.

Estimates for the top decile are both positive and statistically significant. The estimated ETI for those in the 90th percentile to the 99.5th percentile is 0.21 and is statistically significant at the 10-percent level. The estimated ETI for the top one-half of one percent is 0.57—well over twice the size of the estimates for any other quantile—and is strongly significant. That finding is also consistent with other research, which suggests that the ETI is largest at the top of the income distribution. Gruber and Saez, for example, estimated an ETI of 0.57 for taxpayers with base-year broad income exceeding $100,000. (Their estimate is weighted by income, whereas that for this analysis is person-weighted.)[21]

Although ETI variation within quantile is likely lower than the variation within the entire distribution, it still may be substantial. If ETI variation within quantile were negligible, income weighting would have little impact on the estimates. Using the same specification, but weighting by taxable income, raises the estimated ETI for the top half of one percent from 0.57 to 0.72. Similarly, income weighting raises the estimated ETI for those between the 90th and 99.5th percentiles from 0.21 to 0.36.

[20] The first nine dummies represent the first nine deciles. The tenth dummy applies to those between the 90th and 99.5th percentiles. The final quantile dummy applies to filers between the 99.5th and 100th percentiles.

[21] For comparison purposes, reported taxable income at the 99.5th percentile in this analysis is about $203,000; the minimum level of reported broad income in the top one-half of one percent of the reported taxable-income distribution is about $218,300.

V. Conclusion

Replicating the methodology of Gruber and Saez (2002) using different data and different marginal-tax-rate calculators yields estimated elasticities for the 1980s that are similar to those that Gruber and Saez report. Corresponding ETI estimates for the tax cuts of the 1990s are much smaller, a little over half the size of the 1980s estimate for the model with the 10-piece spline. Broad-income elasticities vary less between the two decades and are almost always smaller than the corresponding estimated ETIs. Broad-income elasticities are likely smaller than ETIs because tax filers have fewer opportunities to alter their broad-income base. Furthermore, because broad income is larger than taxable income, the denominator used to calculate the broad-income elasticities is larger than the corresponding denominator used in the ETI calculations. Thus, for a given numerator, a larger denominator necessarily yields a lower estimated elasticity.

Despite the large sample used in this analysis, a *dfbeta* test for the 1980s shows that results depend heavily on a few very high-income observations, likely a product of weighting observations by income in the regression. In fact, eliminating just 0.2 percent of the most influential observations lowers the estimated ETI for the 1980s from 0.37 to 0.10, a drop of more than 70 percent.

Finally, the interaction of the log change in the net-of-tax rate with quantile dummies results in great variation in estimated ETIs for the 1980s. For the first nine deciles, estimates vary greatly and have large standard errors. For the tenth decile, the person-weighted estimated ETI is positive and significant. For the top one-half of one percent, the person-weighted estimated ETI is more than twice as large as for any other quantile. Even within the top quantiles, however, estimated ETIs appear to vary with taxable income.

The findings in this paper suggest a need for more research to understand why responses differ so much between the 1980s and the 1990s. In addition, the sensitivity of the results to just a few observations suggests that more can be learned by focusing on the high end of the distribution and by employing data sets that include many observations for that group.

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Table 1. Sample of Filers Used in the Regression Analysis

Base Year	Observations	Taxable Income[a,b]	Broad Income[a,c]
1979	5,074	$ 28,301	$ 43,654
1980	5,189	28,125	43,695
1981	5,312	26,590	43,753
1982	5,369	25,991	42,956
1983	5,439	25,545	42,560
1984	5,547	25,477	42,520
1985	11,162	26,291	43,858
1986	5,706	25,807	43,435
1987	11,323	29,192	46,668
1988	11,527	29,591	46,895
1989	11,695	29,739	47,082
1990	11,772	30,000	47,329
1991	11,816	30,110	47,260
1992	11,869	30,356	47,442
1993	11,938	30,129	47,098
1994	12,112	30,370	47,169
1995	12,168	29,963	46,503
1996	13,869	29,006	45,668
1997	14,221	28,782	45,322
1998	35,734	29,075	45,518

Source: Tabulations of paired observations are from the Statistics of Income's Continuous Work History Survey.

a. Both income measures are adjusted by the growth in broad income. See text for explanation.
b. Taxable income is based on the 1990 definition used by the IRS and excludes realized capital gains. See Section III of the text for more detail.
c. Broad income is defined as total income less realized capital gains and Social Security benefits.

Table 2. Income Weighted Estimates for the 1980s

	Panel 1: Gruber & Saez Results						Panel 2: Replicated Results					
Income Controls:	none		log income		10-piece spline		none		log income		10-piece spline	
	Broad Income	Taxable Income	Broad Income	Taxable Income	Broad Income	Taxable Income	Broad Income	Taxable Income	Broad Income	Taxable Income	Broad Income	Taxable Income
Elasticity	-0.30	-0.462	0.17	0.611	0.12	0.4	-0.25	-0.37	0.17	0.63	0.12	0.37
	(0.120)	(0.194)	(0.106)	(0.144)	(0.106)	(0.144)	(0.113)	(0.111)	(0.113)	(0.146)	(0.110)	(0.160)
Married	-0.008	-0.062	0.045	0.049	0.05	0.055	0.00	-0.08	0.06	0.04	0.07	0.08
	(0.010)	(0.018)	(0.014)	(0.023)	(0.012)	(0.021)	(0.012)	(0.016)	(0.016)	(0.022)	(0.015)	(0.021)
single	-0.037	-0.053	-0.034	-0.032	-0.036	-0.027	-0.02	-0.07	-0.01	-0.06	-0.01	-0.05
	(0.012)	(0.019)	(0.013)	(0.022)	(0.013)	(0.021)	(0.013)	(0.017)	(0.014)	(0.021)	(0.014)	(0.021)
ln(income)			-0.083	-0.167					-0.10	-0.20		
			(0.015)	(0.021)					(0.018)	(0.018)		
spline: decile 1					0.225	-0.884					0.00	-0.82
					(0.086)	(0.039)					(0.000)	(0.033)
decile 2					-2.74	-0.538					-0.89	-0.57
					(1.130)	(0.047)					(0.219)	(0.040)
decile 3					-0.317	-0.279					-0.21	-0.38
					(0.055)	(0.057)					(0.052)	(0.053)
decile 4					-0.071	-0.445					-0.14	-0.41
					(0.051)	(0.069)					(0.053)	(0.063)
decile 5					-0.197	-0.003					-0.22	-0.22
					(0.054)	(0.075)					(0.059)	(0.074)
decile 6					-0.074	-0.253					-0.07	-0.22
					(0.053)	(0.081)					(0.059)	(0.083)
decile 7					-0.127	-0.124					-0.12	-0.26
					(0.056)	(0.083)					(0.063)	(0.089)
decile 8					-0.061	-0.172					-0.13	-0.22
					(0.057)	(0.083)					(0.068)	(0.079)
decile 9					-0.027	-0.057					-0.02	-0.28
					(0.076)	(0.125)					(0.100)	(0.085)
decile 10					-0.072	-0.126					-0.09	-0.07
					(0.041)	(0.064)					(0.048)	(0.039)
constant							-0.09	0.01	0.94	1.98	0.66	7.42
							(0.014)	(0.018)	(0.187)	(0.180)	(0.139)	(0.257)
Observations:	69,129	59,199	69,129	59,199	69,129	59,199	54,313	54,136	54,313	54,136	54,313	54,136

Source: Panel 1 is from Gruber and Saez (2002): reproduction of Table 4. Panel 2 is from estimates based on Statistics of Income's Continuous Work History Survey data for 1979 to 1990.

a. Estimates are from 2SLS regressions. Income range is $10,000 and above. Regressions are weighted by income. All regressions include dummies for marital status and dummies for each base year. Robust standard errors are in parentheses.

Table 3. Estimates for the 1990s and for Both Decades

	Panel 1: 1990s						Panel 2: 1979-2000					
Income Controls:	**none**		**log income**		**10-piece spline**		**none**		**log income**		**10-piece spline**	
	Broad Income	Taxable Income	Broad Income	Taxable Income	Broad Income	Taxable Income	Broad Income	Taxable Income	Broad Income	Taxable Income	Broad Income	Taxable Income
Elasticity	0.475	0.738	0.184	0.177	0.148	0.195	0.121	0.192	0.174	0.305	0.149	0.298
	(0.105)	(0.168)	(0.094)	(0.137)	(0.097)	(0.144)	(0.077)	(0.103)	(0.078)	(0.099)	(0.080)	(0.100)
Married	-0.015	-0.122	0.087	0.063	0.08	0.086	-0.01	-0.113	0.082	0.056	0.079	0.085
	(0.008)	(0.014)	(0.011)	(0.017)	(0.009)	(0.015)	(0.007)	(0.011)	(0.010)	(0.015)	(0.008)	(0.013)
single	-0.039	-0.090	-0.014	-0.042	-0.014	-0.027	-0.028	-0.083	-0.012	-0.047	-0.012	-0.032
	(0.010)	(0.016)	(0.010)	(0.017)	(0.010)	(0.017)	(0.008)	(0.012)	(0.009)	(0.014)	(0.009)	(0.014)
ln(income)			-0.099	-0.162					-0.099	-0.165		
			(0.010)	(0.013)					(0.009)	(0.013)		
Spline: decile 1					0.00	-0.827					0.00	-0.817
					(0.000)	(0.021)					(0.000)	(0.017)
decile 2					0.00	-0.504					0.00	-0.524
					(0.000)	(0.024)					(0.000)	(0.021)
decile 3					-0.243	-0.408					-0.266	-0.385
					(0.045)	(0.031)					(0.031)	(0.027)
decile 4					-0.186	-0.293					-0.167	-0.334
					(0.030)	(0.039)					(0.025)	(0.033)
decile 5					-0.109	-0.27					-0.122	-0.265
					(0.030)	(0.046)					(0.026)	(0.039)
decile 6					-0.135	-0.277					-0.131	-0.25
					(0.034)	(0.046)					(0.028)	(0.041)
decile 7					-0.039	-0.168					-0.069	-0.196
					(0.035)	(0.049)					(0.029)	(0.043)
decile 8					-0.172	-0.232					-0.151	-0.253
					(0.036)	(0.057)					(0.032)	(0.047)
decile 9					0.097	0.067					0.074	0.01
					(0.049)	(0.071)					(0.048)	(0.065)
decile 10					-0.122	-0.155					-0.116	-0.14
					(0.021)	(0.028)					(0.020)	(0.026)
constant	-0.067	-0.033	0.952	1.588	0.128	7.313	-(0.090)	(0.027)	(0.917)	(1.638)	0.094	7.301
	(0.011)	(0.019)	(0.103)	(0.134)	(0.019)	(0.156)	0.012	0.015	0.096	0.129	(0.015)	(0.133)
Observations:	158,679	139,673	158,679	139,673	158,679	139,673	218,771	193,809	218,771	193,809	218,771	193,809

Source: Estimates are based on Statistics of Income's Continuous Work History Survey data for 1979 to 2001.

a. Estimates are from 2SLS regressions. Income range is $10,000 and above. Regressions are weighted by income. All regressions include dummies for marital status and dummies for each base year. Robust standard errors are in parentheses.

Table 4. Inclusion of Demographic Variables in the Model[a]

	Limited Demographics[b]						Full Demographics[c]					
	Panel 1: Unweighted			Panel 2: Dollar Weighted			Panel 3: Unweighted			Panel 4: Dollar Weighted		
	Taxable Income Elasticities[d]						Taxable Income Elasticities[d]					
Base Years	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1979 to 1987	-1.728	0.63	0.065	-0.369	0.625	0.373	-1.716	0.628	-0.05	-0.195	0.671	0.387
	(0.085)	(0.103)	(0.096)	(0.111)	(0.146)	(0.160)	(0.088)	(0.104)	(0.095)	(0.119)	(0.146)	(0.164)
1988 to 1998	1.211	0.357	0.293	0.738	0.177	0.195	0.882	0.144	0.027	0.577	0.130	0.149
	(0.107)	(0.080)	(0.077)	(0.168)	(0.137)	(0.144)	(0.097)	(0.072)	(0.069)	(0.161)	(0.137)	(0.143)
1979 to 1998	0.013	0.346	0.123	0.192	0.305	0.298	-0.133	0.234	-0.057	0.239	0.336	0.330
	(0.065)	(0.059)	(0.056)	(0.103)	(0.099)	(0.100)	(0.063)	(0.056)	(0.053)	(0.103)	(0.103)	(0.103)
	Broad Income Elasticities[d]						Broad Income Elasticities[d]					
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1979 to 1987	-0.312	0.092	-0.001	-0.249	0.173	0.134	-0.364	0.060	-0.067	-0.170	0.209	0.143
	(0.052)	(0.064)	(0.065)	(0.111)	(0.113)	(0.111)	(0.052)	(0.065)	(0.064)	(0.113)	(0.108)	(0.106)
1988 to 1998	0.321	0.217	0.208	0.475	0.184	0.148	0.122	0.047	0.035	0.324	0.09	0.072
	(0.050)	(0.047)	(0.047)	(0.105)	(0.094)	(0.097)	(0.044)	(0.041)	(0.042)	(0.102)	(0.094)	(0.097)
1979 to 1998	0.073	0.135	0.112	0.121	0.174	0.149	-0.053	0.029	0.000	0.112	0.171	0.155
	(0.036)	(0.036)	(0.036)	(0.077)	(0.078)	(0.080)	(0.034)	(0.035)	(0.035)	(0.078)	(0.080)	(0.082)

Source: Estimates are based on Statistics of Income's Continuous Work History Survey data for years 1979 to 2001.

a. Coefficients other than the elasticities are suppressed. Robust standard errors are in parentheses.
b. Marital status
c. Gender, age, age squared, age cubed, itemizer dummy, and state dummies
d. Elasticity Specifications: (1) No Controls; (2) ln(Income); (3) 10-Piece Spline of ln(Income)

Table 5. Comparison of Dollar-Weighted Estimates Using Federal and State Marginal Tax Rates[a]

	Panel 1: Federal Rates Only			Panel 2: State Rates Only		
	Taxable-Income Elasticities[b]			**Taxable-Income Elasticities[b]**		
	(1)	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
1979 to 1987	-0.478	0.677	0.375	0.286	0.546	0.59
	(0.136)	(0.178)	(0.194)	(0.457)	(0.507)	(0.470)
1988 to 1998	1.035	0.151	0.174	0.694	0.809	0.798
	(0.217)	(0.184)	(0.196)	(0.367)	(0.371)	(0.373)
1979 to 1998	0.224	0.319	0.309	0.598	0.757	0.76
	(0.134)	(0.128)	(0.129)	(0.304)	(0.311)	(0.310)
	Broad-Income Elasticities[b]			**Broad-Income Elasticities[b]**		
	(1)	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
1979 to 1987	-0.363	0.103	0.046	0.504	0.667	0.663
	(0.138)	(0.136)	(0.130)	(0.364)	(0.376)	(0.369)
1988 to 1998	0.625	0.171	0.127	0.43	0.523	0.503
	(0.131)	(0.119)	(0.122)	(0.238)	(0.244)	(0.243)
1979 to 1998	0.112	0.145	0.109	0.444	0.566	0.56
	(0.10)	(0.099)	(0.102)	(0.204)	(0.213)	(0.214)

Source: Estimates are based on Statistics of Income's Continuous Work History Survey data for 1979 to 2001.

a. Estimates are based on the specification with limited demographic information. Coefficients other than the elasticities are suppressed. Robust standard errors are in parentheses.
b. Income Specifications: (1) No Controls; (2) ln(Income); (3) 10-Piece Spline of ln(Income)

Table 6. The Effect of Excluding the Most Influential Observations of Income-Weighted Estimates for the 1980s[a]

Dropped Observations	Sample Size	Estimated ETI
0	49,064	0.368
10	49,054	0.249
25	49,039	0.203
50	49,014	0.139
100	48,964	0.105

Source: Estimates are based on Statistics of Income's Continuous Work History Survey data for 1979 to 1990.

a. Estimates are based on the specification with the 10-piece spline and with limited demographic information. Those with no variation in marginal tax rates between the base year and three years hence are excluded from this sample. Observations are dropped based on the size of their impact on the estimated ETI and as measured by a *dfbeta* test.

Table 7. Person-Weighted Taxable-Income Elasticities by Decile for the 1980s

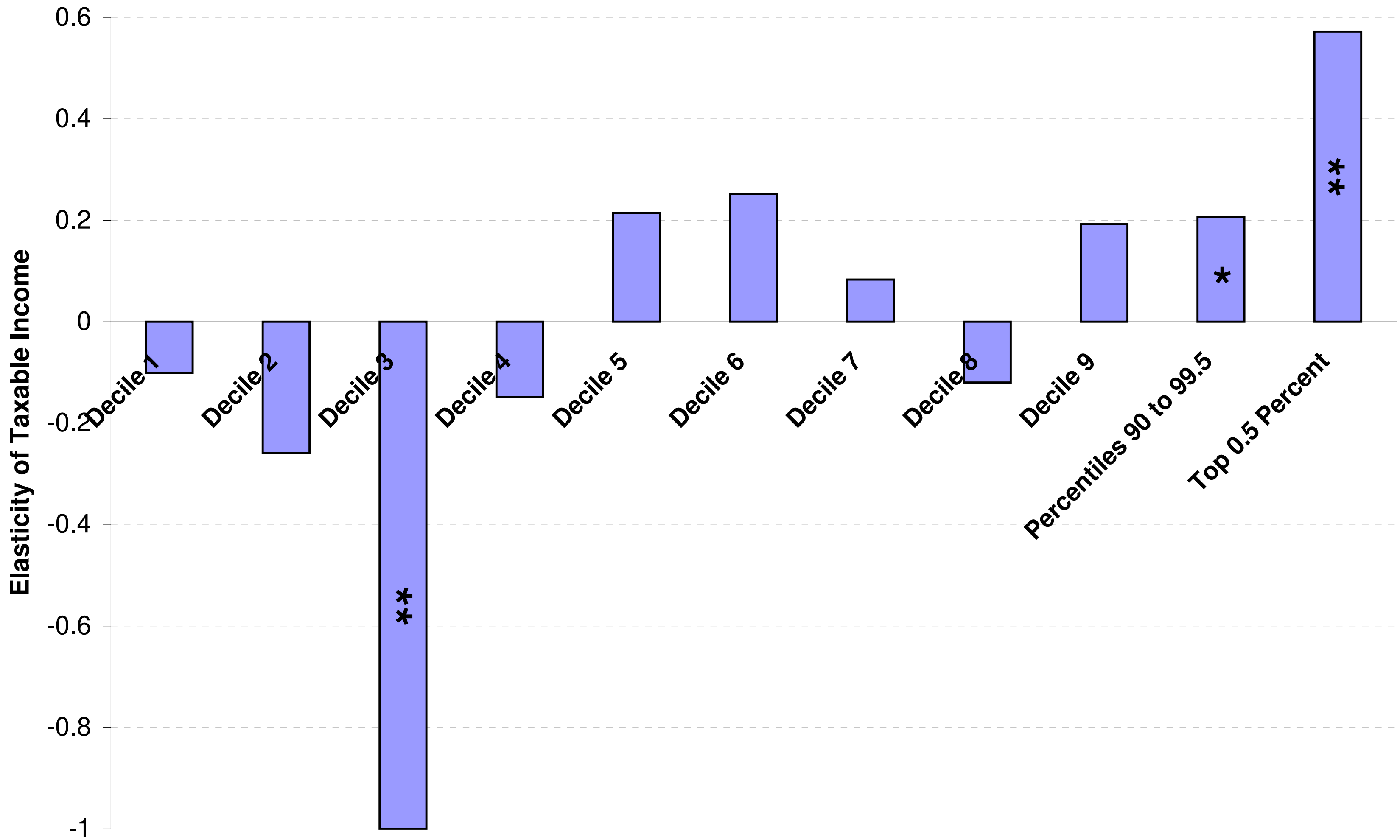
Quantile	Estimated ETI[a]
Decile 1	-0.101
	(0.295)
Decile 2	-0.259
	(0.342)
Decile 3	-1.009
	(0.337)
Decile 4	-0.149
	(0.297)
Decile 5	0.214
	(0.219)
Decile 6	0.252
	(0.200)
Decile 7	0.083
	(0.169)
Decile 8	-0.12
	(0.164)
Decile 9	0.192
	(0.132)
Decile 10[b]	0.207
	(0.126)
Percentiles 99.5 to 100	0.572
	(0.289)
Observations	54,136
R-squared	0.28

Source: Estimates are based on Statistics of Income's Continuous Work History Survey data for 1979 to 1990.

a. Estimated quantile ETIs are generated by interacting quantile dummies with the net-of-tax rate. Estimates are based on the specification with the 10-piece spline and with limited demographic information. Standard errors are in parenthesis.

b. Decile 10 excludes the top one-half of one percent.

Figure 1: Taxable-Income Elasticities by Decile for the 1980s



* Statistically significant at the 10% level.
** Statistically significant at the 5% level.
Source: Estimates are based on Statistics of Income's Continuous Work History Survey data for 1979 to 1990.
Note: Estimates are based on the specification with the 10-piece spline and with limited demographic information. ETIs for deciles are estimated by interacting dummies for each quantile with the log change in the net-of-tax rate.