Tax Bases, Tax Rates and the Elasticity of Reported Income

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Abstract

Tax reforms usually change both tax rates and tax bases. Using a panel of income tax returns spanning the two major U.S. tax reforms of the 1980s and a number of smaller tax law changes, I find that the elasticity of income reported on personal income tax returns depends on the available deductions. This highlights that this key behavioral elasticity is not an immutable parameter but rather that it can be to some extent controlled by policy makers. One implication is that base broadening reduces the marginal efficiency cost of taxation. The results are very similar for all income categories indicating that the rich are more responsive to tax rates because tax rules that apply to them are different (their tax base is narrower). The point estimates indicate that the Tax Reform Act of 1986 reduced the marginal cost of collecting a dollar of tax revenue, with roughly half of this reduction due to the base broadening and the other half due to the tax rate reduction. As a by-product, the analysis in this paper offers a reconciliation of disparate estimates obtained by previous studies of the tax responsiveness of income.

Key words: personal income tax, taxable income elasticity, tax complexity
JEL classification: H2, H24, H31, J22, K34

1 Motivation

Complexity is often considered to be an undesirable feature of the tax system, but this is usually postulated rather than derived from an economic model and its relationship to other criteria for evaluating tax policy is unclear. A recent paper of Slemrod and Kopczuk (2002) provides a specific framework for analyzing the cost of complexity in the tax system by interpreting it in terms of the income tax base. A simple income

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tax is characterized by few deductions and, therefore, a broad tax base. Broadening the tax base increases revenue and affects administrative costs, but more subtly it may also affect the excess burden of taxation: in their model, a broader tax base is associated with a lower elasticity of taxable income and therefore with lower excess burden. Thus, in that framework, simplicity of the tax system directly affects the efficiency cost of taxation.

In this paper, I evaluate the empirical validity of such arguments by estimating the impact of the tax base, measured as a fraction of income subject to taxation, on the elasticity of income reported on personal tax returns. This elasticity is the key parameter necessary to evaluate the deadweight loss of the income tax. My results highlight though that it is not a structural parameter depending only on underlying preferences and technology, but instead it depends on a non-rate aspect of the tax system (tax base) that can be manipulated by policy makers. This effect is not just theoretically possible, it also turns out to be empirically relevant. Consequently, the results indicate that the marginal deadweight loss of taxation can be controlled by policy makers. In particular, and as an illustration, I can assess potential efficiency gains resulting from a change to a broad-base low-rate tax system.

2 Context

The central importance of the elasticity of taxable income for public finance questions follows from two simple realizations. First, by the envelope theorem, the marginal tax rate (t) affects welfare of an individual in proportion to her taxable income (I). The analytics of the response are irrelevant. Second, with just income taxation in place, the marginal effect on revenue is $\frac{dR}{dt} = t\frac{\partial I}{\partial t} + I$, again depending only on the total taxable income. Therefore, having a measure of responsiveness of I is crucial for any attempt to measure the efficiency cost of income taxation. [1] What is the relevant I? The traditional approach was to define $I \equiv wL$, where w is the wage rate and L is labor supply. Under this assumption, the elasticity of labor supply can be used in place of the elasticity of taxable income. Apart from disregarding capital income subject to income taxation, this approach also ignores other potentially important responses to taxation such as effort, tax avoidance, tax evasion and income shifting.

In order to address this concern, following Lindsey (1987) and Feldstein (1995), the literature has concentrated directly on income reported on tax returns (Auten and Carroll, 1999; Carroll, 1998; Goolsbee, 1999; Long, 1999; Sillamaa and Veall, 2001; Aarbu and Thoreson, 2001; Gruber and Saez, 2002). [2] Several authors argued that changes in the definition of taxable income provide an additional source of identifica-

[1] See Feldstein (1999) and Slemrod (1998) for discussions of this argument and its limitations.

[2] See Slemrod (1998) for a critical discussion of this literature.

tion as exogenous limiting or expanding of deductions pushes taxpayers into different tax brackets. Understanding consequences of such changes is important, because they occur at exactly the same time that the tax rates change. An implicit assumption in the literature is that such changes do not have an independent effect on income and that the elasticity of response to marginal tax rates is not affected by them. This assumption is very strong. For example, elimination of the non-itemizer charitable deduction by Tax Reform Act of 1986 changed the relative price of charitable contributions and might have had an independent effect on income. Similarly, a change in the standard deduction affects the decision to itemize and, through this channel, the relative prices of itemizable activities for taxpayers who change their itemization status. [3]

The effect stressed in this paper is that a change in the price of deductions, or more generally the price of legal avoidance or illegal evasion, may affect behavioral elasticities. As argued by Slemrod (1994), taxable income is going to be more responsive when reducing it is cheap (e.g., because deductions are abundant), and it will be less responsive when it is expensive. This effect is conceptually separate from any effect on the level of taxable income and has far-reaching policy implications. Because behavioral elasticities determine the extent of excess burden, a policy that can affect elasticities can also determine the extent of inefficiency of taxation. Understanding the empirical relevance of such policies is important from the optimal policy design perspective (Slemrod and Kopczuk, 2002). It may also be important from the political economy point of view. To appreciate possible implications, observe that in the presence of such effects, supporters of a small government may have an incentive to pursue policies that make the tax system less efficient (and vice versa; Becker and Mulligan, 1998, make this point explicitly). Finally, understanding whether a broader tax base affects deadweight loss of taxation is central for determining the potential or actual efficiency gains of reforms of this kind such as the TRA'86 or the increased reliance on the Alternative Minimum Tax projected as a consequence of recent tax reforms.

That income elasticity is a non-structural parameter may already be suspected based on the existing empirical literature. Gruber and Saez (2002) find that elasticities for high-income individuals are larger than for the rest. Saez (2003) argues that only responses in the upper tail of the income distribution are significant. Higher elasticities were found for itemizers (Gruber and Saez, 2002) and self-employed (Sillamaa and Veall, 2001). Saez (2003) finds that responses to different tax reforms are different: he found evidence of significant responses to the TRA'86 but not much action surrounding the Kennedy tax cut in the mid-1960s. While it is possible that behavioral

[3] Triest (1992) analyzed the role of itemization on labor supply decisions and found that the impact of taxes through the relative price of deductible activities appears stronger than through the wage.

elasticities vary with some personal characteristics,[4] it is also possible that differences in behavior result from differences in the tax and institutional environment faced by different individuals.

To address this issue, I concentrate on a broad measure of income and control for both changes in tax rates and rules. Measuring rules is by itself difficult and a further problem from the econometric point of view is to have enough variation in any such measure to credibly identify the potential effects. In practice, time-variation alone is unlikely to provide such a variation. The model presented in the paper (Section 3) introduces and justifies a quantifiable measure of the non-rate aspects of the tax system in place that varies both over time and in the cross-section. The idea is to use the tax base as a summary statistic for tax rules in place. I rely on a taxpayer-specific measure of the size of the tax base: the ratio of income that is subject to taxation to total income. This is an easily observable quantity that is affected by tax reforms in a mechanical way (although it of course varies also due to endogenous taxpayers' responses). Tax reforms induce variation in both tax rates and tax bases and therefore provide an opportunity to separately identify the two effects.

A few clarifications are in order at the outset. First, my broad income is a measure of all kinds of income reported on tax returns that can be consistently observed over time. Using taxable income instead would be preferred from the theoretical point of view. Such a measure is easy to obtain; however, because its definition changes frequently, it is more difficult to incorporate in the analysis. In this paper, I mainly establish sensitivity of broad income to the size of the tax base. I discuss difficulties involved in analyzing taxable income and show some basic results in Section 6.1. Second, the estimated response to the tax base reflects the degree of substitutability between (broad) income and deductible commodities. This intuition will be made explicit by the theoretical model of Section 3. Previewing the results, they indicate that broad income and deductible commodities are substitutes so that a decrease in the price of deductible commodities (higher tax rate) leads to a significant reduction in the level of broad income. Third, as in other papers in this literature, the major limitation of this approach is due to its focus on personal income only. For the overall efficiency cost of the tax system, one should also understand shifting between personal and other tax bases. It will be argued below, however, that the results are remarkably stable across different income categories that are likely very diverse in terms of the ability to pursue the corporate income tax avoidance avenue. As a result, it appears unlikely that the overall response would be significantly affected by this consideration.

The outline of this paper is as follows. In the next section, I describe a simple model that highlights the role of the tax base and underlies the empirical specification. I present details of the empirical implementation and discuss the data in Section 4. I

[4] For example, individuals with a relative *preference* for tax avoidance may choose careers facilitating avoidance, such as self-employment. Kopczuk (2001) analyzes optimal tax implications of such behavior.

argue that different sample definitions explain differences in the results found in the previous literature and provide baseline results without controlling for the tax base effects in Section 5. Following this discussion, I present my estimates of the elasticity of income and the strength of its dependence on the tax base (Section 6) and an extension to taxable income (Section 6.1).

The major contributions of this analysis lie in demonstrating that the elasticity of reported income varies systematically with the tax base and that this effect is quantitatively important. It also turns out that the results are similar for different income categories suggesting that the major aspects of tax environment relevant for taxpayers' decision are appropriately controlled for. The final section discusses some implications of these results.

3 Income Response to Tax Base Changes

In this section, I present the model underlying the empirical specification that follows. Intuitively, the number of deductible commodities (G) should have implications for the responsiveness of income to the tax rate: marginal tax rate determines tax wedge between income and deductible commodities thereby inducing substitution responses. The importance of these response depends on the extent of deductibility and its interaction with the marginal tax rate. This suggests an empirical specification in which both the tax rate and its interaction with G are controlled for. However, measuring G explicitly is not practical. To motivate the proposed solution, consider the following model. Let D_i, $i = 1, \cdots, N$ be various types of consumption. Assume that the utility function is separable between these goods and determinants of broad income (such as labor supply), and that the utility from consumption is given by $v(D_1, \cdots, D_N)$, where $v(\cdot)$ is "symmetric", so that the order of D_i's does not matter for the value of utility.[5] Denote the generic relative price of broad income B by w and the price of good i by p_i. To simplify the notation, assume that in the absence of taxes all prices are equal to 1. Expenditures on G ($G < N$) commodities are deductible from income. Because of the symmetry, deductions may be taken to be the first G commodities. Then, the after-tax prices are given by $w = \tau \equiv 1 - t$, $p_i = \tau$ for $i \leq G$ and $p_i = 1$ for $i > G$. The demand for B is a function of all prices and the non-earned income. The elasticity of B with respect to the net-of-tax rate has to reflect the impact of all relative prices that are affected by the change. In order to incorporate nonlinear tax schedules, I additionally allow for varying virtual income R (so that the response to R represents the income effect). Thus,

[5] Formally, it is assumed that for any vector D and its permutation $P(D)$, $v(D) = v(P(D))$

$$\Delta \ln(B)\Big|_{\Delta R,\Delta\tau} \approx \left(\frac{\partial \ln(B)}{\partial \ln(w)} + \sum_{i=1}^{G} \frac{\partial \ln(B)}{\partial \ln(p_i)}\right) \Delta \ln(\tau) + \frac{\partial \ln(B)}{\partial R}\Delta R$$
$$= \left(\frac{\partial \ln(B)}{\partial \ln(w)} + G\frac{\partial \ln(B)}{\partial \ln(p_1)}\right) \Delta \ln(\tau) + \frac{\partial \ln(B)}{\partial R}\Delta R\,. \tag{1}$$

The last step makes use of the assumed symmetry of all deductible commodities. This formula depends on G, the number of deductible commodities which is unlikely to be observed. However, using the Slutsky identity, symmetry of the Slutsky matrix and $p_1 = \tau = w$ yields

$$\Delta \ln(B)\Big|_{\Delta R,\Delta\tau} \approx \left(\frac{\partial \ln(B^*)}{\partial \ln(w)} + \frac{GD_1}{B}\frac{\partial \ln(D_1^*)}{\partial \ln(w)}\right) \Delta \ln(\tau) + \frac{\partial \ln(B)}{\partial R}\Big[\Delta R + \Delta\tau(B - GD_1)\Big]\,, \tag{2}$$

where the superscript "$*$" denotes the compensated effect. The first two terms form the compensated elasticity of B with respect to the tax rate: it depends on the elasticity with respect to own price w as in the standard analysis, but it also depends on the cross elasticity of deductible goods with respect to w multiplied by the share of deductible goods.

So far, a response to changes in G was ignored. However, it may be analyzed in a similar manner. Consider an increase in G by ΔG (the case of a decrease would be analyzed identically). It corresponds to prices of goods $G+1$ to $G+\Delta G$ falling from 1 to τ. Therefore, assuming that ΔG is small relative to N,

$$\Delta \ln(B)\Big|_{\Delta G} \approx \sum_{i=G+1}^{G+\Delta G} \frac{\partial \ln(B)}{\partial \ln(p_i)}(\ln(\tau) - \ln(1)) \approx \frac{\partial \ln(B)}{\partial \ln(p_{G+1})} \ln(\tau)\Delta G \tag{3}$$
$$\approx \frac{\partial \ln(B)}{\partial \ln(p_1)} \ln(\tau)\Delta G = \frac{\partial \ln(D_1^*)}{\partial \ln(w)}\frac{D_1\Delta G}{B} \ln(\tau) - \frac{\partial \ln(B)}{\partial R} tD_1\Delta G\,.$$

Combined equations 2 and 3 characterize the response of broad income to a change in tax environment. To express it succinctly, define $\gamma \equiv \frac{GD}{B}$. Then, when evaluated at the original point, $\Delta(\gamma \ln(\tau)) = \frac{D\Delta G}{B}\ln(\tau) + \gamma\Delta\ln(\tau)$. Consequently, the response of B is given by

$$\Delta \ln(B) = \frac{\partial \ln(B^*)}{\partial \ln(w)}\Delta \ln\tau + \frac{\partial \ln(D^*)}{\partial \ln(w)}\Delta(\gamma \ln(\tau)) + \frac{\partial \ln(B)}{\partial R}\Big[\Delta R - \Delta T\Big]\,, \tag{4}$$

where ΔT is a change in the tax liability.

This analysis has two important implications. First, the response to tax changes depends on G. Second, the impact of deductions is measured by the cross-elasticity and it is proportional to the (observable) share of deductions in the total income $\gamma \equiv \frac{GD}{B}$. This suggests using a natural specification where one controls for both the tax rate and its interaction with the share of deductible commodities, attempting to identify both $\frac{\partial \ln(B^*)}{\partial \ln(w)}$ and $\frac{\partial \ln(D_1^*)}{\partial \ln(w)}$. Of course, γ is endogenous but it also reflects the exogenous parameter G. As long as γ responds to changes in G, the two parameters can be separately identified.

Without assuming that the utility function is symmetric, it can be demonstrated that the interaction term in equation 4 should be replaced by

$$\frac{\partial \ln(D^*_{G+\Delta G})}{\partial \ln(w)} \frac{\Delta G \cdot D_{G+\Delta G}}{B} \ln(\tau) + \left(\sum_{i=1}^{G} \frac{D_i}{G\overline{D}} \frac{\partial \ln(D^*_i)}{\partial \ln(w)} \right) \frac{G\overline{D}}{B} \Delta \ln(\tau) \,,$$

where $G + \Delta G$ is the index of a marginal commodity that becomes taxable, $\overline{D} = G^{-1} \sum_{i=1}^{G} D_i$. What is required for $\Delta\gamma \ln(\tau)$ to measure the effect of deductibility as in equation 4 is that $\frac{\partial \ln(D_{G+\Delta G})}{\partial \ln(w)} = \sum_{i=1}^{G} \frac{D_i}{G\overline{D}} \frac{\partial \ln(D_i)}{\partial \ln(w)}$: the marginal deductible commodity should react to w as the average one does. This assumption is implicit in the empirical work that follows.

Motivated by the model, therefore, instead of measuring G explicitly, I rely on the share of broad income that is spent on non-taxable commodities $\gamma \equiv \frac{GD}{B}$, and I control for both τ and its interaction with the tax base γ. Note that γ is affected by tax reforms through their mechanical effect on G. On the other hand, γ also varies in the cross-section. My goal is to estimate parameters ε and β of the following generic specification

$$\ln(B) = \varepsilon \ln(\tau) + \beta\gamma \ln(\tau) + \text{other terms} \,. \tag{5}$$

where other terms may include income effects as well as other control variables. In this specification, ε is the elasticity that would prevail if $\gamma = 0$, i.e. if no deductions were available. The actual size of the elasticity is $\varepsilon + \beta\gamma$: if policy affects γ, it changes this elasticity. The interpretation of β that follows from the model described above is as the average cross-elasticity of deductible goods with income, so that both positive and negative βs are consistent with the theory. More generally, any response of broad income will also reflect reallocation of income between reported and non-reported forms.

Because γ has never been, to my knowledge, considered in the literature, it should be pointed out that from both theoretical and econometric points of view this variable can be thought of in the same way as the marginal tax rate. This quantity is affected by policy changes and it constitutes a parameter of the taxpayer's problem just as the tax rate does. It is clearly endogenous as well, but that will be dealt with in the empirical work just like any potential endogeneity of tax rates must be dealt with.

It also should be stressed that the specifications I consider do not include the direct (i.e., not interacted with the tax rate) effect of the tax base. This is because changes in the tax base have any impact only to the extent that an individual is subject to taxation to begin with and, therefore, there is no theoretical reason to include non-interacted tax base. Other than restrictions implicit due to the parametric character of the analysis, the main assumption is that rules are fully characterized by the single parameter γ.

4 Data and Empirical Strategy

The data used in this paper comes from a panel of tax returns. Before it is described in Section 4.2, I briefly discuss prior approaches to identifying the effect of taxes on taxable income focusing on my proposed modifications, including those necessary to simultaneously identify the effect of the tax base. The identification problems in this setup have been discussed extensively by Moffitt and Wilhelm (2000). The impact of unobservable demographic characteristics whose effect stays constant over time and that are time-invariant can be eliminated by first-differencing the regression specification. Therefore, indexing individuals by i and denoting the time index by s, I specify my model in the first-differenced form as

$$\Delta \ln(B_{is}) = \varepsilon\Delta \ln(\tau_{is})+\beta\Delta[\gamma_{is} \ln(\tau_{is})]+\eta\Delta \ln(B_{is}-T_{is})+\Delta\delta^v Z_i^v+\delta^h\Delta Z_s^h+\Delta\theta_{is}\,, \quad (6)$$

where τ is the marginal net-of-tax rate, γ is the share of deductible consumption, T is the total tax liability and $Z = [Z^h, Z^v]$ is the vector of other relevant characteristics. The objective is to directly estimate the elasticity with respect to the net-of-tax rate $\tau \equiv 1 - t$. As discussed above, the tax elasticity may depend on deductions and therefore the coefficient on $\ln(\tau)$ is allowed to depend on γ. This is the minimal extension of specifications considered in the prior literature that allows for testing the constancy of the elasticity. The parameter ε is the broad income tax elasticity when $\gamma = 0$, that is for the comprehensive tax base. Equivalently, this is the response of broad income motivated by substitution away from items reported on the tax return toward leisure, fringe benefits and other types of income. One can test whether $\beta = 0$, in which case there is a single tax elasticity. In principle, depending on whether deductible goods are substitutes or complements for the broad income, both positive and negative β's are consistent with the theory. The parameter η measures the income effect. Finally, Z^v is the set of time-invariant variables whose effect changes over time and Z^h is the set of time-specific variables whose effect stays constant over time.

All reported regressions include dummies for the single marital status, sex (these are Z^v's) and the full set of year effects (Z^h). The dataset contains no age information other than age exemption for those older than sixty-five, but observe that linear age effects are controlled for by including year dummies in the first-differenced specification. The effect of any other variables is not controlled for and they are subsumed in the $\Delta\theta$ term.

4.1 Endogeneity and Instruments

As in any econometric analysis of the impact of taxes on income or labor supply, one has to worry about endogeneity of the key right-hand side variables. Both the marginal tax rate and the tax base depend on a realization of income. The tax rate is the direct function of the total income. The tax base is not a direct function of income, but it may depend on it. Furthermore, given that only limited demographic information is present in the dataset, one has to worry about any systematic relationship of omitted variables that are relevant for income with the tax base. For example, people with temporarily high income may be willing to invest more in tax avoidance. On the other hand, people with temporarily low income due to, e.g., medical conditions will have a lower tax base as they qualify for the medical deduction. The tax base is, similarly as the marginal tax rate, an endogenous time-varying variable, exogenously affected by policy shocks.

To consistently estimate ε and γ, what is necessary are instruments for $\Delta \ln(\tau_{is})$ and $\Delta\{\gamma_{is} \ln(\tau_{is})\}$ that are uncorrelated with $\Delta\theta_{is}$. I construct and use as my instruments changes in values of $\ln(\tau)$ and $\gamma \ln(\tau)$ absent any change in behavior (which I refer to as "predicted" changes).[6] Only information as of time s is used to construct the predictions of the time $s+1$ variables. In other words, the predicted tax base and the predicted marginal tax rate differ from the original ones only to the extent that there were changes in tax law. This eliminates the effect of behavioral response between time s and time $s+1$, although it still leaves the individual-specific component. In constructing the predicted tax base, I account for changes in the medical deduction,[7] changes in the tax treatment of charitable contributions by non-itemizers (a deduction was present between 1982 and 1986), deductibility of interests on personal debt that was phased out after 1986, changes in the IRA limits, the elimination of the second-earner deduction by TRA86 and the change in the treatment of moving expenses (the TRA'86 changed their status from an adjustment to an itemized deduction). As a part of the process, the predicted itemization status is determined by comparing predicted deductions with the corresponding standard deduction. All calculations are CPI-adjusted and thus account for changes in itemization incentives due to "bracket-creep." Performance of the predicted tax base is illustrated in Figure 1 using the 1985 data to predict the 1988 values (this change is mostly due to the Tax Reform Act of 1986).

The marginal tax rate instrument is constructed analogously. I adjust all period s quantities for inflation and compute the period s measure of taxable income accounting for changes in its definition. The new itemization status is predicted and the new tax schedule is applied to the result.[8] The income instrument is constructed as

[6] In general and apart from the orthogonality assumptions, with just two years of data what is required for identification of both parameters is that the effect of at least two of the variables used in computing the marginal tax rate and tax base stayed constant over time so that they don't enter specification (6). With multiple years of data and multiple tax reforms, this assumption can be somewhat weakened: I can still identify the effect if *trends* by at least two characteristics stayed constant over time.

[7] Until 1982, medical expenses above 3% of AGI were deductible, until 1986 - above 5%, after 1987 - above 7.5%. There were minor changes regarding how health insurance affects the calculation in 1982 and 1983.

[8] The results are not sensitive to a few other ways of constructing the tax rate instrument. For example, neither using inflated first-period capital gains as a component of the predicted

in Gruber and Saez (2002): it is simply $\ln(B_s - T_s^P/p_{s+1}) - \ln(B_s - T_s)$ where T_s is tax liability in period s, T_S^P is the tax liability predicted for period $s+1$ by applying the tax law as of period $s+1$ to the period-s values, and p_{s+1} is the inflation factor between periods 1 and 2. As was the case with the other two instruments, the income instrument relies only on variables as of period one.

The tax rate is a function of taxable income, and demographic characteristics (such as state of residence, marital status, number of dependents, or age). Effectively then, the tax rate is a function of broad income, the structure of deductions/adjustments and demographic characteristics. In constructing the predicted tax base I rely on taxable income, deductions and tax adjustments. As a result, the tax base is affected by individual-specific and transitory components present in each of them. Some examples of such influences are tastes for charity (that affect charitable contributions), own health status (affecting medical deduction), home ownership (affecting real estate tax and home mortgage deductions), credit history (affecting personal interest deductions) and unobservable income shocks (affecting state tax liability and, through this channel, the itemization status). The effect of the tax base on income can be identified to the extent that at least some of these characteristics are either (1) time-invariant with their effect staying constant over time or (2) they do not independently affect income (in which case they need not be time-invariant). In either case, it implies that such characteristics can be excluded from equation 6. Determinants of the tax base whose independent effect on income is not differenced out may be either due to transitory effects or group-specific trends. The consistency of estimates rests on these effects being appropriately controlled for, exactly as it does in the analysis of the tax rate effects. Many individual characteristics can be expected to fall in this category. For example, own health status is likely a determinant of the transitory component of income while home ownership is likely closely related to permanent income and the group-specific trend. I assume that the effect of unobservable person-specific determinants of deductions that do not stay constant over time is fully accounted for by transitory and permanent income controls

The earlier version of this paper (Kopczuk, 2003) contains a detailed discussion of the importance of controlling for both transitory and income components of inequality. Because I rely on instruments constructed using information as of time s, I need to address their possible correlation with both the group-specific trend and the transitory income component. To do so, I include two kinds of controls. I control for the individuals' ranks in the income distribution by including the level of income for year preceding the first year of the difference (i.e., $t-1$ income). [9] Due to reliance on year

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income nor ignoring adjustments of the definition of income subject to taxation made a difference.

[9] I am grateful to an anonymous referee for suggesting this approach. The working paper version of this article used instead income as of the first year of the panel (1979). Although major conclusions are unaffected by this change, the "$t-1$" approach is likely to lead to more consistent measures of the rank and transitory income because these measures do not "age" as the panel ages. In particular, it turns out that this approach makes results for

$t-1$ income, observations for the first year (1979) are automatically excluded from the sample used for estimation. I define the transitory income component as the difference between current and $t-1$ income. I experiment with 10-piece splines in logarithms of both the $t-1$ income and the "transitory" component to allow for potential nonlinear effects. Nonlinearity in the permanent component allows me to account for trends in income varying across different income classes. In principle, the transitory component can be controlled for in a linear fashion. However, because my measure of temporary income is a proxy and therefore certainly includes a measurement error, allowing for higher-order effects may aid in eliminating the residual correlation and the resulting bias.

4.2 Data

I use the Statistics of Income/University of Michigan panel of tax returns that were selected every year between 1979 and 1990, according to the last four digits of the social security number. There are usual pros and cons of relying on tax return data: the dataset contains little demographic information, but it includes detailed information about tax returns. The latter is crucial here, because it allows for constructing a measure of the tax base. [10]

I follow Gruber and Saez (2002) in comparing differences between observations three years apart. In other words, when differencing, I subtract observations for 1980 (1981, 1982,...,1987) from the corresponding observations for 1983 (1984, 1985,...,1990). The three year spread was also used by Feldstein (1995). Using a longer spread allows for estimating permanent elasticities, while short-term differences can be significantly affected by income shifting over time. Using a much longer spread would confound effects of ERTA'81 and TRA'86 that were just five years apart. For example, the four-year window would include the 1982-1986 pair that adjoins both of the major tax reforms.

The panel is not balanced. There are almost $300,000$ observations that translate into close to $100,000$ three-year differences, but not all observations are used in the analysis. I use only observations of individuals who are observed in year $t-1$ and whose marital status in years $t-1$, t and $t+3$ is identical. There are 59,006 such observations. Additionally, I exclude those who claim age exemption in either of the two years (9,309), those filing as the "head of household" (5052), those with non-positive income in $t-1$ or either year of the pair (776), those whose state of residence

single individuals somewhat more stable than when 1979 income is used.

[10] The predicted change in tax base is used as an instrument for tax base, but there is no information to construct predictions of new deductions. An instrument relying only on the pre-existing deductions is a valid instrumental variable if it remains correlated with actual tax base.

is unknown (20)[11] and some tax returns with missing data. This procedure leaves 43,839 differenced observations.

I construct and use as the dependent variable the measure of broad income consisting of almost all income that had to be reported every year, regardless of whether it was taxable or not. The only type of income that is excluded (following most of the previous studies) are realized capital gains. This is due to the lump-sum pattern of their realizations. An extension of the analysis to taxable income is discussed in Section 6.1. Further details are in the appendix of the working paper version.

Tax rates and liabilities were computed by applying the NBER TAXSIM[12] calculator to the actual taxable income (in particular, deductions are taken into account). Both state (t_s) and federal income (t_f) tax rates are used. The effective marginal tax rate is calculated as $t_f(1 - t_s) + t_s$ for itemizers who claim state tax deductions and as $t_f + t_s$ for all others.

Spending on deductible commodities is defined to include total adjustments to income, total deductions (with the exception for state and local taxes) for itemizers, charitable deductions for non-itemizers between 1982 and 1986 and non-taxable but reported components of income (such as the non-taxable part of unemployment insurance). The value of γ is defined as the ratio of such spending to the broad income measure. Note that, consistently with the model described earlier, the inelastic personal exemptions and the standard deduction are not a part of the definition of γ. For the purpose of constructing γ, deductions need not be enumerated, because the tax base can be mechanically constructed by dividing the taxable income observed on the return through a measure of the broad income. The extent and sources of variation in γ will be discussed in what follows.

Table 1 shows basic summary statistics for the sample used in estimation. The average reported income is about \$40,600 dollars, compared to the average initial income of about \$39,394 dollars. 38% of the population is single and 46% of the sample itemizes. The average marginal tax rate for the whole sample is 25.3% in period 1 and 24.1% in period 2, while the tax base $(1 - \gamma)$ in both periods is on average the same at about 0.87.

[11] There is a small number of predominantly rich taxpayers whose state of residence is not reported in the dataset (for confidentiality reasons). For most of them, I do have information about their state of residence in one of the prior years and this is what I use, implicitly assuming that they have not relocated in the meantime.
[12] The calculator is available at `http://www.nber.org/taxsim/` and described in Feenberg and Coutts (1993).

4.3 Variation in the tax base.

There are two major aspects of the tax system that are responsible for determining the broadness of the tax base. First, deductions and adjustments explicitly exclude parts of income from taxation. As they vary, the tax base of the taxpayer varies. Second, tax bases of itemizers and non-itemizers are different. Changes in both the standard deduction and the availability of itemized deductions affect relative payoffs from different itemization regimes. Therefore, they affect the itemization status even without other behavioral responses.

Importantly, effects of such changes also vary cross-sectionally. Changes in the standard deduction affect itemization status (and therefore the tax base) only of those whose gains from itemization are small enough. The elimination of the charitable deduction for non-itemizers affected the tax base of people making charitable contributions but not others. Changes in medical deduction affect itemizers who have high enough medical expenses. These effects can interact suggesting that tax base effects are not simple functions of income (and, therefore, aiding in identification). For example, following the repeal of the non-itemizer deduction for charitable contributions, a non-itemizer may (but need not) change the itemization status. Without a change, the tax base would increase. If the itemization status changes, the tax base would likely fall as deductions available to itemizers are taken advantage of.

Table 2 presents descriptive statistics showing the degree of variation of the key variables over the years for the whole sample (this table is based on more observations than actually are used in the estimation). The temporal pattern indicates that tax reforms of the 1980's affected the tax base. The tax base was falling before 1986 and was sharply increased by the Tax Reform Act of 1986. Columns 7 and 8 show that similar patterns are present for both itemizers and non-itemizers. The proportion of itemizers fell sharply following the TRA'86. If only the standard deduction had changed, the remaining itemizers would be people with relatively small tax bases. Nevertheless, the average tax base among itemizers increased indicating that these changes were not simply caused by changes in the standard deduction but also involved elimination of some of deductions.

Column 8 of Table 2 shows that non-itemizers do not automatically have γ equal zero (the tax base equal to one),[13] although it is not far from that. The tax base of non-itemizers was on average lower following the ERTA'81 mostly due to the availability of a deduction for charitable contributions by non-itemizers. The cross-sectional changes are illustrated in Figure 2. It shows the distribution of the tax base in 1980, 1982, 1985 and 1988 (only individuals in the sample used for estimation are included). In every year, the distribution is bimodal corresponding to groups of itemizers and non-

[13] Observe that the standard deduction and dependent exemptions do not enter the definition of γ. Subtractions from the broad income in the numerator of γ include only items that can be adjusted by taxpayers.

itemizers. The ERTA'81 shifted the whole distribution to the left, while the TRA'86 shifted it back to the right.[14]

5 Results — Tax Rate Effect Only

I begin by considering specifications without the interaction of the marginal tax rate and the tax base. By doing so, I am able to identify the source of differences in previous studies and present directly corresponding estimates obtained using my approach. These estimates serve as a reference point for the discussion of the role of tax base in the next section.

Income controls. In order to highlight the importance of the choice of income controls, I present in Table 3 estimates of the net-of-tax coefficient (i.e., the coefficient on $\Delta \ln(\tau) \equiv \Delta \ln(1-t)$) using the full sample and various means of income controls.[15,16] The first specification excludes income controls and leads to a significant negative coefficient. The following two specifications are as in Gruber and Saez (2002): controlling for the current income has a huge impact, but allowing for nonlinearities reduces the estimated elasticity to about 0.15. The same result was obtained by Gruber and Saez (2002).

The following four specifications highlight the importance of both permanent and transitory components of income. The effect of the permanent component is sensitive to nonlinearities. Allowing for a nonlinear effect in $t-1$ income or controlling for just the transitory component has relatively little impact on the estimated elasticity, which remains significantly negative. The last panel allows for both types of income controls entering in different combinations of linear and nonlinear effects. Allowing for nonlinear effects in each case significantly reduces the estimated elasticity. When both income controls are allowed to enter in a nonlinear fashion, the estimated elasticity

[14] Although I account for many changes in the tax base as discussed in Section 4.1, empirically the major source of variation in the tax base is due to changing incentives for itemization. In fact, none of the results in this paper would be affected in a major way if the tax base instrument was only accounting for the change in the itemization status, without adjustments for other changes in the definition.

[15] As discussed later, these specifications are not directly comparable to the results of Gruber and Saez (2002) and Auten and Carroll (1999), because these papers additionally restrict samples used in estimation.

[16] All reported results come from the IV regressions. There is no evidence of the weak instrument problem for the tax base and the tax rate instruments, although the income effect instrument has low explanatory power in some specifications. Estimates are robust to not controlling for the income effect. I report the Huber-White standard errors clustered by individuals that are robust to non-independence of the error terms for the same individual (as well as heteroskedasticity).

is at 0.27 and significant. The final specification allows for year-specific nonlinear transitory controls, but this generalization has virtually no impact.[17]

Sample Selection. As discussed above, it is important to control for the mean reverting components of income. Apart from controlling for the current level of income, earlier papers also restricted their samples by excluding certain individuals with low incomes. Gruber and Saez (2002) exclude "taxpayers whose income is below $10000 in year 1 [in 1992 dollars], to avoid very serious mean reversion at the bottom of the income distribution." Feldstein (1995) excludes taxpayers with tax rates below 22 percent. Similarly, Auten and Carroll (1999) limit their sample to "taxpayers with incomes at or above the threshold for the 22% marginal tax rate in 1985." Carroll (1998) excludes taxpayers with income below $50,000 in 1989 (approximately $56,000 of 1992 dollars).

By relying on the realized tax rate, the selection rule used by Feldstein (1995) and Auten and Carroll (1999) excludes high income individuals with low taxable income. These papers find larger elasticities than the other two papers that base their sample selection on the income directly. That this is not a coincidence is illustrated in Table 4. I use the same dataset as Gruber and Saez (2002). This dataset constitutes about 20% of the dataset used by Auten and Carroll (1999). The rest of their sample oversamples rich individuals and is not publicly available. They state that they obtain very similar results when they limit the sample to the public subset (p. 692, footnote 2). They analyze the 1985-1989 difference only. Because the Feldstein (1995) and Auten and Carroll (1999) restriction depends on the tax system in place, I present the results for the 1985-1988 change only, using logarithm of income in 1985 as a control for the mean reversion problem.[18] Coefficients estimated based on the full sample are extremely large, suggesting that the mean reversion problem at the bottom of the distribution may be indeed important. Using the Auten and Carroll (1999) restriction to taxpayers with taxable income qualifying for at least 22% tax bracket in 1985 brings the elasticity down to about 0.8.[19] The Gruber and Saez (2002) restriction to individuals with current income above $10K reduces the elasticity to less than 0.4,[20] while the further restriction to those with current income above $30K makes it essentially zero (with the sample size similar to the A-C specification). These results closely track the results obtained in the corresponding

[17] The results for the subsample of married individuals are fairly similar and available from the author. The difference between results for the full sample and those for married individuals only was much more pronounced in the working paper version when 1979 income was used to measure permanent income and to construct the transitory income. Although controlling for $t-1$ income helps at this stage, it will be shown below that it does not solve similar problems when the tax base is controlled for.

[18] Auten and Carroll (1999) report results with log income control only.

[19] The Auten and Carroll (1999) estimate in the directly comparable specification is 0.67.

[20] An appendix available from the author contains a detailed discussion of the differences in definitions of variables and sample selection between this paper and Gruber and Saez (2002).

papers: it appears that different sample choices played crucial role. Compared to these differences, the effect of excluding older individuals and those subject to the AMT (cf. the first and second panels of Table 4) is minor.[21]

Splitting the sample according to either current income or the marginal tax rate is influenced by transitory and permanent components of income as well as individual effects. Additionally, splitting the sample according to the level of the tax rate is affected by the itemization and tax avoidance behavior. If the parameter of interest is constant, the sample selection bias will be present to the extent that factors determining selection are correlated with the error term and are not separately controlled for. Were transitory and permanent components of income and other determinants of selection appropriately controlled for, the sample selection bias should not be present. In that case, if the underlying parameter of interest is indeed constant, how the sample is split should not affect the results, contrary to the results in Table 4. The results in that table suggest a misspecification. Although in principle it is possible that one of such arbitrary restrictions will yield correct results, it is hard to defend a priori any particular choice.

The decision to split the sample may also be motivated by the belief that the underlying parameters vary in population. This was likely an implicit motivation of previous research that did not consider the low-income group as a valid control for high-income people who experienced the largest tax changes. Differences in behavior of the rich and the poor can be ascribed to either tastes or technology. In the framework of this paper, taste differences are accounted for by allowing for individual effects and thus should not affect the results. Differences in available technology are allowed for by controlling for the tax base. The case for the elasticity of income to vary across different groups is therefore weaker than in prior research. Therefore, I investigate how sensitive my estimates are to the sample selection and consider stability of estimates as a testable prediction of the approach.

6 Results — Tax Rate vs. Tax Base

The previous section offered a mechanical explanation for the differences in results found in previous papers. Relying on insights regarding the relevance of sample selection and income controls, I turn now to the main question: the impact of the tax

[21] Although not reported here, including current income splines as in the preferred specification of Gruber and Saez (2002) renders tax coefficients in all specifications in Table 4 insignificant. With a single difference and just one tax change, allowing for nonlinearity in income eliminates income as the source of identification. This is not a problem for Gruber and Saez (2002) and this paper, because with multiple years of data one need not rely on identification off the cross-sectional variation in tax rates. However, this is the major source of identification in the context of Feldstein (1995) and Auten and Carroll (1999).

base on reported income.

The main results are shown in Table 5. For comparison purposes, the first specification shows results when only the tax rate is controlled for. The estimated elasticity for the whole sample is .27 while estimates for subsamples are all smaller and usually imprecisely estimated. Estimates obtained by splitting the sample using $t-1$ income appear larger than those obtained by splitting the sample according to the contemporaneous income level. Results are sensitive to sample selection suggesting a possible specification error. The rest of the table contains results when both tax rate and tax base are controlled for. Estimates for the whole sample indicate that both direct tax elasticity and tax base effects are important. The direct tax elasticity is 0.096 while the coefficient on $\gamma \ln(\tau)$ is .789 and very significant. Evaluated at the average (in the sample used for estimation) tax base of 0.881 (i.e., $\gamma = .119$), this corresponds to the tax elasticity of 0.19. In the same sample, following the Tax Reform Act of 1986 the average tax base increased from 0.846 in 1986 to 0.900 in 1987, so that γ declined from 0.154 to 0.100. Consequently, these point estimates imply that the elasticity of broad income at the average tax base fell from 0.217 to 0.175.

In the following column, the direct effect of the tax base is estimated. There is no theoretical argument for why the tax base should enter the specification directly — tax base matters only to the extent that it implies tax savings. Comfortingly, the direct effect of the tax base is very close to zero, although it reduces the precision (though not point estimates) of the interaction coefficient.[22] The next seven columns show estimates in subsamples defined by either current or "permanent" income. In each case, the direct tax elasticity is insignificant, while the effect of interaction is usually large and close to estimates for the whole sample. These results suggest that by allowing the tax base to affect the elasticity of response, the model is appropriately controlling for heterogeneity in behavioral responses.

The next two panels of Table 5 show results by marital status. While one might argue that variation in marital status variations provides an additional source of identification, this is a difficult point to make, because it implies that the same behavioral model applies to both types of households. Furthermore, single individuals are likely to be predominantly young and therefore experiencing large changes in income following completion of their education. Such reasoning led Auten and Carroll (1999) to exclude individuals younger than 25 from their sample. In the absence of more detailed demographic information (in particular, having no information about age), I am not able to control for such considerations explicitly. However, splitting the sample by marital status allows for assessing the relevance of this problem if most of the young individuals are single.

Table 5 reveals that results for single and married individuals are quite different. The

[22] The results for subsamples are more sensitive to the inclusion of the direct effect of the tax base. Given a high degree of collinearity that it induces and the lack of economic argument for controlling for the tax base, I do not present these results.

results for singles are all over the map. Both estimates of the direct elasticity and the interaction term vary widely in subsamples and are always insignificant. It makes it difficult to treat seriously the somewhat larger (but still statistically insignificant) estimates based on the whole sample of single individuals. It is very likely that many individuals in this group are working part-time or entering the labor force while in the sample, so that changes in their income are not tax motivated. Given the inability to control for other demographic characteristics of these individuals, I believe that results for single individuals are not meaningful. The results for the sample of married individuals are, however, remarkably stable. The direct tax elasticities are always insignificant and close to zero. The effect of the interaction is quite precisely estimated at 0.73 when all married individuals are included and this point estimate is within one standard error of estimates for each of the considered income groups. As was the case when the full sample was considered, the direct effect of the tax base plays no role.

With very few exceptions, income effects are close to zero and insignificant.

A number of other specifications were considered (but are not reported here). The results are quite similar (although somewhat more sensitive to the choice of the sample) when one controls for splines in current income (as in Gruber and Saez, 2002) rather than separately for "transitory" and "permanent" components. The results are not affected by limiting attention to individuals who were observed in all years. Results are also very similar when one uses only differences starting between 1980 and 1982 to eliminate the Tax Reform Act of 1986 from the analysis or when using 1983-1987 to eliminate the ERTA'81 (though extensive controlling for income makes identification based on a single reform tenuous). Limiting attention to just 1980 and 1985 to avoid observations adjacent to reforms results in point estimates that are insignificant, but within one standard error of the results based on the full sample.

6.1 Taxable Income

Focusing on broad income, I demonstrated that its elasticity is a non-trivial function of tax policy. From the point of view of evaluating distortions of the tax system, broad income allows for a wider range of responses than traditional analysis focusing on labor supply. However, it falls short of measuring all tax motivated responses, as required by the taxable elasticity approach advocated by Feldstein (1999).

Given that a number of papers attempted an analysis of taxable income (e.g., Auten and Carroll, 1999; Gruber and Saez, 2002), it is worthwhile to discuss related problems. Incorporating any consistently defined concept of income in the analysis is straightforward and fits easily into the framework of this paper. This was the intention of approaches pursued in previous papers: taxable income was defined as broad income minus consistently defined deductions and adjustments. However it is important to recognize that in the presence of itemization decision (an important consideration in the United States) no deduction is in fact "consistently" observed: whether a researcher can observe it or not depends on the taxpayer's itemization decision.[23] Denoting broad income as B, the consistent definition of deductions as D, the (reference level of) standard deduction as $\bar{S}$ and personal exemptions by $\bar{E}$, all previous papers defined taxable income as $T \equiv B - \max(D, \bar{S}) - \bar{E}$.[24] Taxable income defined in this way is not a differentiable function of individual decisions: it has a kink at $D = \bar{S}$ violating an implicit assumption underlying econometric approaches based on a linear regression. It also introduces censoring of the residual present in D, potentially leading to a bias when estimating the response of taxable income. For example, consider an individual who chooses not to pursue certain deductions in response to a tax cut (e.g., because the relative price of charitable contributions rises) and therefore finds it non-profitable to itemize anymore. The response of his taxable income on the margin should reflect a change in deductions. Consider estimating the tax coefficient. In the presence of a discrete tax change, the change in deductions will be censored and the response will be understated. The bias for individuals who switch to itemization will go in the opposite direction. While these effects may cancel out (approximately 15% of individuals change their itemization status, with similar numbers switching to and away from itemization), it is not an appealing assumption a priori.

Even ignoring the censoring problem, the response for itemizers reflects the response of $B - D$ while the response for non-itemizers reflects the response of broad income only. It is unlikely that $B - D$ and B respond in the same way, after all the expectation that these responses are not the same is the rationale for separately analyzing taxable and broad income. At best therefore, when only the marginal tax rate is controlled for, this approach could be interpreted as discovering some form of the weighted average of the two types of responses. These weights will be related to the relative importance of itemizers and non-itemizers in identification and are therefore likely to be sensitive to the reform and instruments considered. Controlling for the tax base would help to alleviate this concern because it allows for the elasticity of response to vary with comprehensiveness of person-specific taxable income and therefore it allows for different elasticities for itemizers and non-itemizers.

Even without any behavioral response, taxable income would change when the itemization decision changes as a result of altered rules. This problem has been recognized before and it may be addressed using a constant definition of taxable income that relies on the least generous deduction regime, as in some of the previous papers. Even under a constant definition of taxable income, though, there may be responses of taxable income that occur purely as the result of changes in rules without any changes in tax rates. When a deduction is eliminated (in particular, it cannot then be included

[23] Adjustments can be consistently observed but their quantitative importance is small.

[24] According to this definition, taxable income excludes tax-free standard deduction and personal exemption, both set at the level in a selected reference year.

in the least generous constant definition), a taxpayer may decide not to itemize anymore. This may entail scaling down of other deductions (included in the constant definition) that might have been large enough before so that they were deductible under the constant definition of income. As a result, the constant-definition taxable income will respond without any change in tax rates. Because such changes occur at the same time as tax changes, they may be confounded with tax effects. This effect will not be picked up by year effects: it applies to a selected group of individuals, i.e. those who switch their itemization status. These individuals are, likely, located somewhere in the middle of income distribution. The direction of the bias from this source depends on its correlations with the instruments for marginal tax rate and tax base changes. Finally, an approach using a "constant" definition of taxable income at best measures the response of the actual taxable income under just one particular tax regime that corresponds to the "constant" definition.

One can imagine approaches to addressing the responsiveness of taxable income by explicitly modeling itemization decision and incorporating changes in observability of deductions in the econometric framework. Such an approach would be a major extension of this paper and it would be a very interesting contribution to this literature.

In what follows, I present specification checks that are intended to assess the relevance of concerns listed above. Table 6 contains the corresponding results. All regressions include splines in permanent and transitory taxable income defined analogously as in the case of broad income. The results of basic regression with taxable income as a dependent variable and without the tax base is shown in the first column. This regression suffers from problems discussed above but, except for not restricting the sample by income level, it is analogous to the specifications estimated in previous papers. The baseline estimate of the elasticity for the whole sample is 0.41, similar to the Gruber and Saez (2002) estimate and smaller than the estimates in Auten and Carroll (1999). The elasticity for married individuals is somewhat smaller at 0.3. The next two columns present two specification checks intended to assess the importance of problems due to switching itemization and censoring. In the first one, I eliminate those individuals whose itemization status changed between the two years. Although this is an endogenously selected group, this approach allows for assessing its quantitative importance for the results. In the following column, I rudimentarily control for the impact of censoring by including the actual change in itemization status as a regressor. Eliminating individuals whose itemization status changed reduces the elasticity, while the censoring control has only a small impact on the results. The following three columns repeat the same exercises, this time weighting all regressions by individuals' taxable income. Consequently, these estimates reflect sensitivity of revenue (relevant for tax policy evaluation) rather than individual behavioral parameters. This distinction is important when there is heterogeneity in responses. In particular, it seems that over-weighting high-income people results in higher estimated elasticity, suggesting that perhaps they are more responsive to taxation.

In the second panel, the same experiments are repeated when the tax base is controlled for. The basic regression indicates that the elasticity of response is sensitive to the tax base. Point estimates indicate both stronger sensitivity of the elasticity to the tax base and a stronger direct effect (based though on the comparison of insignificant coefficients). Estimates of the elasticity evaluated at the mean value of $\bar{\gamma}$ (about 0.12) are lower than estimates based on the results without the tax base. These results suggest that there was a bias due to omitting the tax base effect. The following two experiments demonstrate the relevance of the itemization-switching problem. Both removing "switchers" and controlling for censoring leads to a much sharper effect of the tax base. The message is very similar in weighted regressions.

The large and significant interaction coefficient provides a strong evidence of heterogeneity in responses to taxation. These results also raise concerns about results arising when the tax base is not controlled for. Suppose that these results indeed reflected the average elasticity. In order to reconcile taxable income elasticity arising from that approach (panel one of Table 6) with structural results in the second panel, one needs $\bar{\gamma}$ of the order of 0.3 to 0.4 (depending on specification). In fact, though, the average γ in the sample used for estimation is about 0.12 and the average *income weighted* γ is just 0.16. Less than 12% of the sample have γ greater than .3 and only about 5% have γ greater than 0.4. Even among those with income over $100,000, there are just 6% people with γ above 0.4. Consequently, high taxable income elasticities estimated in the first panel are hard to reconcile with the structural approach.

This analysis suggests that taxable income is indeed sensitive to the tax base changes. It can be tentatively concluded that the elasticity of taxable income is more sensitive to the tax base than it was the case with broad income. The specification checks presented above suggest that proper estimation of the interaction coefficient requires further work on addressing the issue of changes in the definition of taxable income.

7 Discussion and Implications

I interpret the results as indicating that, apart from the difficulty of controlling for transitory and permanent shocks in income, previous studies suffered from two additional problems. First, the model was mis-specified due to ignoring the effect of the tax base. Second, the results indicate that mixing individuals with different marital status while identifying the effect of taxes on income is suspect (at least, given scarce demographic information).

Table 5 contains the major results. Results for married individuals are consistent across all considered specifications: the direct effect of the tax rate is small and insignificant while the interaction term is in most cases of the order of 0.7 and comfortably significant. The results based on the full sample are a bit less reliable, although they also indicate that the interaction term plays an important role. Therefore, I concentrate on the results for all married individuals in developing normative implications. The estimated direct tax elasticity of broad income is 0.003 while the estimated effect of the interaction with the tax base is 0.727. In the case of taxable income, the corresponding (income weighted) results are 0.123 and 1.063. These results imply that an individual who has no access to any deductions would not respond to changes in the tax rates. The more deductions are available, the stronger the response.

Are these results reasonable? As highlighted by the theoretical model, the strength of estimated response reflects the degree of substitutability of broad income and deductible commodities. The estimated coefficient indicates that broad income and deductible commodities are strong substitutes: a decrease in the price of deductible commodities (higher tax rate) leads to a significant reduction in the level of broad income. Thus, for example, the results are consistent with lower prices of charitable contributions or medical care leading to less labor supply and, therefore, less income reported on the tax return. When the tax rate increases broad income responds for two reasons. First, there is a standard direct effect on determinants of broad income that now become costly. The finding of this paper is that this effect is close to zero and this result is consistent with the consensus regarding inelasticity of labor supply. Second, there are indirect effects present: an increase in the tax rate reduces prices of all deductible commodities. I find that broad income is reduced in response. Financing the same level of cheaper deductions requires less income, and the finding is that income reported on tax returns falls. The elasticity of substitution is smaller than one (of the order of 0.7 to 0.8), suggesting that broad income is not reduced one for one with the falling cost of deductions but that it is instead used for other purposes. In particular, there seems to be evidence that taxable income responds more strongly than broad income so that deductible goods are responsive to tax rates as well. The response of broad income can take many forms, but the importance of the interaction with deductions is suggestive of reporting rather than real responses: additional income that could be potentially concealed/re-timed/unrealized is reported on the tax return if there is a corresponding deduction to be taken.

As Table 2 shows, the mean marginal tax rate for fell from 0.212 in 1985 to 0.184 in 1988, while the mean average tax base increased from 0.880 to 0.926. The estimated results suggest therefore that the Tax Reform Act of 1986 reduced the elasticity of reported income to the tax rate at the mean tax base from 0.09 to 0.06, while the responsiveness of taxable income fell from 0.25 to 0.20.[25] There are two reasons for the change. First, the tax reform had a mechanical effect on the tax base, absent behavioral response. Second, under the new tax environment taxpayers adjusted their behavior and, consequently, there has been some endogenous change in the tax base. The last effect could be present even if only tax rates changed but it would be ignored by the standard analysis.

One simple implication of this result can be described by using the marginal cost of

[25] I find no evidence to conclude that the income effect is different from zero, so that compensated and uncompensated income elasticities are assumed to be equal.

funds (MCF). The simple formula for the MCF of the linear income tax is $MCF = \frac{1}{1-\frac{t}{1-t}\pi}$, where t is the marginal tax rate and π is the elasticity of taxable income. I proceed by replacing π by the estimate of the taxable income elasticity at the mean: $\varepsilon + \bar{\gamma}\beta$. Evaluating this formula at the mean tax rates yields the 1985 value of the MCF of 1.072 and the 1988 value of 1.044. Interpreting these numbers, they imply that the social cost of collecting a dollar of revenue fell by 3 cents per dollar. Alternatively, given estimated null income response, it directly translates into a reduction in the marginal excess burden by 39%, from 0.072 cents per dollar to 0.044. Holding the tax base constant at the initial level, the same change in the marginal tax rate would have reduced the MCF to just 1.060, resulting in the 60% smaller marginal excess burden reduction. While these are only suggestive calculations, they illustrate the potential quantitative importance of understanding the role of non-tax instruments in evaluating the efficiency cost of tax policy.

These results also indicate that the elasticity of income may well be different for different groups, to the extent that their tax bases are different. The results in Table 5 indicate (using the average tax base in each group and estimates for the full married sample) that the elasticity of reported income for people below the $30,000 threshold was 0.088 while the corresponding elasticity for those with incomes above $100,000 was 0.156. These differences are much smaller than found by Gruber and Saez (2002). Even though they still systematically vary with income, they do not necessarily imply that tax rates at high incomes need to be adjusted to account for stronger behavioral response: the differences in elasticities are themselves a function of policy. Finally, accounting for the tax base effects offers a positive framework for understanding differences in behavioral elasticities across countries: estimates for different countries may vary reflecting different tax systems in place.

To be sure, there are complicating factors that are not addressed in this paper and that may be very relevant. To the extent that the estimated response merely reflects shifting from other tax bases such as the corporate or capital gains tax, the elasticity of reported income should be supplemented by losses or gains of revenue from other sources. Accounting for such responses could undermine calculations performed above.

Additionally, the elasticity of income determines only the cost of taxation, while any complete analysis of policy requires understanding benefits as well. There may be trade-offs involved in the choice of tax base to the extent that deductions from the tax base are socially beneficial on, for example, redistributive grounds. Also, a broader tax base may feature different administrative costs (Yitzhaki, 1979; Wilson, 1989).

The bottom line is that any analysis of the cost of taxation should not ignore the fact that the crucial elasticity of taxable income is endogenous to the size of the tax base and, more generally, to other aspects of tax system. Putting these results in a broader perspective, this paper lends empirical support to the theoretical ideas advanced by e.g., Mayshar (1991); Slemrod (1994, 2001) and Slemrod and Kopczuk (2002). The cost of taxation is not merely a function of marginal tax rates, consumer preferences and technology, but rather it crucially depends on a broader tax environment and the structure of tax policy. Therefore, economic analysis of the optimal tax policy has to incorporate tax avoidance and administration.

Finally, the non-tax-rate effect stressed in this paper can be relevant for any analysis of the effects of taxation on economic variables. As a general lesson, one should be careful when using tax reforms as natural experiments to identify the effect of taxation on economic variables. Such exercises usually assume that the elasticity of response is constant, while major changes in the tax system are likely to invalidate this assumption: tax elasticities are fundamentally non-structural parameters. As demonstrated here, acknowledging this issue does not necessarily eliminate usability of tax reforms as a source of variation, but it calls for a more comprehensive account of the changes that they induce.

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Table 1
Summary Statistics

Variable	Mean	Std. Dev.	N
Current Income (1992 dollars)	40611	48008	43839
Income in year $t-1$ (1992 dollars)	39394	38081	43839
Single	0.376	0.484	43839
Itemizers	0.461	0.499	43839
t_1	0.253	0.116	43839
t_2	0.241	0.104	43839
$1-\gamma_1$	0.875	0.162	43839
$1-\gamma_2$	0.872	0.165	43839
$\Delta\ln(B)$	0.078	0.668	43839
$\Delta\ln(\tau)$	0.019	0.123	43839
$\Delta\ln(\tau^P)$	0.029	0.056	43839
$\Delta\gamma\ln(\tau)$	0.003	0.040	43839
$\Delta\gamma^P\ln(\tau^P)$	0.008	0.019	43839
$\Delta\ln(X)$	0.080	0.619	43785
$\Delta\ln(X^P)$	0.010	0.059	43822

τ denotes the marginal tax rate. $1-\gamma$ is the tax base. B represents broad income and X is equal to broad income less the tax liability. Subscripts $i = 1, 2$ refer to the first and second year in each three-year difference. The "P" superscripts mark instruments (predicted values of variables) as defined in text. Definitions of other variables are as follows: $\Delta\ln(B) = \ln(B_2/B_1)$, $\Delta\ln(\tau) = \ln(\tau_2/\tau_1)$ $\Delta\ln(\tau^P) = \ln(\tau^P/\tau_1)$, $\Delta\gamma\ln(\tau) = \gamma_2\ln(\tau_2) - \gamma_1\ln(\tau_1)$ and $\Delta\gamma^P\ln(\tau^P) = \gamma_P\ln(\tau^P) - \gamma_1\ln(\tau_1)$, $\Delta\ln(X^P) = \ln(X^P) - \ln(X)$. Sample includes all 3-year differences used for estimation.

Table 2
Means of Selected Variables by Year of Filing

					Share	Tax Base	
Year	**Number**	t	$1-\gamma$	$t(1-\gamma)$	**Item.**	**Item.**	**N-Item.**
1979	45393	0.225	0.926	0.205	0.284	0.762	0.991
1980	45781	0.234	0.920	0.213	0.306	0.760	0.990
1981	46250	0.243	0.913	0.219	0.328	0.756	0.990
1982	9445	0.229	0.897	0.203	0.350	0.735	0.984
1983	18833	0.216	0.891	0.190	0.363	0.731	0.982
1984	9862	0.213	0.884	0.186	0.384	0.729	0.981
1985	19878	0.212	0.880	0.184	0.390	0.724	0.980
1986	10285	0.211	0.874	0.182	0.388	0.720	0.972
1987	21002	0.191	0.919	0.174	0.338	0.775	0.992
1988	21553	0.184	0.926	0.170	0.292	0.768	0.991
1989	22031	0.185	0.928	0.170	0.287	0.765	0.993
1990	21977	0.184	0.921	0.169	0.288	0.754	0.989
Summary	292290	0.215	0.913	0.194	0.325	0.752	0.988

Definitions of variables are as in Table 1. All observations present in the dataset (not just those used in the estimation) are used.

Table 3
Tax Rate IV Regressions Using Different Approaches to Controlling for Permanent and Transitory Components of Income

	$\Delta \ln(\tau)$	**T-value**
No income controls	-1.09	-12.61
Logarithm of current income	1.38	9.45
Splines of log current income	0.15	1.24
Logarithm of $t-1$ income	0.03	0.25
Splines of log of $t-1$ income	-0.47	-4.39
Deviation of log current income from log $t-1$ income	-0.97	-11.18
Splines of the above	-0.76	-8.52
Log of $t-1$ income and log of deviation from it	1.28	9.07
Log of $t-1$ income and splines of deviations	0.93	6.98
Splines of log of $t-1$ income and log of deviation	0.48	3.97
Splines of log of $t-1$ income and splines of log-deviations	0.27	2.28
Splines of log of $t-1$ income and yearly splines of log-deviations	0.27	2.24

Sample size is 43,839 for the full sample and 27,347 for the sample of married individuals. All regressions include marital status (where applicable), as well as the full set of year dummies. "Splines" refer to a flexible piecewise linear functional form (10 components). The tax rate instrument is described in the text.

Table 4
Tax Rate IV Regressions — Sensitivity to Sample Selection Using 1985-1988 Data and Previous Methodology

	Restricted Sample (A+C)				Full Sample (G+S)			
	All	A+C	G+S	G+S 30K	All	A+C	G+S	G+S 30K
				1985-1988 Only				
$\Delta \ln(\tau)$	2.279	.822	.361	-.021	2.559	.640	.239	-.152
	(.262)**	(.237)**	(.199)	(.191)	(.235)**	(.201)**	(.165)	(.158)
$\ln(B)$	-.497	-.114	-.127	.007	-.480	-.105	-.082	.014
	(.022)**	(.026)**	(.020)**	(.025)	(.021)**	(.025)**	(.016)**	(.023)
N	11253	5200	9035	5655	13589	5978	11054	6508

The restricted sample excludes couples with at least one age or blindness exemption and subject to the AMT (for comparability with Auten and Carroll (1999) and Gruber and Saez (2002)). Compared to other specifications in this paper, this sample does not exclude individuals who are not observed in year $t-1$, those filing as the "head of households" or those with non-positive $t-1$ income. The specification marked: (1) "all" does not impose additional restrictions; (2) A+C removes taxpayers with federal tax rate below 22%; (3) G+S eliminates taxpayers with total income below 10,000 (1992 dollars) (4) G+S 30K eliminates taxpayers with total income below 30,000 (1992 dollars). All regressions include marital status (where applicable), as well as the full set of year dummies.

Table 5
Tax Rate and Tax Base IV Regressions Using Controls for Permanent and Transitory Income Components

			Current income		$t-1$ income				
	NR		> 10K	> 30K	< 30K	> 10K	> 30K	> 50K	> 100K
Full sample, tax rate only									
$\Delta\ln(\tau)$	.269		.057	-.038	.327	.147	.054	.128	.307
	(.118)*		(.111)	(.116)	(.248)	(.115)	(.123)	(.152)	(.278)
Full sample, tax rate and tax base									
$\Delta\ln(\tau)$	.096	.081	-.008	-.028	.028	.032	.000	.052	.150
	(.112)	(.144)	(.111)	(.125)	(.201)	(.105)	(.115)	(.148)	(.295)
$\Delta\gamma\ln(\tau)$	.789	.846	.573	.576	.815	.610	.719	.582	.489
	(.262)**	(.445)	(.266)*	(.316)	(.552)	(.269)*	(.310)*	(.438)	(.724)
$\Delta\gamma$		-.032							
		(.179)							
$\Delta\ln(X)$	.087	0.087	.010	-.093	.216	.087	-.001	-.028	-.001
	(.068)	(.069)	(.073)	(.088)	(.113)	(.076)	(.064)	(.078)	(.079)
N	43785		37427	24008	20126	36565	23658	12337	1797
$\bar{\gamma}$	.119		.134	.167	.069	.137	.173	.196	.209
Married Individuals									
$\Delta\ln(\tau)$	.003	-.058	-.057	-.118	.049	-.034	-.061	-.083	.220
	(.103)	(.150)	(.108)	(.122)	(.159)	(.104)	(.124)	(.144)	(.298)
$\Delta\gamma\ln(\tau)$	.727	.924	.715	.707	.668	.766	.761	.667	.407
	(.286)*	(.490)	(.289)*	(.324)*	(.478)	(.296)**	(.348)*	(.473)	(.789)
$\Delta\gamma$		-.117							
		(.220)							
$\Delta\ln(X)$	.144	.150	.082	-.036	.489	.129	-.027	-.048	-.027
	(.059)*	(.060)*	(.061)	(.078)	(.041)**	(.059)*	(.070)	(.083)	(.085)
N	27312		26615	20807	6580	26606	20731	11644	1696
$\bar{\gamma}$	.161		.165	.176	.117	.164	.180	.197	.210
Single Individuals									
$\Delta\ln(\tau)$	.319	.407	.130	.406	-.047	.357	.216	.785	-1.459
	(.362)	(.394)	(.364)	(.516)	(.480)	(.431)	(.347)	(.725)	(1.963)
$\Delta\gamma\ln(\tau)$	.955	.271	.228	-.451	.860	.262	.768	-.041	.558
	(.685)	(.965)	(.630)	(.778)	(.963)	(.715)	(.607)	(1.123)	(4.014)
$\Delta\gamma$		.343							
		(.356)							
$\Delta\ln(X)$	-.045	-.012	-.164	-.177	-.044	-.123	.231	.289	.094
	(.152)	(.125)	(.176)	(.189)	(.156)	(.315)	(.169)	(.234)	(1.619)
N	16473		10812	3201	13546	9959	2927	693	101
$\bar{\gamma}$	.066		.084	.133	.048	.088	.142	.183	.202

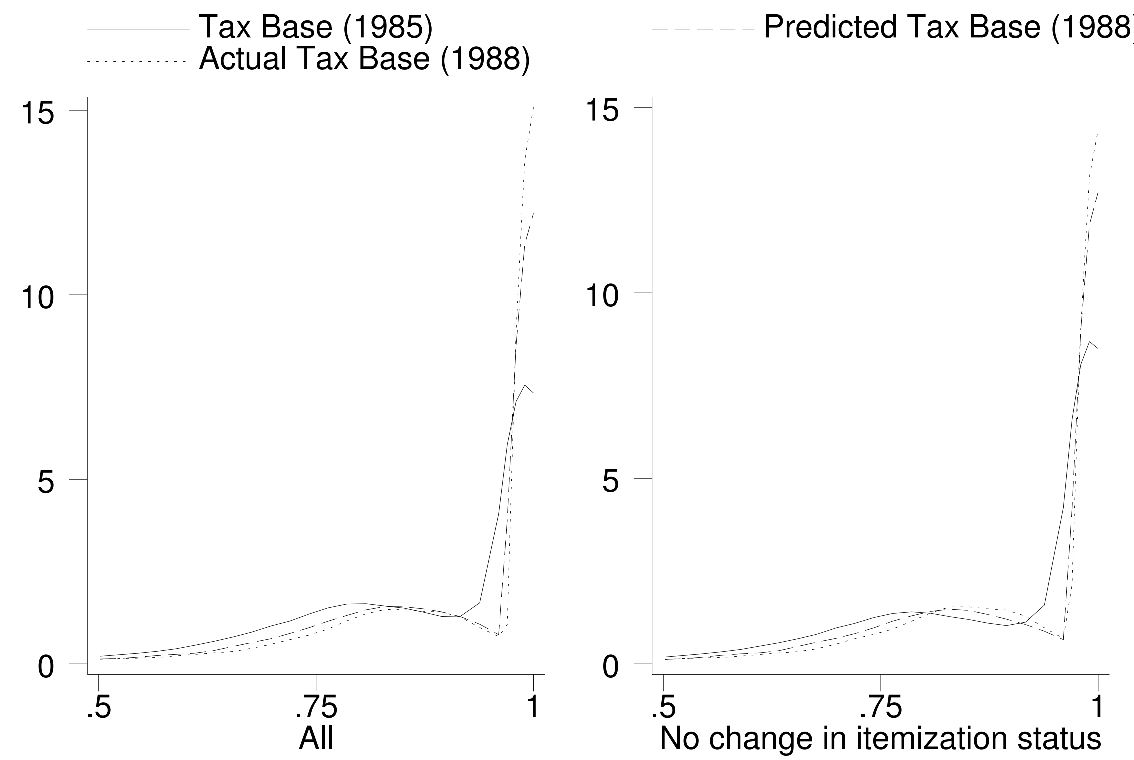
All regressions include marital status (where applicable), as well as the full set of year dummies. 10-piece linear splines in $t-1$ income and in deviation of the current income from $t-1$ income are used. Instruments as described in text.

Table 6
Analysis of Taxable Income

	Unweighted			Taxable Income Weighted		
	Base	No change itemiz.	Censoring control	Base	No change itemiz.	Censoring control
$\Delta\ln(\tau)$	.416	.351	.392	.428	.584	.383
	(.127)**	(.131)**	(.124)**	(.224)	(.232)*	(.223)
N	43529	36906	43529	43529	36906	43529
			Married Individuals			
$\Delta\ln(\tau)$	.296	.249	.273	.377	.528	.330
	(.131)*	(.137)	(.130)*	(.248)	(.252)*	(.247)
N	27124	22506	27124	27124	22506	27124
			Single Individuals			
$\Delta\ln(\tau)$	.486	.333	.422	.676	.983	.663
	(.316)	(.334)	(.304)	(.620)	(.747)	(.603)
N	16405	14400	16405	16405	14400	16405
			Allowing for the tax base interaction and income effect			
$\Delta\ln(\tau)$	.172	-.037	-.115	.197	.169	-.026
	(.147)	(.156)	(.130)	(.218)	(.227)	(.205)
$\Delta\gamma\ln(\tau)$	1.138	2.166	2.607	.831	1.486	1.653
	(.294)**	(.352)**	(.367)**	(.425)	(.438)**	(.451)**
$\Delta\ln(X)$	.029	-.031	.031	.091	.101	.123
	(.100)	(.135)	(.118)	(.081)	(.086)	(.076)
N	43486	36873	43486	43486	36873	43486
			Married Individuals			
$\Delta\ln(\tau)$	.062	-.130	-.157	.123	.093	-.078
	(.129)	(.132)	(.117)	(.235)	(.236)	(.223)
$\Delta\gamma\ln(\tau)$	1.160	1.888	2.222	1.063	1.688	1.792
	(.294)**	(.362)**	(.368)**	(.474)*	(.465)**	(.497)**
$\Delta\ln(X)$	.099	.071	.118	.086	.092	.113
	(.074)	(.074)	(.071)	(.091)	(.091)	(.086)
N	27095	22484	27095	27095	22484	27095
			Single Individuals			
$\Delta\ln(\tau)$	.327	.156	.0002	.584	.633	.259
	(.409)	(.556)	(.424)	(.599)	(.718)	(.544)
$\Delta\gamma\ln(\tau)$	.718	3.497	4.421	-.416	.599	1.106
	(.850)	(1.601)*	(1.522)**	(.872)	(1.298)	(1.088)
$\Delta\ln(X)$	-.081	-.325	-.245	.136	.188	.173
	(.177)	(.522)	(.344)	(.150)	(.234)	(.138)
N	16391	14389	16391	16391	14389	16391

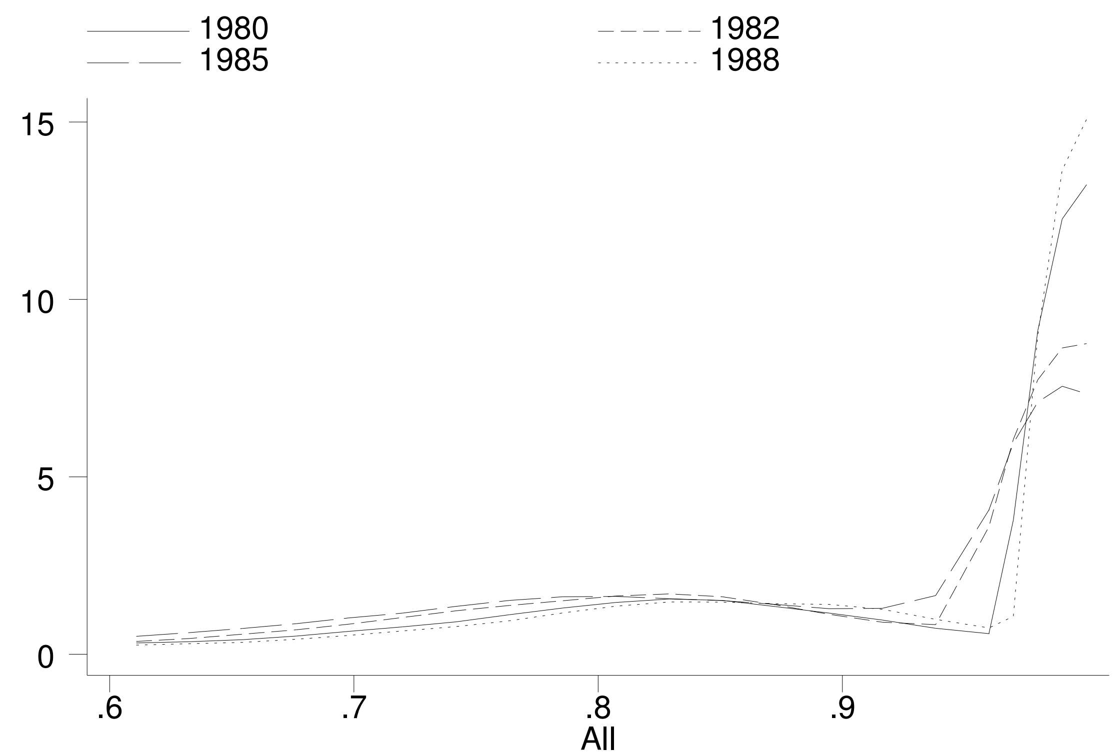
All regressions include marital status (where applicable), as well as the full set of year dummies. 10-piece linear splines in $t-1$ taxable income and in deviation of the current taxable income from $t-1$ taxable income are used. Instruments as described in text.

Fig. 1. Distribution of the Actual and Predicted Tax Bases in 1985 and 1988



Notes: Tax base is represented on the horizontal axis. The tax base varies between 0 and 1, as defined in text, the graphs are however truncated at 0.5 because few observations have values smaller than 0.5. The vertical axis represents the estimated density value. The probability distribution functions were estimated using kernel density estimator with the Epanechnikov kernel using Stata 7 default "optimal" setting of bandwidth (procedure *kdensity*).

Fig. 2. Distribution of the Average Tax Base in 1980, 1982, 1985 and 1988



Notes: See notes corresponding to Figure 1.