Capital Gains Taxes and Realizations: Evidence from a Long Panel of State-Level Data

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We estimate how capital gains realizations respond to marginal tax rates on capital gains using a panel of aggregate data for U.S. states for the years 1957 through 2007. In specifications controlling for state fixed effects and year fixed effects, where identification comes from difference-in-differences variation in effective state marginal tax rates, our point estimate of the elasticity of capital gains realizations with respect to the marginal tax rate is -0.6 with a standard error of 0.2. This point estimate suggests a significant and policy-relevant responsiveness of capital gains realizations to incentives, implying that the revenue gain from a capital gains tax increase would be in the ballpark of 60 percent smaller than it would have been in the absence of the behavioral response, and is based on a relatively more convincing identification strategy than has been used in the previous literature. When we remove state and / or year fixed effects, relying on cross-state variation in tax rates and / or federal time-series variation tax rates for identification, our estimates of the elasticity of capital gains to the marginal tax rate are larger in absolute value, but also potentially subject to greater concerns about omitted variable bias.

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1. INTRODUCTION

A critical issue in the evaluation of tax policy towards capital gains is the extent to which investors' decisions about realizing capital gains respond to the tax rate. Investors can respond to capital gains taxes in a variety of ways. They can reduce the amount they invest in assets that will generate capital gains either by reducing total savings or shifting their portfolios toward other assets. Given that capital gains are only taxed upon realization, once investors own assets that have appreciated in value, they have an incentive to delay realizing their capital gains so as to minimize their tax burdens. Overall, these behavioral effects of capital gains taxes can distort investment and portfolio decisions and reduce economic efficiency.

While numerous studies from the 1980s and 1990s examined the effects of capital gains taxes on realization choices of investors, somewhat surprisingly, with the notable exception of work by Dowd, McClelland, and Muthitacharoen (2012), relatively few recent papers have examined more recent data on capital gains taxes and realizations. Prior estimates of the responsiveness of capital gains realizations to tax rates have relied largely on cross-sectional variation in top state tax rates, or time-series variation in federal tax rates, for identification, either of which may plausibly be correlated with unobserved influences on capital gains, leading to biased estimates. A fresh examination of the relationship between capital gains taxes and realizations is especially timely since the current U.S. income tax system is in a perilous position. Despite the recent legislation that resolved the sunsets of tax rates enacted in 2001 and 2003, increasing concerns about the Federal government's budget deficit and widespread dissatisfaction with the income tax have led to calls for fundamental tax reform.

In this paper, we present new evidence on the effects of capital gains taxes on capital gains realizations, building on the data and methodology of Bogart and Gentry (1995), which examined state-level data on capital gains realizations from 1979 to 1990. Bogart and Gentry's primary specification includes year fixed effects to control for macroeconomic and financial market conditions and transitory responses to Federal tax policy and uses the top combined federal and state marginal tax rate on capital gains as its key explanatory variable, together implying that most of the identification comes from cross-state variation in top state tax rates. It yields an estimated elasticity of capital gains realizations with respect to the marginal tax rate of -0.63 with a standard error of 0.19, suggesting that capital gains are quite responsive to tax rates. However, when Bogart and Gentry add state fixed effects to control for unobservable time-invariant differences across states, the estimated elasticity falls to -0.38 with a standard error of 0.2, implying a confidence interval that includes an elasticity of zero. To our knowledge, that estimate is the only one in the literature applying a difference-in-differences strategy exploiting the fact that tax rates changed in different ways over time in different states, a source of identification that is especially likely to be exogenous. However, the estimates cited above probably understate the degree of uncertainty considerably, for reasons later pointed out by Bertrand, Duflo and Mullainathan (2004).[1] To address this issue of uncertainty in the estimates, we need data with considerably more and larger independent policy quasi-experiments to estimate the tax elasticity of capital gains with any confidence.

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[1] In this kind of regression analysis, errors are likely to be correlated across time within each state, and if the policy treatment is also serially correlated over time (which state capital gains tax rates clearly are), that can lead to serious downward bias in the standard errors (a point we corroborate empirically later in the paper). The problem can be solved by clustering the standard errors, which is now standard, but was not at the time Bogart and Gentry wrote their paper. Many of the most influential prior papers on the tax elasticity of capital gains likely suffer from this problem, or from another related problem pointed out by Moulton (1990), which implies that standard errors will be biased downwards substantially when variables that vary only at an aggregate level (such as the top state tax rate) are used in regressions with individual level data, a problem that can also be fixed by clustering. This problem applies in the influential Burman and Randolph (1994) study discussed below, among others.

One suggested solution to the biased standard errors caused by the Moulton problem when the exogenous identifying variation in the main explanatory variable of interest differs across states, but is fairly uniform within states among the types of people who might respond (which may be the case with state capital gains tax rates given the concentration of capital gains realizations at the top of the income distribution) would be to collapse the data into state level means. Thus, aggregate state level data may be no worse and even in some ways better than individual level data given our purposes, especially given that aggregate state level data allows us to follow data on similar people over long periods of time and greatly reduces noise arising in small samples of individual data when examining a high-variance variable such as capital gains realizations.

To address these challenges, we extend the state-level panel data back to 1957 and forward to 2007, which more than quadruples the data used by Bogart and Gentry. In addition, we construct more precise but still plausibly exogenous tax rate measures. We exploit the growing importance of state tax policy relative to federal tax policy. Over time, the changes in effective state marginal tax rates have differed across states for several reasons. First, prior to 1987 many states followed the federal exclusion of 50 or 60 percent of long-term capital gains from taxable income (depending on the year); when the Tax Reform Act of 1986 eliminated this exclusion, most states followed suit, which magnified differences across states in marginal income tax rates. Second, in contrast, most states have not followed the federal government's 1991 reduction in tax rates on capital gains relative to tax rates on ordinary income. Third, over the long run, inflationary bracket creep and policy changes greatly increased state marginal income tax rates on high-income people in many states. Fourth, over the long run, federal marginal tax rates on ordinary income declined considerably at high income levels. This reduction has reduced the extent to which the deductibility of state-level income taxes mitigates the effective variation in tax rates across states. Fifth, as the federal Alternative Minimum Tax (AMT) has grown in importance, more individuals with capital gains are losing their ability to deduct their state tax liability against their federal taxable income altogether, which raises effective state marginal tax rates even further. The impacts of these changes have been heterogeneous across states, for example because several states, such as Texas and Washington, do not have state income taxes, and thus have been unaffected.

In econometric specifications that control for unobservable time-invariant influences on capital gains that differ across states, and for any influences in capital gains that are changing in the same way over time across all states, along with a reasonable set of control variables, we estimate a substantial elasticity of capital gains realizations with respect to capital gains tax rates:

our benchmark specification with state and year fixed effects yields an elasticity of -0.62 with a robust clustered standard error of 0.22. A difference-in-differences strategy that collapses the data into means over two long time periods 1957-1979 and 1990-2007, and then estimates whether the states that had larger increases in capital gains tax rates over that very long span of time also had larger declines in capital gains realizations, yields an elasticity estimate of -0.73 with a standard error of 0.25. Estimates from specifications without state fixed effects, thus adding average differences across states over time to the identifying variation, but also increasing the risk of omitted variable bias, yield point estimates of the elasticity that are larger in absolute value, in the range of -0.8 to -1.1, with robust clustered standard errors from 0.26 to 0.28. Estimates from specifications without time fixed effects, thus adding time-series variation in federal tax rates to the identifying variation, produce elasticity estimates that are close to -1 with standard errors less than 0.1, but those particular estimates deserve considerable skepticism because of the difficulty of disentangling the effects of tax rates from all the measured (but possibly misspecified) and unmeasured influences on capital gains that are changing dramatically over time for the nation as a whole, such as developments in financial markets.

The paper proceeds as follows. Section 2 provides an overview of relevant tax law and the predicted effects of a change in capital gains taxes on realizations decisions. Section 3 reviews the relevant empirical literature on the elasticity of capital gains realizations to tax rates. Section 4 discusses our data and empirical methodology. Section 5 presents our results and section 6 offers concluding comments.

2. TAX RULES FOR CAPITAL GAINS AND BEHAVIORAL RESPONSES

A crucial feature for understanding how individuals respond to the taxation of capital gains is that the income is taxed upon realization instead of as the gain accrues. Since individuals control when they sell assets, realization-based tax rules provide discretion over when income will be recognized for tax purposes. Realization-based taxation creates a number of incentives for investors. If tax rates are constant over time, then investors may want to delay realizing capital gains in order to defer their tax liability; this incentive to delay the recognition of gains is commonly referred to as the "lock-in effect." The lock-in effect is strengthened by U.S. tax rules that allow for a step-up in basis at death for assets that are bequeath to heirs.[2] The importance of the lock-in effect increases with the marginal tax rate on capital gains so that higher tax rates on capital gains may reduce the amount of capital gains realized. For assets that have lost value, this incentive works in the opposite direction in that taxpayers may want to accelerate the recognition of a loss by selling the asset.

When tax rate changes are predictable, realization-based taxation creates incentives for taxpayers to time their realizations so that gains are recognized when tax rates are relatively low and losses are recognized when tax rates are relatively high. Due to these timing incentives, capital gains realizations may respond more to temporary differences in tax rates than to permanent differences in tax rates. With a progressive tax schedule, these intertemporal incentives can occur at the individual-level even when tax policy stays constant over time. These differential incentives have led prior studies, as discussed below, to estimate separate permanent and transitory elasticities of capital gains realizations.

Taxable capital gains are associated with the returns on a wide variety of assets. Ownership of publicly-traded corporate stock is a canonical example of a capital gains generating asset. However, capital gains can also arise from the sale or exchange of assets used in a business, a variety of financial transactions, and investments in partnerships or S corporations. Owner-occupied housing can generate capital gains, but special tax rules have

[2] The step-up in basis at death means that the decedent does not recognize a capital gain on a final tax return and the recipient of the bequest calculates future capital gains based on the value of the asset when the bequest is received.

typically limited the amount of such gains that are taxable; for example, current tax law exempts from taxation the first $250,000 ($500,000 for returns of married households filing jointly) of capital gains on a primary residence.

Capital gains are classified as short-term (defined as assets held for less than one year in most years) or long-term. Short-term capital gains are typically taxed at the same tax rates as ordinary income. Long-term capital gains face preferential tax rates (relative to ordinary income) in most years of our data. The tax law permits losses to offset gains. Burman, Auerbach, and Siegel (1997) discuss the incentives created by the various rules for offsetting losses and gains. If a taxpayer realizes a net capital loss in a year, up to $3,000 of the net loss can offset ordinary income. Capital losses in excess of this limit can be carried forward to offset future capital gains (or ordinary income up to the annual limit).

3. PRIOR ESTIMATES OF THE ELASTICITY OF CAPITAL GAINS REALIZATIONS

The debate about the relationship between capital gains tax rates and tax revenues focuses on the elasticity of realizations with respect to the tax rate as a measure of whether a reduction in the tax rate will increase revenues. As an approximation, an elasticity of greater than one in absolute value suggests that tax rates and tax revenues will be negatively related, and the elasticity approximately represents the fraction of government revenue that would otherwise be raised due to an increase in the capital gains tax rate that is lost due to the behavioral response.[3] This elasticity captures the revenue effects of taxing capital gains, but a change in the capital gains tax rate can also have broader tax consequences. If preferential tax rates for capital gains induce taxpayers to engage in tax shifting strategies that affect other categories of income, an increase in tax revenues from taxing capital gains may be offset by decreases in tax

[3] The benchmark of an elasticity of one as determining the sign of the revenue consequences, as well as the more general relation to the revenue loss from the behavioral response stated in the text, assumes a proportional tax system; with progressive tax rates, these benchmarks are approximations.

revenues from taxing other forms of income. In contrast, if the level of overall investment responds to the capital gains tax rate, then the behavioral adjustment may increase other forms of income taxation associated with the investments. We abstract from these complicated issues in reviewing the previous work on the relationship between capital gains tax rates and realizations.

Prior empirical work on capital gains realizations and tax rates have studied a range of types of data, including cross-sectional data on individuals, aggregate time series data, longitudinal data on individuals, and panel data on state-level aggregate data. Pioneering work by Feldstein, Slemrod and Yitzhaki (1980) studied a cross-section of individuals and found a strong negative relationship between capital gains tax rates and realizations. Cross-sectional analysis relying on variation in federal marginal tax rates suffers from a number of potential sources of bias. First, in a single-year cross section, it is impossible to distinguish the long-run response of realizations to persistent differences in tax rates from re-timing of realizations in response to temporary differences between current and expected future tax rates. Second, as Feenberg (1987) has emphasized, because federal income tax rates are a nonlinear function of income, if the functional form of the effect of income on the dependent variable is mis-specified in the regression equation, the coefficient on the marginal tax rate may reflect a combination of the effects of income and tax rates.

Aggregate time series analysis provides an alternative strategy that captures the dynamics of capital gains tax policy. Such analysis has generated a wide range of estimates for the capital gains realizations elasticity, but the estimates typically range between -0.5 to -0.9 (see, e.g., the review in Eichner and Sinai, 2000). One striking feature of the time series data is the timing response associated with the watershed Tax Reform Act of 1986 (TRA86), which included a phased increase in capital gains tax rates. Since taxpayers easily anticipated this increase, TRA86 led to a substantial acceleration of capital gains ahead of the higher tax rates. Eichner and Sinai (2000) build on prior time series analysis by including data through 1997, which allows them to incorporate TRA86 and examine whether capital gains realization behavior changed after TRA86. Not surprisingly, the inclusion of 1986 influences the estimated elasticity: including 1986 in the analysis generates an estimated elasticity of -0.81, but excluding it reduces the estimated elasticity to -0.45. In a model that attempts to include the effects of anticipated changes in tax rates, they estimate a long-run elasticity of -0.74. One advantage of time series analysis is the ability to include legislated tax changes over many years. However, the disadvantages include the need to compress a complex tax system into a single tax measure and the possibility that other time varying unobservable factors influence the estimates.

Panel data provides an important opportunity to combine micro-level modeling of realizations with time series changes in tax incentives. Numerous studies have used panel data on individual taxpayers. Early studies include Auten and Clotfelter (1982) and Auten, Burman and Randolph (1989). Similar to the time series studies, these early studies produced a wide range of estimated elasticities. As expected, the elasticities with respect to transitory differences between current and expected future tax rates tended to be larger than the long-run elasticities. In a widely-cited study, Burman and Randolph deal with a number of econometric complications associated with estimating transitory and permanent components of the capital gains realizations elasticity. Using data from 1979-1983, they estimate a quite low permanent elasticity of -0.18 but a substantial transitory elasticity of -6.42. However, these estimates are quite imprecise with the permanent elasticity not being statistically different from either zero or one.

A common concern with such panel studies is that they often use data with a relatively short time span. Dowd, McClelland and Muthitacharoen (2012, DMM hereafter) apply similar estimation techniques to Burman and Randolph to data from 1999-2008, a longer time span that includes the tax reforms of 2001 and 2003. Using these more recent data, they estimate a permanent elasticity of -0.72 with a standard error of 0.11, which is considerably larger (in absolute value) and more precisely estimated than the estimates of Burman and Randolph. They estimate a transitory elasticity of -1.19 with a standard error of 0.26. These estimates focus on capital gains associated with personal assets, which excluded capital gains from pass-through entities and mutual funds. When they expand the analysis to include other types of assets, they estimate a similar permanent elasticity for the sale of businesses or business assets, but a larger transitory elasticity of -2.07. They estimate a much lower elasticity for distributions from mutual funds suggesting that fund managers trade for reasons unrelated to the tax consequences of their investors.[4]

Studies using panel micro data to study the effects of tax rates on realizations have typically controlled for year fixed effects, but so far none has controlled for individual fixed effects, state fixed effects, or income-class fixed effects. So they are all essentially pooled cross-sectional analyses, and rely heavily on cross-sectional variation in federal and especially state tax rates for identification, making them vulnerable to omitted bias arising from unmeasured time-invariant differences across individuals, income classes, and states.

State-level panel data combines some of the advantages of time series analysis and analysis of individual-level panel data. As discussed in the introduction, Bogart and Gentry (1995) estimate the capital gains tax elasticity using state-level panel data from 1979 to 1990. These data span TRA86 as well as a number of state tax reforms. We extend these data to 1957 to 2007, which covers numerous changes in federal tax policy as well as significant and heterogeneous changes in effective state marginal tax rates. Thus, our analysis shares the advantage of aggregate time series analysis of using a long time span of tax reforms. Like prior

[4] Alternatively, even if fund managers are sensitive to federal tax consequences of capital gains realizations, they may not be sensitive to the sorts of variation in tax rates that provide econometric identification in these regressions (e.g., variation in state tax rates) since investors in the funds vary in their particular tax situations.

panel micro-data studies, state-level data allows us to exploit plausibly exogenous cross-state variation in effective state marginal tax rates. Moreover, in contrast to previous studies, the extensive nature of our data enables us to estimate, with a reasonable degree of statistical confidence, specifications where the identification arises solely from difference-in-differences variation in effective marginal tax rates across states, which is especially likely to be exogenous.

4. EMPIRICAL METHODOLOGY AND DATA

4.1 Econometric specification

Our primary econometric specification is equation (1) below:

$$(1)\qquad \log(\textit{capital gain}_{it}) = \alpha_i + \alpha_t + \beta_1(MTR_{it} - MTR_{it-1}) + \beta_2 MTR_{it} + \beta_3(MTR_{it+1} - MTR_{it}) + \mathbf{X}_{it}'\boldsymbol{\gamma} + \varepsilon_{it}.$$

In the equation, *i* indexes states and *t* indexes years. The dependent variable is the natural logarithm of the mean value per tax return of realized capital gains among federal income tax return filers in state *i* and year *t*, measured in constant year 2011 dollars. The α_i is a state fixed effect to control for any time-invariant differences across states, estimated by inclusion of a set of state dummies. The α_t is a year fixed effect to control for any influences on capital gains that are changing in the same way over time in all states, estimated by inclusion of a set of year dummies. We also report estimates from specifications without the state fixed effects or the year fixed effects or both, to show how the key sources of identifying variation (difference-in-differences in the base specification, cross-sectional comparisons when state fixed effects are removed, and time-series variation in federal tax rates when time fixed effects are removed) affect the estimates.

The primary explanatory variable of interest is MTR_{it} the combined federal and state marginal income tax rate on long-term capital gains, expressed in decimal terms (i.e., a 15% tax rate is 0.15). To better distinguish responses to long-run variation in tax rates from responses to transitory differences between current and expected future tax rates, for example due to people anticipating legislated changes in tax rates a year in advance of their implementation, and to allow for gradual learning about and adjustment to changes in tax law, we include as control variables lag and lead changes in the tax rate, ($MTR_{it} - MTR_{it-1}$) and (MTR_{it+1}-MTR_{it}). When specified this way, β_2 is our estimate of the semi-elasticity, or percent change in capital gains associated with a persistent long-run one percentage point increase in the capital gains tax rate. If higher tax rates deter people from realizing gains, β_2 should be negative. The long-run elasticity of capital gains realizations with respect to the marginal tax rate (that is, the percent change in capital gains realizations associated with a one *percent* increase in the tax rate, i.e. from 20% to 20.2%) will then be β_2 times the marginal tax rate (expressed in decimal terms). Throughout the paper we report elasticities computed at the mean combined federal-state marginal capital gains tax rate on long-term capital gains in the sample, which is 0.227 (that is, 22.7%).

The coefficient on next year's increase in marginal tax rate, β_3, represents the percentage increase in capital gains realizations this year caused by a one percentage point increase in next year's tax rate. If people time their realizations to reduce their tax liabilities, we would expect β_3 to be positive, as people accelerate gains realizations if they anticipate a future tax increase and delay gains realizations to future years when they anticipate future tax reductions.

The coefficient on the lagged change in marginal tax rate, β_1, represents the percent change in capital gains realizations associated with the tax rate being one percentage point higher this year compared to last year. If people gradually learn about or adjust to changes in tax rates, so that there is some delay in the response, we would expect the coefficient β_1 to be positive. That would mean that the response to a tax change in the first year it applies would be smaller in absolute value (a positive β_1 plus a negative β_2) than it is in subsequent years when the effect will just be β_2. On the other hand, if people shift realizations across adjacent years in response to anticipated future changes in tax rates, β_1 could be negative, because if people had anticipated an increase in the tax rate this year, they might have accelerated gains realizations into the previous year at the expense of realizations in year *t*. If there is heterogeneity in the degree to which people anticipate changes in tax law, the speed with which they adjust to such changes, and the extent to which they time their realizations across adjacent years, then β_1 will reflect some combination of the positive coefficients of lagged adjusters and the negative effects of re-timers. In any event, we expect that, consistent with previous literature (e.g., a study of the effects of taxes on charitable giving by Bakija and Heim 2011), when we control for time fixed effects, lagged and future tax changes will not matter much. Controlling for time fixed effects absorbs essentially all of the time-series variation in federal tax rates, effectively controlling for the big obvious signals to time realizations such as TRA86, except to the extent that those reforms have disparate effects across similar people in different states. The remaining intertemporal variation in tax rates in our aggregate state panel data with representative tax rates are likely to be rather subtle and potentially unexpected so that people are less likely to respond to them in advance.

Rounding out the econometric specification, $\mathbf{X}_{it}'\boldsymbol{\gamma}$ is a vector of control variables which we will discuss later, multiplied by a vector of $\boldsymbol{\gamma}$ coefficients, and ε_{it} is an error term. We compute and report White-consistent robust standard errors with clustering by state, which provide consistent estimates of the standard errors even if there are arbitrary forms of heteroskedasticity in the variance in errors across states, or arbitrary forms of correlation over time in the errors within each state.

4.2 Data on Marginal Tax Rates

As indicated above, the main explanatory variable of interest is the combined federal and state marginal tax rate on long-term capital gains, MTR_{it}. Conceptually, given that we are using cell-mean data where each cell is a state-year combination, we would like to compute a representative marginal tax rate that applies to the average dollar of capital gains in a particular state and year. While we would like MTR_{it} to be as accurate as possible to reduce classical measurement error in the explanatory variable that would tend to bias the estimated coefficient towards zero, we are also concerned about endogeneity.

Aside from the obvious endogeneity problem that a change in capital gains realizations can mechanically cause marginal tax rates to change, by pushing the taxpayer into a different tax bracket, we are also concerned about potential biases arising when actual marginal tax rates change in different ways over time in different states due to changing characteristics of their taxpayers. Relative changes over time in taxpayer characteristics across states may be having an independent effect on capital gains realizations, or omitted variables could be driving both capital gains realizations and the changing taxpayer characteristics that feed into changing tax rates. For example, if some omitted factor is causing incomes and wealth to grow disproportionately quickly at the top of the income distribution in a particular state, and the state's income tax has a progressive tax rate structure, that will tend to push up marginal tax rates in the state, and will simultaneously tend to cause capital gains realizations to go up – when the rich get richer, their greater wealth causes them to have more capital gains to realize. In that case, if we do not control perfectly for the other factors that are jointly driving changes in tax rates and changes in realizations, such as state-specific changes in wealth and income inequality, or if we do not specify the functional forms of their effects correctly, the estimated coefficient on the tax rate will be biased (in the story above, probably towards a positive number, as higher inequality causes both higher tax rates and higher realizations).

In order to address concerns such as these, Bogart and Gentry use the combined maximum federal and state marginal tax rate on capital gains in each state as the key explanatory variable of interest, which cannot be mechanically caused by changes in income or other taxpayer characteristics within the state, and therefore is likely to be exogenous. On the other hand, using the maximum combined federal and state rate is likely to produce measurement error bias, which would be towards zero if the measurement error is classical. In our setting, the measurement error would be particularly severe, because our data extends back to the late 1950s, when the top statutory federal marginal income tax rate was 91 percent, but the very high tax rates at the top applied to vanishingly small numbers of taxpayers. For example, data reported in Baneman and Nunns (2012) suggests that in 1958, despite the 91 percent top statutory federal income tax rate that applied at the time, 99.9 percent of federal income tax filers faced a statutory marginal tax rate of 62 percent or below, and 99 percent of tax filers faced statutory marginal tax rates of *36 percent* or below. Gradually over subsequent decades, though, more taxpayers started to face marginal tax rates close to the top statutory rate, as top statutory rates and the thresholds of taxable income to reach them were reduced, and inflation pushed taxable incomes up into higher tax brackets because they were not indexed for inflation until the 1980s. Despite most of our identifying variation coming from differences in the time path of state taxes, using the top tax rate would still lead to substantial measurement error that varies in different ways over time in different states, for example because overstating the federal tax rate understates the value of state taxes being deductible from federal taxable income.

To construct a representative tax rate that more accurately reflects the incentives faced by taxpayers in each state and year, while still keeping the tax rates plausibly exogenous, we take an approach that we briefly outline here and describe in more detail in the data appendix. We select a random sample of actual tax returns from the 1985 IRS public use file, and replicate the same set of returns for all 50 states and DC and across all 51 years. We adjust all dollar-valued items on each return for differences in the average price level between 1985 and each previous and subsequent year, also adjust each dollar-valued item to allow for a steady long-term linear trend growth in real income (reflecting the actual U.S. trend in real per capita personal income from 1957 through 2011), and we replace sales tax deductions and property tax deductions with imputed state-specific values. We then use the tax calculator program described in Bakija (2009) to calculate marginal tax rates on that identical sample of taxpayers for all states and all years. Next, we compute a weighted average of these tax rates within each state year cell, where the time-and-state-invariant weights represent the inverse of the sampling probability for each return,[5] times the share of all capital gains realizations that accrued in each taxpayer's slice of the income distribution on average over the full 1957-2010 period for the U.S. as a whole. Thus, we calculate tax rates holding all taxpayer characteristics constant across states and years, except we allow dollar amounts of items on the tax return to change in a uniform way over time for everyone due to inflation and a steady trend growth in real income, and we allow for variation in income tax rates caused by state tax policy itself (such as state property and sales taxes).

Our procedure should effectively remove all endogenous variation in tax rates that would otherwise mechanically arise due to changes in taxpayer characteristics that might have an independent effect on gains realizations or that might be driven by other factors that also affect capital gains. When we control for year fixed effects, it effectively controls for all of the variation in federal tax rates contained in our MTR_{it} variable, leaving only state taxes and their interactions with federal taxes as independent identifying variation. While we could use this as an instrumental variable for a measure of the tax rate that more closely reflects marginal tax rates applying in each state and each year taking into account variation across states and time in taxpayer characteristics, we simply use it directly in ordinary least squares as a proxy variable.

[5] IRS Statistics of Income cross-sectional data sets of individual income tax returns involve a stratified random sampling scheme that heavily over-samples high-income taxpayers.

4.3 Description of Variables Included in Our Regressions

Descriptive statistics for the variables used in our regression analyses are reported in Table 1. Details on data construction and sources are provided in the data appendix. The mean marginal tax rate on capital gains is 0.227, and it ranges from 0.15 to 0.35. We represent the portion of the variation in this tax rate that is due to state income taxes and their interaction with the federal tax by calculating the difference between the combined federal and state marginal tax rate, and what the marginal tax rate would be if state tax liability were set to zero, which we call *state MTR*.[6] The *state MTR* variable incorporates both the direct effect of the state income tax and variation caused by interactions between the state and federal tax systems.[7] Mean *state MTR* is only 0.024 (or 2.4 percent) but as we will see below, that low number reflects a long historical period where effective state marginal tax rates were almost uniformly low, combined with a later period where they were quite high in some states and remained low in others, which creates a quasi-experimental treatment and control group situation where the treatment changed in different ways over time in different states for reasons that were plausibly exogenous. The minimum *state MTR* is approximately zero[8] and the maximum is 0.085 or 8.5 percent.

[6] Descriptive statistics on the *state MTR* variable are provided purely for illustrative purposes since all regression specifications include the full combined federal and state marginal tax rate *MTR*. Given how the *MTR* variable is constructed, specifications that include year fixed effects yield identical regression coefficient estimates with either the *MTR* or *State MTR* variable.

[7] Deductibility of state taxes from federal taxable income is a simple example of such an interaction. The AMT creates more complicated interactions: if changing from a positive state income tax liability to zero state tax liability shifts a taxpayer from paying the federal AMT to not paying it, the change appears as part of the taxpayer's federal marginal tax rate, but is counted as part of $state\ MTR_{it}$ because it would not have happened without the state income tax, and because it contributes identifying variation even when we control for year fixed effects.

[8] A state income tax can reduce the combined federal and state marginal tax rate, for example if the state does not tax capital gains but the deduction for state income taxes pushes the taxpayer into a lower federal tax bracket. In that case *state MTR* will be negative.

Table 1 -- Variables and descriptive statistics: panel of aggregate state level data 1957 - 2007

Variable	Description	Mean	Std. Dev.	Min	Max
MTR	Combined federal-state marginal tax rate on long-term capital gains.	0.227	0.048	0.151	0.352
state MTR	Difference between MTR and what MTR would be if state income tax were zero.	0.024	0.021	-0.003	0.085
capital gain	Net capital gain less loss in AGI (plus capital gain excluded from AGI before 1987), average per return	2,233	1,620	212	13,464
dividend	Dividend income, average per return	1,012	486	103	5,249
interest	Taxable interest income, average per return	1,700	918	135	4,999
other income	Adjusted gross income less *capital gain*, *dividend*, and *interest*, average per return	38,253	8,689	18,921	75,446
top5 log income	Share of people in state in top 5% of national distribution of family income (excluding capital gains), times log of national mean income (excluding capital gains) for top 5% in that year	0.51	0.23	0.13	1.51
home price	Median price of owner-occupied housing in state	117,915	63,246	39,637	694,877
homeowner	Share of households in state owning their own home	0.66	0.07	0.28	0.78
college	College graduates as a share of state residents aged 25 or above	0.17	0.08	0.04	0.48
elderly	Share of people in state who are aged 65 or above	0.11	0.02	0.02	0.18
unemployment	State unemployment rate	0.06	0.02	0.02	0.18

All dollar amounts are in constant year 2011 dollars, adjusted for inflation using the NIPA personal consumption expenditures price index. Number of observations is 2,596. Each observation is a state-year cell, and all variables listed above are state- and year-specific. Includes all states and DC for all years 1957 - 2007, except for MD and DC in 1961 and 1962, and DE in 1962 (IRS did not publish the necessary data for those places in those years).

When we control for state fixed effects and year fixed effects, unbiased estimates require that there are no omitted variables that influence capital gains realizations that are changing in different ways over time in different states in ways that are correlated with differences in how tax rates change over time across states. An additional concern is that a correlation between tax rates and capital gain realizations could work through a different channel that has nothing to do with realization decisions – for example, high tax rates could induce high-income and wealthy people who tend to realize a lot of capital gains to move out of the state. There is limited evidence of migration responses among high wealth individuals across states in response to taxes, but the magnitudes of estimated effects tend to be small (see e.g., Bakija and Slemrod 2004). Aside from noting that, the best we can do is to control for the types of people living in the state. Since we are primarily trying to estimate the realization elasticity, we want to control as much as possible for factors that would independently affect one's stock of unrealized capital gains and propensity to realize them, such as wealth and non-capital gains income. Although comprehensive data on interstate variation in household net worth are generally unavailable, we have controls for various types of income within a state that we have assembled from IRS Statistics of Income publications, along with a number of proxies that should be strongly correlated with state-specific trends in wealth or propensities to realize gains. We control for dividend income per tax return, taxable interest income per return, and other income per return, where "other income" is adjusted gross income (AGI) minus capital gains, dividends, and interest in AGI. These and all other dollar-valued variables in our analysis are measured in constant 2011 dollars, and we use their natural logarithms our regression specifications.

We would ideally like to control for what is happening to incomes at the top of the income distribution in each state, especially because capital gains realizations are concentrated at the top of the distribution (taxpayers in the top 5 percent of the income distribution accounted for

82 percent of capital gains realizations on average between 1957 and 2010)[9] and because the increase in national-level income inequality may have been unequal across states. Publicly-available data on top incomes by state are sparse, because Census income data are top coded, because published IRS data on the distribution of incomes in each state are based on AGI including capital gains (which would induce serious endogeneity problems), and because IRS public use microdata files omit state of residence for taxpayers with AGI above $200,000. Given the data limitations, we construct the control variable *top 5 log income* which represents the share of people in a state that are in the top five percent of the national distribution of family income for each state and year estimated from census data, multiplied by the log of national average gross income (excluding capital gains) of tax units in the top 5 percent of the *national* income distribution in each year (expressed in constant year 2011 dollars), the latter of which is from Piketty and Saez (2012). For both components used to calculate this variable, income and rank in the income distribution are defined excluding capital gains, to avoid endogeneity.

We control for a measure of the median price of owner-occupied housing in each state and year, spliced together from a variety of sources such as decennial census data and the FHFA state-specific housing price index.[10] We would expect median home price to have a positive association with capital gains realizations, both because housing is a direct source of potentially taxable capital gains (despite a large exclusion for capital gains on a home in the federal income tax in recent years), but perhaps more importantly because it probably a strong indicator of differential trends in economic conditions and wealth across states. We control for the share of households owning their own home in each state and year, the share of state residents aged 25 or above who attended college for at least 4 years, and the share of people in each state-year cell

[9] Author's calculations based on data in Piketty and Saez (2012).

[10] Again, methods and sources for each variable are explained in the appendix.

who are aged 65 above, all derived from various U.S. Census Bureau data sources. The share of college graduates should be a good indicator of permanent income and wealth to complement our other measures of income. The fraction of households that own their own home has implications for the meaning of the median home price value, and also reflects household portfolio allocation decisions (e.g., to invest in corporate stock instead of purchasing a home, with the former more likely to produce a taxable capital gain due to the federal exclusion for capital gains on a home). We also control for the state unemployment rate to account for state-specific fluctuations in economic conditions that may proxy for changes in wealth and the stock of gains available to be realized. Data were sometimes unavailable for certain control variables in some years early in our sample, in which cases we filled in the missing years with interpolations that are described in the appendix.

Figures 1a through 1c depict how *state MTR* changes over time in each state. States are grouped by their rank in terms of the size of the increase in tax rate between 1957 and 2007. State marginal tax rates on capital gains changed in very different ways over time in different states. Many states, especially those in figure 1a, experienced significant increases, with the largest, such as that in California, being on the order of 8 percentage points. In contrast, states shown in figure 1c, such as Florida and Texas, experienced little or no change in state marginal tax rates (in the two cases mentioned, because they had no state income tax), and these states effectively serve as our control group. It is also worth noting that there were occasional sharp increases, in particular (but not limited to) when TRA86 eliminated the federal tax exclusion for 60 percent of long-term capital gains and many states followed suit, and these large discrete changes affected some states but not others. There were also some states, such as Wisconsin, where the *state MTR* declined over time.

Figure 1a – State marginal tax rates on long-term capital gains, 1957 – 2007: top 1/3rd ranked by increase

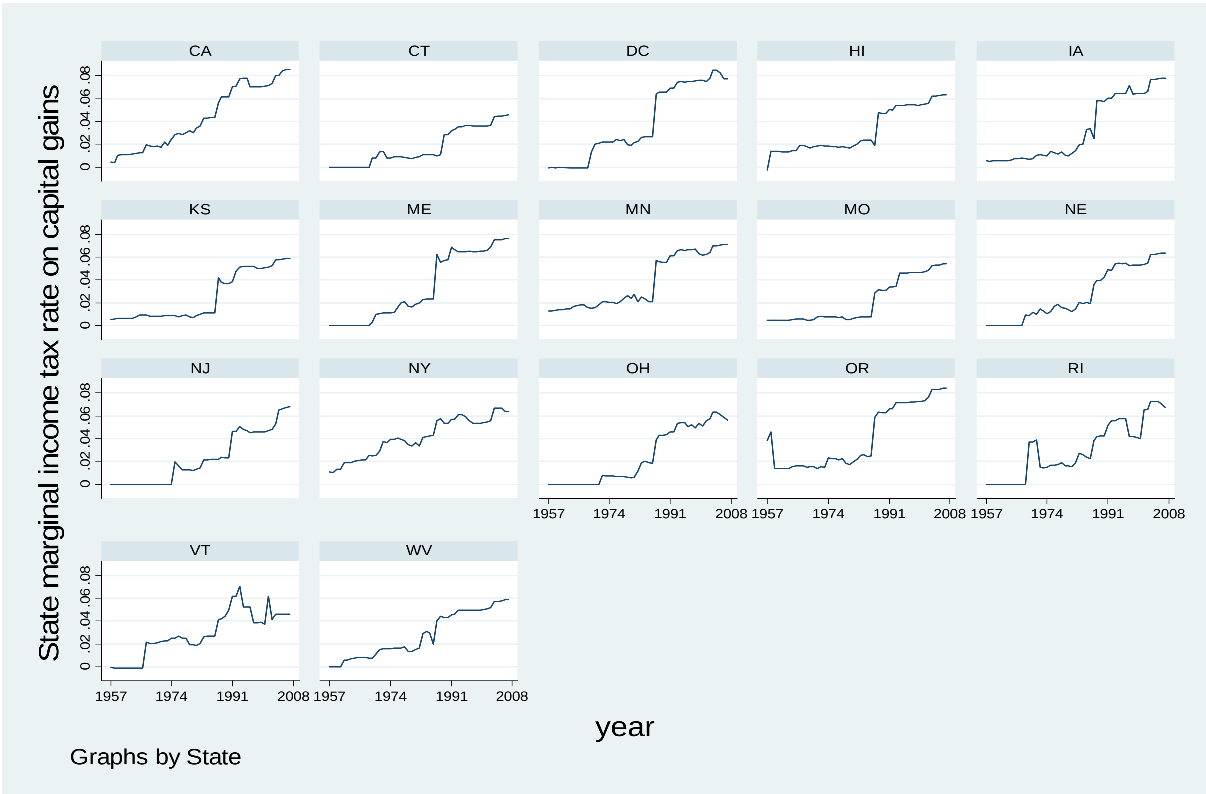


Figure 1b – State marginal tax rates on long-term capital gains, 1957 – 2007: middle 1/3rd ranked by increase

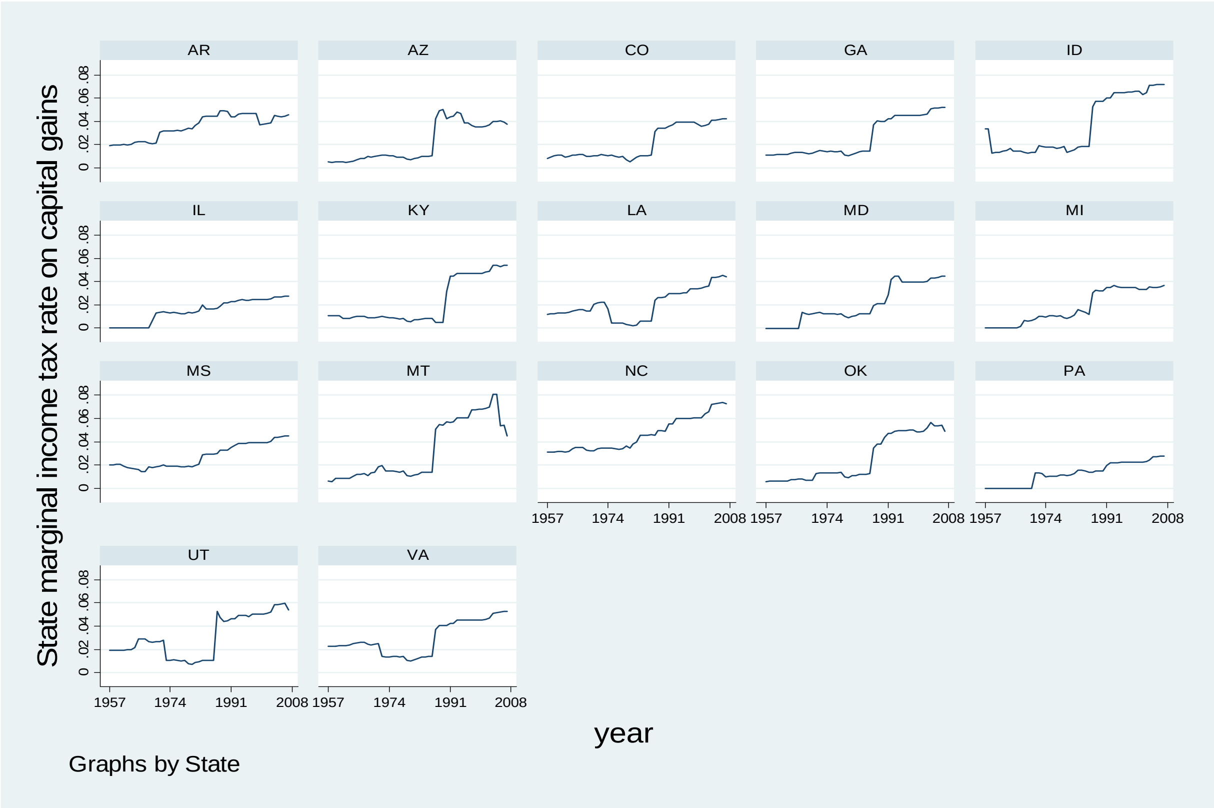


Figure 1c – State marginal tax rates on long-term capital gains, 1957 – 2007: bottom 1/3rd ranked by increase

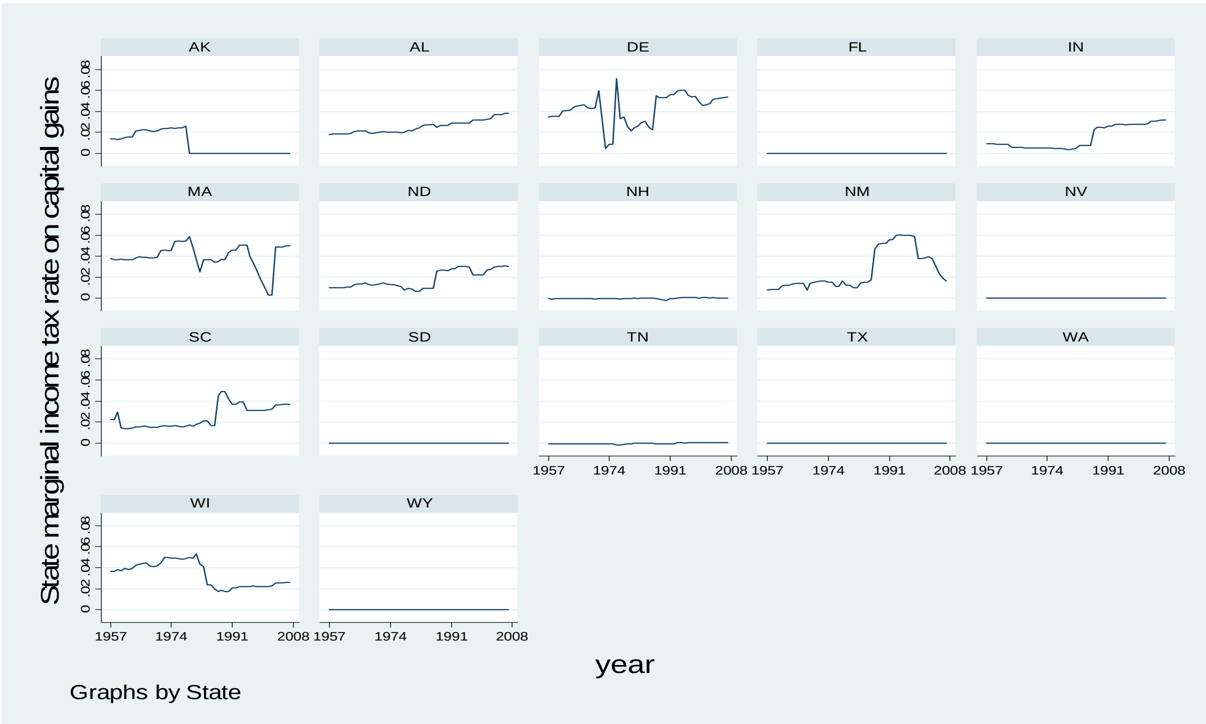
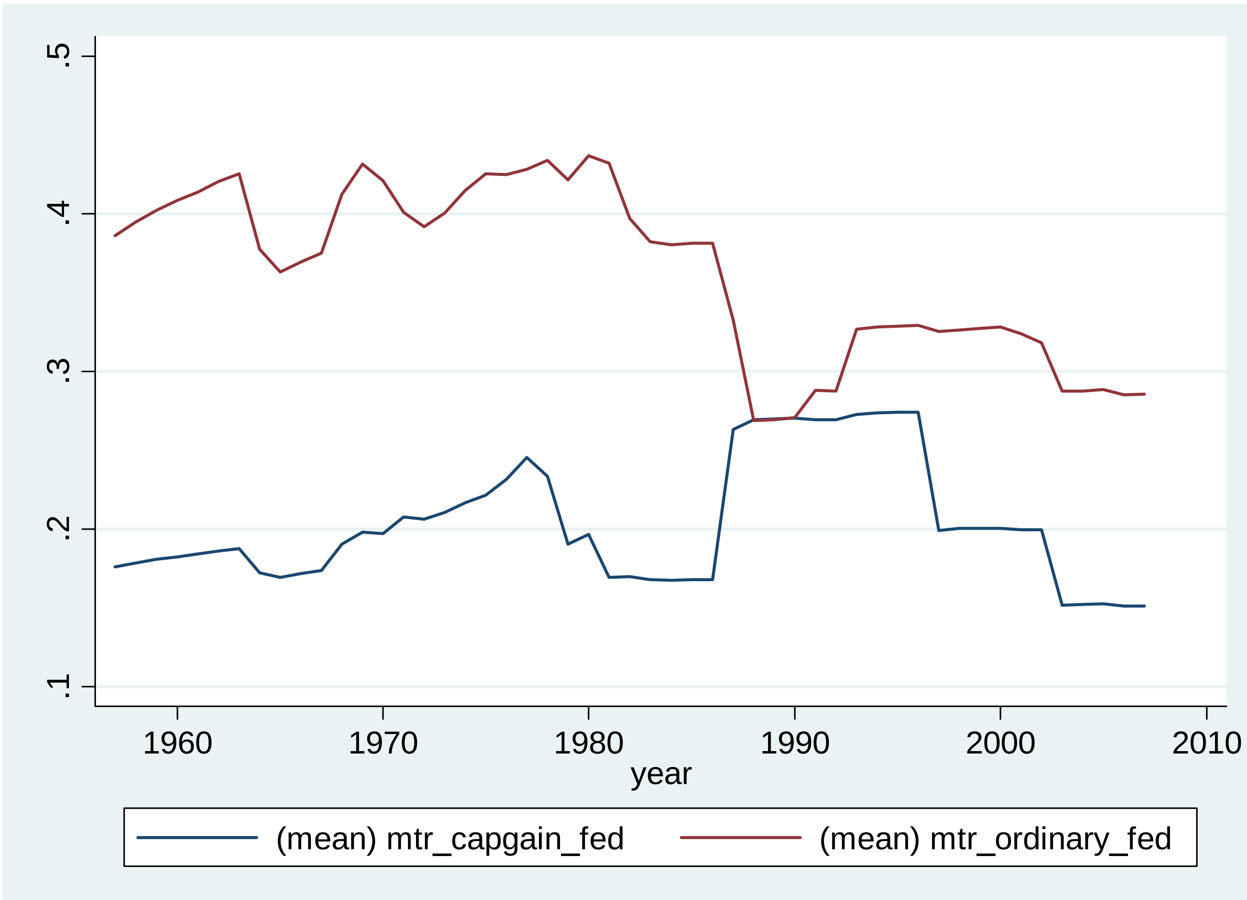


Figure 2 depicts the variation in the federal marginal tax rates on capital gains and on ordinary income over time. These are both weighted means of individual tax rates where the weights reflect the (time-invariant) national average concentration of capital gains for taxpayers across income levels during 1957-2010, as described above, and so are mostly representative of tax rates on relatively high-income people. Figure 2 shows that gain-weighted marginal tax rates on ordinary income declined substantially over time (which as noted above has important implications for cross-state variation in state tax rates due to federal deductibility), while federal capital gains tax rates were almost always substantially lower than tax rates on ordinary income, and experienced some substantial, and sometimes sharp, increases and decreases over time.

Figure 2 – Federal marginal tax rates on ordinary income and on capital gains, 1957-2007



Notes: The top line represents the marginal federal tax rate on wage and salary income received by the primary earner. The bottom line represents the marginal federal tax rate on long-term capital gains. Both are calculated setting state income tax liability to zero, and represent capital gains weighted means (using a time-invariant average capital gains realizations by income class over 1957-2010 as weights).

5. ESTIMATES

5.1 Main Specification with State and Year Fixed Effects

Column (1) of table 2 presents estimates from our main specification (equation 1). The implied elasticity of capital gains realizations with respect to the tax rate is -0.62 with a standard error of 0.22. That is highly statistically significant in its difference from zero, with a 95 percent confidence interval ranging from -0.17 to -1.07. The robust but un-clustered standard error, shown in square brackets, is just 0.09, implying a tighter 95 percent confidence interval from -0.44 to -0.80. Nonetheless, Bertrand, Duflo, and Mullainathan make a compelling case that clustering is the best approach in a setting like ours.

Coefficients on most control variables seem sensible, with *interest*, *other income*, *college*, *houseprice,* and *unemployment* all having particularly large and statistically significant effects. So for example, a 10 percentage point increase in the percentage of the state population is college-educated is associated with a 15 percent increase in capital gains realizations, and the estimated elasticity of capital gains with respect to other income (besides interest, dividends, and capital gains) is 1.18. A ten percent increase in state median home price is associated with a 4 percent increase in capital gains realizations, and a one percentage point increase in the state unemployment rate is associated with a 4.5 percent decrease in capital gains realizations.[11]

The coefficients on the lag and lead changes in capital gains tax rate display no logical pattern and in any event are small with relatively large standard errors, rendering them statistically insignificant from zero. This is not surprising given the subtlety of the tax changes identifying responses to lagged and future tax rate changes after controlling for for year fixed effects. In any event, excluding these two variables has virtually no effect on the estimated coefficient on the current capital gains tax rate, as shown in column (2) of table 2, which suggests that year fixed effects adequately control for re-timing incentives in this specification.

One concern with the econometric specification used in the first two columns of table 2 is that ordinary least squares regressions may be influenced by outliers. As an alternative to OLS

[11] Despite the statistical significance of the estimated effects of the control variables for capital gains realizations, the estimate of the elasticity of capital gains realizations with respect to the tax rate is not sensitive to the inclusion of these variables. In a specification similar to the specification reported in column (2) of table 2 but without any of the control variables (except the state and year fixed effects), the estimated coefficient on the marginal tax rate is -2.69 with a standard error of 1.83, suggesting that the control variables improve the precision of the estimated effect of the tax rate but that these control variables are not highly correlated with the marginal tax rate variable. Furthermore, dropping each control variable one at a time generates estimates of the coefficient on MTR_t and its standard error which are quite similar to those reported in table 2.

techniques, column (3) of table 2 reports the results from estimating equation (1) using a median regression, which yields estimators that are less susceptible to influential outliers. The specification includes year fixed effects. A median regression is a non-linear estimator, so that controlling for dummy variables for each state can involve an incidental parameters problem. Thus, rather than including state fixed effects, we estimate the closely-related correlated random effects model, as suggested by Wooldridge (2010, chapters 10 and 12) and Mundlak (1978). This specification adds controls for the mean value over time in each state of each explanatory variable, which is meant to account for any correlation between time-invariant omitted variables that vary across states and which may correlated with the explanatory variables.[12] As reported in column (3) of table 2, the estimated elasticity of capital gains realizations with respect to the tax rate from the median regression is -0.72, which is slightly larger (in absolute value) than the OLS estimate, with a standard error of 0.24. The similarity between the OLS and median regression estimates suggests that the OLS results are not driven by outliers.

[12] As discussed by Wooldridge, in linear models, this specification generates identical coefficient estimates to the fixed effects estimator. We estimate the standard errors using a block bootstrap method, where the blocks are states. This deals appropriately with the possibility of correlated errors within each state.

Table 2 – Effect of marginal tax rate on log capital gains realizations, controlling for state and year fixed effects

Dependent variable: log(*capital gain*)	(1) OLS	(2) OLS	(3) Median Regression
log(*dividend*)	0.08	0.05	0.01
	(0.07)	(0.07)	(0.07)
log(*interest*)	0.21***	0.20**	0.25***
	(0.07)	(0.07)	(0.08)
log(*other income*)	1.18***	1.12***	1.31***
	(0.17)	(0.19)	(0.19)
top5 log income	0.14	0.14	0.12
	(0.14)	(0.15)	(0.15)
log(*homeprice*)	0.41***	0.42***	0.34***
	(0.09)	(0.10)	(0.08)
homeowner	0.58	0.65*	0.53
	(0.36)	(0.36)	(0.36)
college	1.50***	1.58***	1.25***
	(0.48)	(0.47)	(0.45)
elderly	0.58	0.34	0.86
	(0.73)	(0.77)	(0.89)
unemployment	-4.54***	-4.47***	-4.64***
	(0.67)	(0.67)	(0.71)
$MTR_t - MTR_{t-1}$	0.26		
	(0.80)		
$MTR_{t+1} - MTR_t$	-0.82		
	(1.37)		
MTR_t	-2.73***	-2.71***	-3.17***
	(0.99)	(0.93)	(1.09)
Elasticity	-0.62***	-0.62***	-0.72***
	(0.22)	(0.21)	(0.25)
	[0.09]	[0.09]	[0.09]
State fixed effects?	Yes	Yes	No
Correlated random effects?	No	No	Yes
Year fixed effects?	Yes	Yes	Yes
Observations	2494	2596	2596
R-squared	0.90	0.91	

In columns (1) and (2), robust standard errors with clustering by state are in ( ) parentheses, and robust standard errors without clustering are in [ ] brackets. In column (3), block bootstrapped standard errors are in () parentheses, and bootstrapped standard errors are in [] parentheses. Elasticity is evaluated at mean MTR in sample, 0.227.
*** p<0.01, ** p<0.05, * p<0.1

5.2 Difference-in-Differences over a Long Period of Time

Next, we try an alternative approach to eliminating potential biases caused by time-invariant omitted variables that differ across states, which is to difference the data over time. To make sure we are picking up long-run effects after people have had a chance to learn about and adapt to changes in tax incentives, and to ensure that our estimates are not driven by high-frequency variation in the data that is more likely to reflect short-run responses and re-timing, we compute means of all of the variables for two large chunks of time, 1957-1979 and 1990-2007, and then estimate a regression where all the variables are differenced between those two periods. The differencing controls for any time-invariant unobservable state characteristics, removing any potential bias from those sources just as when we control for state dummies; since we have just one difference for each state, the overall constant in the regression controls for anything that is changing in the same way over time in all states. We omit the 1980s because, as shown in figure 1, many effective state tax rates gradually increased during the 1980s and data in the 1980s is clearly contaminated by major re-timing effects. The idea here is to compare the relative changes in capital gains realizations across states over a long time period where state tax rates changed very differently across states, a classic difference-in-differences comparison. An advantage of this approach is that it enables us to simply and transparently illustrate whether states that had larger increases over time in marginal tax rates on capital gains had smaller increases over time in capital gains realizations, conditional on the relative changes over time in other obvious influences on gains and realizations that we can control for.[13] On the other hand, a

[13] Clustering standard errors by state is not applicable in this approach, because there is just one observation (a single difference over time) for each state, and so no scope for errors to be correlated over multiple observations for the state. Indeed, Bertrand, Duflo, and Mullainathan (2004) suggest that this general approach of collapsing the data into means over several years pre-treatment and again post-treatment and then differencing those means over time as a potential solution to the clustering problem.

disadvantage is that it does discard some useful information on the particular timing of changes in tax rates and changes in realizations.[14]

The results of this exercise are shown in table 3. The point estimate of the elasticity of capital gains realizations to the tax rate is -0.73 with a standard error of 0.25, broadly similar to but slightly larger than the estimates from table 2. Column (2) illustrates that the estimated elasticity is almost identical when we limit the set of control variables to a very parsimonious list of log(*interest*), log(*dividend*), log(*homeprice*) and *college*, suggesting that the estimated effect of taxes is reasonably robust.

The conditional relationship between change in log capital gain and change in marginal tax rate estimated in column (1) of table 3 is illustrated graphically in figure 3. That graph plots the residuals from regressions of change in log capital gains and change in marginal tax rate on changes in all of the other control variables, and the slope of the OLS regression line through those points is the coefficient on change in marginal tax rate from column (1) of table 3.[15] The figure illustrates that indeed there is a general tendency for the states with larger increases in marginal tax rates, relative to what would be predicted based on the control variables, to have larger declines in capital gains realizations, relative to what would be predicted based on the control variables, and vice versa. The relationship is somewhat loose, which is duly reflected in the standard errors and confidence intervals around the estimate.

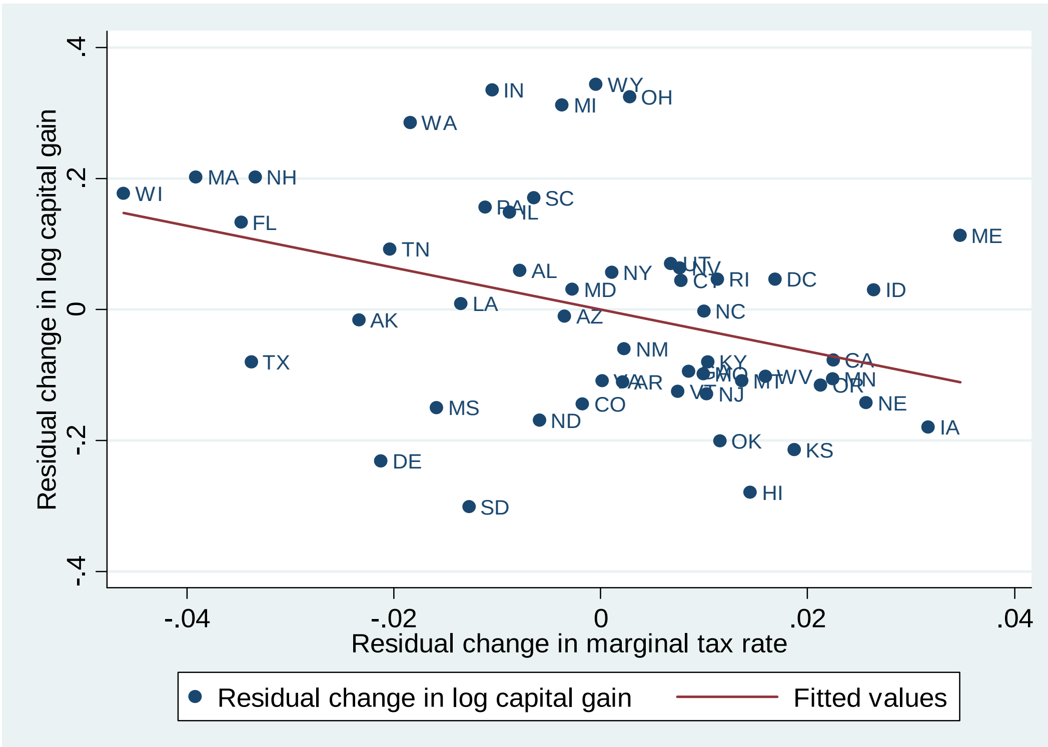
[14] In future work, we plan to implement more sophisticated econometric techniques for dealing with large time-dimension panel data that are intended to distinguish long-run effects from transitory effects, among other things, such as structural vector autoregression and cointegrating panel techniques.
[15] Angrist and Pischke (2009, section 3.1.2) explain this point.

Table 3 – Difference-in-differences: effect of change in marginal tax rate on change in log capital gains realizations across states, 1957-1979 to 1990-2007

Dependent variable: Δlog(*capital gain*)	(1)	(2)
Constant	-0.44	-0.54***
	(0.30)	(0.17)
Δlog(*dividend*)	-0.18	-0.19
	(0.15)	(0.14)
Δlog(*interest*)	0.72**	0.89***
	(0.28)	(0.16)
Δlog(*other income*)	0.52	
	(0.78)	
Δ*top5log income*	-0.09	
	(0.48)	
Δlog(*homeprice*)	0.59***	0.59***
	(0.19)	(0.16)
Δ*homeowner*	1.01	
	(1.11)	
Δ*college*	3.88**	5.30***
	(1.55)	(0.82)
Δ*elderly*	-1.26	
	(2.54)	
Δ*unemployment*	0.58	
	(3.21)	
ΔMTR_t	-3.20***	-3.21***
	(1.10)	(1.12)
Elasticity	-0.73***	-0.73***
	(0.25)	(0.25)
Observations	51	51
R-squared	0.74	0.73

Data in these regressions are calculated by taking the mean values of each variable in each state in the 1957-1979 and 1990-2007 periods, log-transforming where "log" is indicated, and then differencing over time for each state. Robust standard errors are in parentheses. Elasticity is evaluated at mean MTR in sample, 0.227.
*** p<0.01, ** p<0.05, * p<0.1

Figure 3 – Partial association between change in log capital gain and change in marginal tax rate across states, 1957-1979 to 1990-2007



5.3 Pooled Cross Section Estimates

In table 4, we report estimates from regressions that omit state fixed effects but continue to control for year fixed effects, and thus rely heavily on cross-sectional variation in state tax rates for identification. This specification has the advantage that persistent cross-state differences in tax rates are relatively large signals that may be more salient as well as more easily distinguished from noise in the data, but the disadvantage is that these estimates are more vulnerable to omitted variable bias. For example, voters in states where the wealthy are disproportionately concentrated may be systematically more or less likely to vote for high tax rates on capital gains, due either to the political influence of wealthy campaign donors or to the rest of the population having more to gain from redistribution when there is greater inequality.

To the extent that such considerations persist over time within a state, controlling for state fixed effects will resolve biases caused by such stories, but pooled cross-sectional analysis will not.

Column (1) of table 4 shows that when state fixed effects are omitted, the estimated elasticity of realized gains with respect to the tax rate increases in absolute value, to -0.86, with a robust clustered standard error of 0.26. Column (2) shows that again, this estimate is not sensitive to whether or not we control for lag and lead changes in the tax rate. In column (3), we try a different approach, referred to as the "between estimator," that isolates the identification coming purely from cross-sectional variation in state tax rates. In this case, we collapse all of the data into mean values over the entire 1957-2007 period, and estimate an OLS regression on that data, with a single observation for each state. The between estimator further increases the estimated elasticity in absolute value, to -1.12 with a robust clustered standard error of 0.28. The point estimate of the elasticity suggests the marginal capital gains tax rate was on the wrong side of the Laffer Curve when at the mean tax rate over the period of 22.7%, but this result should be interpreted with caution given the greater scope for omitted variable bias in these cross-sectional regressions, and the relatively wide confidence interval around the point estimate. Relative to the regressions estimated in columns (1) and (2), the between estimator is perhaps more likely to pick up long-run as opposed to short-run effects if gradual adjustment is important; however, it has the disadvantage of discarding some information, including the more plausibly exogenous source of identification arising from relative changes over time in state taxes.

Another feature of the between estimator is that the results can be easily reported in a figure that makes the source of our identification transparent. Figure 4 graphically depicts the partial cross-sectional association between tax rates and capital gains realizations, using an

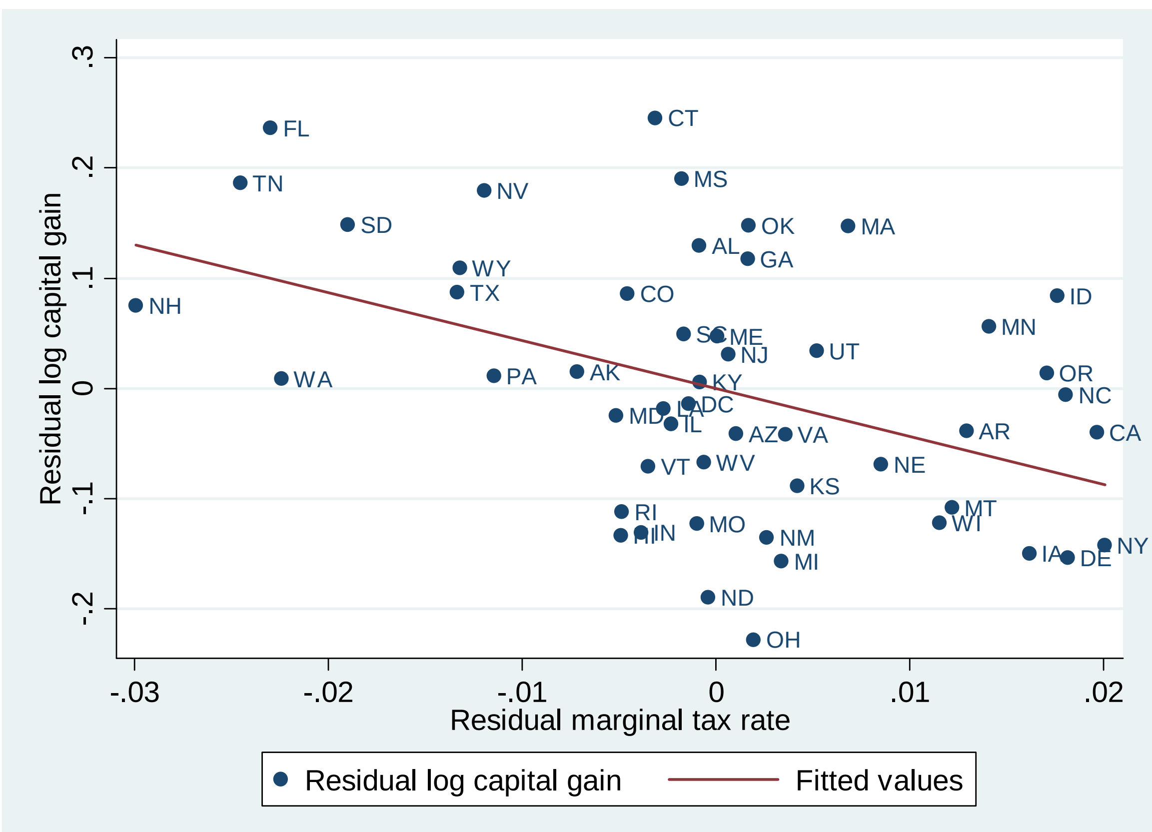
Table 4 -- Effect of marginal tax rate on log capital gains realizations, pooled cross-section and collapsed cross-section estimates

Dependent variable: log(*capital gain*)	(1)	(2)	(3)
constant			2.83
			(4.31)
log(*dividend*)	-0.03	-0.04	0.33***
	(0.06)	(0.06)	(0.09)
log(*interest*)	0.79***	0.80***	1.00***
	(0.09)	(0.09)	(0.13)
log(*other income*)	0.16	0.17	-0.41
	(0.28)	(0.27)	(0.43)
top5log income	-0.42**	-0.42***	-0.50*
	(0.16)	(0.16)	(0.28)
log(*homeprice*)	0.35***	0.34***	0.19
	(0.11)	(0.11)	(0.14)
homeowner	-0.54**	-0.50*	-1.20***
	(0.26)	(0.26)	(0.38)
college	2.12***	2.20***	1.51
	(0.79)	(0.79)	(0.98)
elderly	-1.55	-1.52	-7.09***
	(1.28)	(1.28)	(1.72)
unemployment	-4.71***	-4.71***	-2.49
	(0.97)	(1.00)	(1.94)
$MTR_t - MTR_{t-1}$	-1.07		
	(0.92)		
$MTR_{t+1} - MTR_t$	-2.62*		
	(1.31)		
MTR_t	-3.80***	-3.73***	-4.92***
	(1.17)	(1.13)	(1.27)
Elasticity	-0.86***	-0.85***	-1.12***
	(0.26)	(0.26)	(0.28)
	[0.07]	[0.07]	
State fixed effects?	N	N	N
Year fixed effects?	Y	Y	N
Observations	2494	2596	51
R-squared	0.82	0.83	0.88

Column (3) uses the mean values of each variable in each state for the whole 1957-2007 period, and then log-transforming where "log" is indicated. Robust standard errors are in ( ) parentheses and [ ] brackets. Standard errors are also clustered by state in ( ) parentheses in columns 1 and 2. *** p<0.01, ** p<0.05, * p<0.1

approach analogous to that used in figure 3. Using the "collapsed mean" data for 1957-2007 for each variable in each state, we regress log capital gains and marginal tax rate against the other control variables shown in column (3) of table 4, and plot the residuals against each other. The slope of the regression line fitting the points is the -4.9 coefficient on marginal tax rate in that regression. A steeper (compared to figure 3) negative relationship between the portions of log capital gains and tax rates that differ from what one would predict based on the control variables is apparent. There are still clusters of observations that do not fit the pattern particularly well, but the overall pattern is indicative of a negative relationship that is statistically significant in its difference from zero.

Figure 4 – Partial association between log capital gain and marginal tax rate across states, 1957-2007 averages



5.5 Time-Series Variation: Omitting Year Fixed Effects

Finally, table 5 depicts estimates from regressions that omit year fixed effects, thus restoring the time series variation in federal tax rates depicted in figure 2 to the identifying variation. We add the log of the Personal Consumption Expenditure (PCE) price deflator and the log of the S&P 500 stock price index (adjusted to constant year 2011 dollars using the PCE price deflator) as explanatory variables in this specification, to control for the influence of inflation and financial market prices on capital gains realizations (all nationwide aggregate factors of that nature were already controlled for by the time fixed effects in earlier specifications). All of the specifications in table 5, reflecting a variety of approaches, suggest elasticities that are close to -1 and statistically significantly different from zero. However, these elasticity estimates must be interpreted with caution because of the myriad possibilities of omitted variable bias, arising from possibly coincidental correlation between federal tax rates and aggregate factors such as periodic asset price booms and busts that are extremely important in explaining capital gains, especially when we are unsure whether we have adequately controlled for such aggregate influences.

Column (1) of table 5 takes our primary specification (equation 1) and drops the year fixed effects while retaining state fixed effects. The estimated price elasticity is large at -0.91 with a robust clustered standard error of just 0.05. Notably, the coefficient on next year's increase in tax rate is now large, positive and highly statistically significant, implying that a one percentage point increase in next year's tax rate is associated with a 2.87 percent increase in this year's capital gains realizations, consistent with re-timing responses we have observed such as the one around the enactment of TRA86. The coefficient on the lagged change in tax rate is positive 1.1 with a standard error of 0.17, which as noted above could be consistent with gradual learning and adjustment to tax changes by some taxpayers.

Table 5 – Effect of marginal tax rate on capital gains realizations, omitting time fixed effects

Dependent variable: log(*capital gain*)	(1)	(2)	(3)	(4)	(5)
constant	-2.29	-1.63	-0.07***	-0.06***	1.90
	(1.67)	(1.74)	(0.01)	(0.01)	(1.78)
log(*dividend*)	0.15**	0.09	0.20***	0.16*	0.06
	(0.06)	(0.06)	(0.07)	(0.08)	(0.05)
log(*interest*)	0.33***	0.43***	0.06	0.09*	0.49***
	(0.02)	(0.02)	(0.05)	(0.04)	(0.03)
log(*other income*)	0.01	-0.14	0.41	0.67***	-0.37*
	(0.16)	(0.15)	(0.25)	(0.20)	(0.22)
top5 log income	0.62***	0.63***	0.19*	0.18**	-0.11
	(0.09)	(0.09)	(0.10)	(0.08)	(0.12)
log(*homeprice*)	0.41***	0.46***	1.12***	1.12***	0.39***
	(0.10)	(0.10)	(0.10)	(0.09)	(0.13)
homeowner	0.32	0.01	-0.52**	-0.43*	-0.32
	(0.43)	(0.41)	(0.26)	(0.25)	(0.29)
college	1.81**	1.99***	-0.35	-0.29	2.05**
	(0.69)	(0.71)	(0.49)	(0.49)	(0.86)
elderly	-0.35	-0.40	0.75	0.84	-1.07
	(0.90)	(0.87)	(0.67)	(0.67)	(1.31)
unemployment	-4.80***	-3.97***	0.02	1.59***	-4.92***
	(0.73)	(0.75)	(0.54)	(0.50)	(0.84)
log (*real S&P500*	0.29***	0.38***	1.09***	1.08***	0.48***
index)	(0.02)	(0.02)	(0.06)	(0.06)	(0.05)
log(*PCE price*	-0.09	-0.18***	0.91***	0.65***	-0.18**
deflator)	(0.07)	(0.07)	(0.15)	(0.14)	(0.08)
$MTR_t - MTR_{t-1}$	1.10***		-0.52***		0.88***
	(0.17)		(0.12)		(0.21)
$MTR_{t+1} - MTR_t$	2.87***		1.07***		2.11***
	(0.20)		(0.14)		(0.27)
MTR_t	-3.99***	-4.11***	-4.29***	-5.79***	-4.40***
	(0.21)	(0.18)	(0.21)	(0.15)	(0.31)
Elasticity	-0.91***	-0.93***	-0.97***	-1.31***	-1.00***
	(0.05)	(0.04)	(0.05)	(0.03)	(0.07)
	[0.03]	[0.03]	[0.10]	[0.09]	[0.03]
State fixed effects?	Yes	Yes	No	No	No
Year fixed effects?	No	No	No	No	No
First-differencing?	No	No	Yes	Yes	No
Observations	2494	2596	2440	2542	2494
R-squared	0.80	0.81	0.43	0.40	0.71

Robust standard errors with clustering by state are in ( ) parentheses. Robust standard errors without clustering are in [ ] brackets. *** p<0.01, ** p<0.05, * p<0.1

The regression in column (2) of table 5 is identical to that in column (1) except it drops the lag and lead tax changes. Although the coefficients on those variables had large and significant effects in column (1), column (2) suggests that omitting them has little effect on the estimated elasticity of gains with respect to the current tax rate, which may suggest that a specification estimated in levels and controlling for state fixed effects does a reasonably good job of uncovering long-term effects regardless of whether lag and lead changes are included. In column (3), we first-difference the data, which cancels out the effects of any time invariant omitted variables that differ across states, similar to controlling for state dummies in the first two columns. First-differencing has some different properties in other regards, including some advantages in avoiding spurious correlations when dealing with non-stationary data with possibly stochastic time trends, and some disadvantages in terms of relying heavily on high-frequency variation for identification and arguably being worse at uncovering long-term relationships and worse at distinguishing them from short term ones. For the main parameter of interest, the elasticity of realized gains with respect to tax rate, it turns out that it does not matter much, as the elasticity increases slightly (in absolute value) from -0.91 in column (1) to -0.97 in column (3). However, in this specification, excluding the lag and lead tax changes has a more substantial effect on the estimated elasticity (in absolute value): the estimated elasticity in column (4) is -1.31. The intuition for this change is that the first-differenced specification relies heavily on short-term changes in capital gains for identification, which increases the importance of controlling for tax rates in adjacent years. Finally, in column (5) we report a regression estimated in levels that omits both state fixed effects and year fixed effects (and which includes lag and lead tax changes) which yields an elasticity estimate of -1.00 with a standard error of 0.07.

6. Discussion and Conclusion

Our regressions focus on different types of variation in the capital gains realizations and taxes over time and across states to generate a range of estimates of the elasticity of capital gains with respect to the tax rate. Our preferred specifications control for both state and year fixed effects. The virtue of having data from over a fifty-year period is that states vary in the long-run change in their capital gains tax rates. As we document, these differences over time within a state can be of the same order of magnitude as proposed changes in federal tax rates. Evaluated at the sample mean tax rate of 22.7%, our most credible specification, controlling for state and year fixed effects (in table 2) suggests a point estimate of the elasticity of about -0.62, with a 95 percent confidence interval extending from -0.17 to -1.07. This estimate implies that there is probably substantial responsiveness of capital gains realizations to capital gains tax rates. Given the increases in capital gains tax rates legislated in early 2013, the current weighted-average marginal tax rate on capital gains is likely fairly close to this 22.7% historical average. At current tax rates, an increase in capital gains tax rates would reduce realizations by enough to offset a substantial portion – potentially as much as 60 percent – of the revenue increase that would be predicted by a static model that does not incorporate behavioral responses.

Despite the econometric advantages of the difference-in-differences / year- and state-fixed-effects approach, it has the disadvantage, relative to some of our other specifications, of relying on differences in changes in tax rates across states that, while quite substantial, are still relatively subtle compared to major historical changes in federal capital gains tax rates. To the extent that our tax rate variable is measured with error, our more demanding specification that controls for state and year fixed effects may exacerbate any classical measurement error bias towards zero by removing more of the signal relative to the noise. This concern cautions against dismissing out of hand the estimates based on cross-sectional state variation or federal time-series variation. In general, our estimates of the realizations elasticity based on specifications use cross-sectional state variation or federal time-series variation in tax rates for identification are larger (in absolute value) than our benchmark specification. However, given the relatively long period over which we have data for each state and, as illustrated by figure 1, the fact that many of the "treatment" states in our sample had substantial increases in their capital gains tax rates, we expect that the potential disadvantages of cross-state variation (i.e., omitted variable bias) and federal time-series variation (i.e., omitted variable bias as well as the potential to misattribute short-run responses as long-run responses) outweigh the concerns that including both state and year fixed effects exacerbate measurement error.

A natural question to ask is whether our preferred estimated capital gains realization elasticity of -0.62 is plausible as an estimate of the permanent response to changes in capital gains tax rates. Comparing this estimate of the permanent elasticity reported in previous studies suggests that, despite using quite different data and identifying the effect mainly from how taxes vary by states over time, our estimate is congruous with existing estimates. The most recent study using data on individuals, Dowd, McClelland and Muthitacharoen (2012), reports a permanent capital gains realizations elasticity of -0.72.

Gravelle (1991 and 2010) criticizes econometric studies of capital gains realizations. One of her critiques is that the simple relationship that realized capital gains cannot exceed accrued capital gains puts a limit on the permanent elasticity of capital gains realizations with respect to the tax rate. Based on aggregate data 1954-1989, evaluated at a tax rate of 22 percent, she calculates an upper limit for the absolute value of the elasticity of 0.50.[16] While this upper

[16] As reported by Slemrod and Bakija (forthcoming, table 2.5), over the period 1987-2011, gains reported on personal income tax returns averaged 25 percent of accrued capital gains, compared to approximately 30 percent reported by Gravelle for the earlier years. This lower ratio of realized to accrued gains suggests that the upper bound of the realizations elasticity may be higher since there is more scope for increasing realizations relative to accruals.

limit seems to preclude many of the econometric estimates of the capital gains realizations, several observations may resolve the apparent inconsistency of her calculation with empirical estimates. First, the nature of empirical work is that parameter estimates inherently have some imprecision; for example, the 95 percent confidence intervals around our point estimates of elasticities typically include Gravelle's upper limit.

Second, the simple statement that capital gains realized cannot exceed capital gains accrued over the long run seems to assume away the possibility that tax policy can affect the amount of capital gains accrued. As an upper limit, one might want to include the possibility that capital gains tax rates affect investment and the generation of capital gains. While evidence on this channel is limited, Gompers and Lerner (1998) present evidence that higher state-level capital gains taxes reduce the amount of venture capital disbursements within a state, a result that they attribute to capital gains taxes reducing start-up activity.[17]

Third, using aggregate data may understate the importance of various tax-planning strategies by which taxpayers time the recognition of losses and gains so that they have relatively low aggregate realizations. One such strategy is to hold assets until death in order to benefit from the step-up in basis at death. Using Survey of Consumer Finances data from 1998, Poterba and Weisbenner (2001, table 8) estimate that 36 percent of the total value of estates of all decedents consists of unrealized capital gains, suggesting considerable scope for income tax policy to affect decisions about whether gains are realized before death. More complicated tax-planning strategies include optimal timing of gains and losses. Since the realizations elasticity is the elasticity of gains net of losses, the extent to which taxpayers realize losses faster than they realize gains can affect the amount by which a change in tax rates can affect net realizations; for example, if many taxpayers use losses to offset fully their realized gains, then net realizations

[17] Gentry (2010) updates the Gompers and Lerner analysis with a somewhat different specification and finds similar results.

would be low so that a modest change in this timing behavior could have a large effect on the net realizations. Based on detailed tax return data from 1987 to 1994, Auerbach, Burman, and Siegel (2000) report that a modest fraction (roughly 10 percent depending on the year and choice of weighting of returns) of taxpayers follows the relatively extreme strategy of realizing sufficient losses to offset all of their realized capital gains. Despite this fraction being relatively modest, it still raises the possibility that tax planning provides a reason why the stock of unrealized gains is relatively large.

Our benchmark estimate of the elasticity of capital gains realizations of -0.62 implies that static estimates of the revenue changes due to changes in capital gains tax rates could be inaccurate. Moreover, since our estimation techniques focus on long-term variation in tax rates, these revenue effects go beyond simply shifting tax revenue from one year to another. While the elasticity of capital gains with respect to the tax rate is helpful for tax policy decisions, other factors are also important. In terms of tax revenue, the change in capital gains realizations may provide an incomplete picture of the overall tax revenue implications if some of the behavioral response is in the form of strategies that re-label ordinary income as capital gains income. In addition, the substantial elasticity of realizations with respect to tax rates may have implications beyond the revenue impacts of tax rate changes: the elasticity also suggests a substantial behavioral response that may be relevant for understanding the deadweight loss associated with changes in capital gains tax rates. Since deadweight loss increases in the elasticity of behavior, our estimates suggest that the deadweight loss from taxing capital gains may be substantial. We leave estimates of overall revenue consequences as well as the deadweight loss of capital gains taxation for future research.

DATA APPENDIX

Marginal tax rates

We calculated representative marginal tax rates via the following method. First, we selected a random 10% sub-sample of the 1985 IRS Statistics of Income public-use file of individual income tax returns. We replicate that sample of taxpayers 51 times, once for each state and DC, and then replicate that full set of returns another 51 times, once for each year 1957 through 2007. Then we adjust all dollar amounts on the tax returns for inflation, multiplying them by the ratio of the PCE price deflator index in year *t* to the value of that index in 1985. We additionally adjust all dollar amounts by a factor reflecting linear trend growth in real per-capita personal income in the U.S. between 1957 and 2011. Specifically, we estimate the regression: $(\textit{real per capita personal income})_t = -1103344 + 569.9*(\textit{year}_t)$, using NIPA data for the years 1957 through 2011. We multiply each dollar amount on each tax return by the ratio of the predicted value for real per capita personal income in year *t* from the regression above, to its predicted value in 1985.

On each of the replicated returns, we adjust property tax deductions and sales tax deductions for systematic differences in these taxes across states and time in the following manner. After taking the measures described above, we multiply each return's property tax deduction by the ratio of state and local property tax revenue as a share of state personal income in the replicate's state and year, to the same for the original taxpayer's state in 1985 (or to the national average in 1985 for returns where state is not reported in the public use file). We impute state- and year-specific sales tax deductions for 2004 to 2007 using regressions that approximate the optional state sales tax deduction tables included in the IRS Form 1040 instructions each year, reported on the NBER web site <http://users.nber.org/~taxsim/sales-tax-irs-publication-600/>. For 1985, we estimate our own, similar regressions based on the 1985 version of the optional state sales tax deduction table. For other years in our sample when state sales taxes were deductible from the federal income tax, we take the 1985 imputed value and multiply it by the ratio of the statutory retail sales tax rate for that state in that year to its value for that state in 1985.[18]

We then take our sample of 27,274,086 individual income tax returns (10,486 for each state and year) and estimate each return's combined federal and state marginal income tax rate on long-term capital gains using the tax calculator described in Bakija (2009) <http://web.williams.edu/Economics/papers/bakijaDocumentation_IncTaxCalc.pdf>. Marginal tax rates are calculated by adding $0.10 to the long-term capital gains realizations reported by the primary taxpayer, and dividing the resulting change in combined federal and state income tax liability by $0.10. In the case of "notches" leading to very large marginal tax rates, the marginal rate is re-computed by reducing long-term capital gains realizations by $0.10 and dividing the resulting reduction in combined federal and state tax liability by $0.10, and using that instead. In

[18] Data on state and local property tax revenue as a share of state personal income starting in 1977 are from Urban-Brookings Tax Policy Center's *State and Local Finance Data Query System*. In earlier years, we compute these values using data on state and local property tax revenues from various issues of the U.S. Bureau of Census's *Census of Governments*, and data on state personal income from the U.S. Bureau of Economic Analysis National Income and Product Accounts <http://www.bea.gov>. State statutory retail sales tax rates are from the University of Michigan Office of Tax Policy Research *World Tax Database*, updated by the authors using various issues of the Research Institute of America's *All States Tax Handbook*.

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cases where different marginal tax rates are applied to gains depending on the holding period of the asset, we use the tax rate applying to the longest holding period. The tax calculator takes into account all important relevant considerations in federal and state tax law, including for example accounting for the effects of deductibility of state income taxes from the federal income tax and vice versa through an iterative process, as well as the alternative minimum tax, federal income averaging when it applied, etc. A federal marginal tax rate is computed by setting state income tax liability to zero, and then the state marginal tax rate is computed by subtracting the federal marginal tax rate from the combined federal-state marginal tax rate.

To convert those individual tax returns' marginal tax rates into a single marginal tax rate for each state / year combination that is representative of the marginal tax rate on the average dollar of long-term capital gain in that state and year, we do the following. We use tax rates calculated for each individual return in the replicated sample of returns for each state and year to calculate population-weighted average marginal tax rates for each of six slices of the national income distribution in each year: bottom 90 percent (p0-p90), 90^{th} to 95^{th} percentiles (p90-p95), 95^{th} to 99^{th} percentile (p95-p99), 99^{th} to 99.5^{th} percentile (p99-p99.5), 99.5^{th} to 99.9^{th} percentile (p99.5-p99.9) and top 0.1 percent (p99.9-p100). Each replicated return is assigned to one of the six income distribution categories based on the original 1985 return's position in the national income distribution in 1985, using thresholds for each slice of the income distribution (based on gross income including capital gains) reported for 1985 in Piketty and Saez (2012) <http://elsa.berkeley.edu/~saez/TabFig2010.xls>. For each state and year, the representative marginal tax rate on capital gains that we use in our regressions is a weighted average of the average state-year specific marginal capital gains tax rates in each of the six slices of the income distribution, where the weights represent the average fraction of total realized capital gains that were reported by taxpayers in each slice of the income distribution during 1957 through 2010 (computed by us based on data reported in Piketty and Saez 2012). So our marginal tax rate variable for each state and year (MTR_{it}) is:

$$MTR_{it} = 0.1201*MTRp0\text{-}p90_{it} + 0.0561*MTRp90\text{-}p95_{it} + 0.1602*MTRp95\text{-}p99_{it} + 0.0712*MTRp99\text{-}p99.5_{it} + 0.1575*MTRp99.5\text{-}p99.9_{it} + 0.4347*MTRp99.9\text{-}p100_{it}$$

where the i indexes states and t indexes years, the MTR terms on the right hand side represent the population-weighted mean values of the marginal tax rate on capital gains in each of the slices of the income distribution, and the numbers represent the fractions of aggregate capital gains reported on personal income tax returns that were realized by that part of the income distribution on average in the years 1957 through 2010. So for example, $MTRp99.9\text{-}p100_{it}$ is the population-weighted average federal-state marginal tax rate on long-term capital gains for taxpayers in the top 0.1 percent of the 1985 national income distribution (with the dollar values on their tax return grown forward or backwards to year t at the rate of inflation and linear per capita personal income growth), and that part of the income distribution accounted for 43.47 percent of all realized capital gains, on average, from 1957 through 2010.

The upshot of our procedure for calculating marginal tax rates is that it holds constant across all states the characteristics of the taxpayers used to compute the tax rates, aside from state taxes themselves, and it also holds those characteristics constant in real terms across years except for allowing for a steady linear trend growth reflecting the long-run trend in real per capita personal income at the national level. The tax rate computations thus hold the distribution of income constant across states and across years, and hold constant the weights that are used to compute the capital-gain weighted mean of marginal tax rates. When we control for year fixed effects in our regression specifications, all of the independent variation in our marginal tax rate variable comes from variation in state taxes, including any indirect effects that those state taxes have on federal marginal tax rates (for example because state taxes are potentially deductible from federal taxable income, which can affect one's federal tax bracket, because of how state income taxes affect whether one is on the federal alternative minimum tax, etc.). That independent identifying variation arising from state taxation is illustrated in figure 1.The identifying variation is not driven mechanically by any differences in income or taxpayer characteristics across states, nor is it driven by any transitory fluctuations in income or changes in income distribution over time, nor by any changes in the composition of income over time. Thus, our identifying variation in tax rates is very likely to be exogenous. Ideally we would like to use these plausibly exogenous representative tax rates as instruments for tax rates that more closely reflect a capital-gains weighted average of the actual tax rates faced by taxpayers in a particular state and year, and plan to do so in a future draft, but for now we use our exogenous tax rate measures as proxies.

Capital gains, dividends, interest, AGI, and number of returns

We assembled a consistent series of data on capital gains realizations, dividends, interest, and adjusted gross income reported on income tax returns, and total number of returns, for each state and year from 1957 and 2007 from a variety of sources ultimately deriving from the IRS. Data for the years 1979 through 1990 are from the data set assembled Bogart and Gentry (1995), which was in turn derived from IRS Statistics of Income publications for 1979-1981 and unpublished tabulations provided to Bogart and Gentry by the IRS Statistics of Income division. Data for 1997-2007 is from the IRS web site < http://www.irs.gov/uac/SOI-Tax-Stats---Historic-Table-2>. For all other years, we electronically scanned tables from various hard copy publications of the IRS, used *Nuance PDF Converter Assistant* software to convert the scanned tables into Excel spreadsheets, and performed extensive consistency checks (such as making sure that the sum of values for all states added up to national totals) and data cleaning, and then converted the data into a Stata data set. We are grateful to Patrick Aquino, Josephat Koima, Trust Mandevhana, and Tarun Narasimhan for outstanding research assistance on this task. Data for 1991 through 1996 is from various issues of the IRS *SOI Bulletin*, and data for 1957 through 1978 is from various annual issues of the IRS *Statistics of Income Individual Income Tax Returns* publication. The capital gains realization variable we use is called "net capital gain less loss in AGI" and is reported on a fairly consistent basis under that or similar names in all years 1957 through 2007. From 1957 through 1978, 50 percent of capital gains were excluded from AGI, and from 1979 through 1986 60 percent of capital gains were excluded from AGI. We adjust for this by dividing "net capital gain less loss in AGI" by 0.5 during 1957 through 1978 and by 0.4 during 1979 through 1986. This is not perfectly accurate because a small portion of the gains in "net capital gain less loss in AGI" was not subject to the exclusion, but we compared the actual amounts of excluded capital gains reported in the IRS public use files of individual income tax returns for selected years with what we would impute them to be using the method described above, and found them to be very close. Dividends represent the value of ordinary dividends (which includes both qualified and unqualified dividends) gross of any exclusions, except for 1957-1960, when dividends net of exclusion is the only data available from the IRS. Interest is taxable interest income reported on individual income tax returns. We convert these and all other dollar-valued variables into constant year 2011 dollars using the personal consumption expenditures (PCE) price deflator from the U.S. National Income and Product Accounts.

Top 5 log income

Most details of the *top 5 log income* variable are explained in the text. For purposes of computing this variable, we calculate the share of people in the top 5% of the family income distribution for each state in 1950, 1960, 1970, 1980, 1990, and 2000 from the decennial Census Public Use Files, and for 2001 through 2007 from the American Community Survey, both obtained from the IPUMS-USA web site (Ruggles *et al*. 2010), and linearly interpolate for all other years.

The *home price* variable is a state-specific series on median home prices that we assembled from a variety of sources. We started with the median home price for each state in 1950, 1960, 1970, 1980, 1990, and 2000 based on U.S. decennial census data, reported by the U.S. Census Bureau <http://www.census.gov/hhes/www/housing/census/historic/values.html>. We extrapolated the series for each year from 2000 through 2010 using the percentage growth rate in median house price for each state in each year derived from Federal Housing and Finance Agency (FHFA) statistics <http://www.fhfa.gov/Default.aspx?Page=87>. For all other years, we interpolated between beginning and end points of decades assuming a constant compound growth rate, and then further adjusted the growth rate for annual fluctuations in housing prices evident in a variety of other sources. For the years 1976 through 2009 we adjusted the annual interpolations using the annual percentage growth rate in the state-specific FHFA housing price index. For 1965 through 1975 we adjusted the annual interpolations based on the annual percentage growth rate in the region-specific median price for new single-family homes reported by the U.S. Department of Housing and Urban Development <http://www.huduser.org/portal/periodicals/ushmc/fall12/USHMC_3q12_historical.pdf>. Prior to 1965 we adjust the annual interpolations using the annual growth rate in the national Case-Shiller repeat sales housing price index <http://www.econ.yale.edu/~shiller/data/Fig2-1.xls>. Generically, we will call the FHFA house price index, HUD series, and Case-Shiller series "alternative price indexes." In each case, the adjustments involve applying a growth rate to the interpolated house value that equals the ratio of the growth rate in the alternative housing price index in that particular year to the average compound growth rate in that alternative housing price index between the two years we are interpolating between (e.g., the beginning and end of the decade when we have the same alternative housing price index over a whole decade). The growth factors thus cancel out over the span we are interpolating, so that the various series that were splice together fit together smoothly. We have all of the alternative price indexes as well as the FHFA median house price index available for every year between 2000 and 2010, so we are able to check how closely our interpolated valued match the true median house prices during that decade. The correlation between true and interpolated median house prices is 0.997 for interpolations involving the FHFA state-specific housing price index, 0.9631 for interpolations involving the HUD regional median new single family home price, and 0.962 for interpolations involving the Case-Shiller national home price index.

Homeowner*, *college*, *elderly*, *and unemployment

Our state-specific variables on home ownership, share of adults with a college education, and share of population that is elderly all derive from various census data sources. For 1950, 1960, 1970, 1980, 1990, and 2000, we calculate *elderly* and *college* from the IPUMS-USA Census Public Use Microdata Files (Ruggles *et al*. 2010). The value of *homeowner* for those years is from tables based on decennial U.S. Census data posted at:

<http://www.census.gov/hhes/www/housing/census/historic/owner.html>. All three variables are calculated from the IPUMS-USA version of the American Community Survey for 2001 through 2007. For other years between 1977 and 1999 we compute them from the IPUMS-CPS versions of the Current Population Survey (King *et al*. 2010). In all other years we impute their values through linear interpolation.

Data on state unemployment rates are from the U.S. Bureau of Labor Statistics web site <http://www.bls.gov> for 1976 and later years, and from data posted on the web site of Robert Moffitt of Johns Hopkins University <http:/www.econ2.jhu.edu/people/moffitt/datasets.html> for years from 1960 through 1975. State-specific unemployment rates are unavailable for 1957-59, so for those 3 years we impute state unemployment rates as the 1960 state unemployment rate multiplied by the ratio of the national unemployment rate in year *t* to the national unemployment rate in 1960.

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