How Do Firms Respond to Corporate Taxes?

Jeffrey L. Coles*, Elena Patel[1]†, Nathan Seegert[1] ‡ and Matt Smith[2]§

[1]Department of Finance, University of Utah Spencer Fox Eccles Business Bldg., 1655 East Campus Center Drive, Salt Lake City, Utah 84112
[2]Office of Tax Analysis, U.S. Treasury, 1500 Pennsylvania Avenue NW, Washington, D.C.

Abstract
Using a novel empirical approach and newly available administrative data on tax filings in the United States, we estimate the corporate elasticity of taxable income and determine how such tax responsiveness varies depending on accounting method, firm size, and interest rate. In response to a 10% increase in the expected marginal tax rate, private firms decrease taxable income by 9.1%, which indicates a discernibly more elastic response than prevailing estimates. This response reflects a decrease in taxable income of 3.0% arising from real economic adjustments to a firm's scale of operations and 6.0% arising from tax adjustments via, for example, revenue and cost timing. Responsiveness to the corporate tax rate is more elastic if a firm uses cash (9.9%) rather than accrual accounting (7.4%), if the firm is small (9.9%) rather than large (8.6%), and if the firm has a relatively high-cost access to capital.

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*E-mail: jeff.coles@eccles.utah.edu
†E-mail: elena.patel@eccles.utah.edu
‡E-mail: nathan.seegert@eccles.utah.edu
§E-mail: matthew.smith@treasury.gov

1 Introduction

The extent to which US corporations avoid higher tax rates by reducing taxable income is a fundamentally important concern to researchers and policymakers. This conduct is summarized by the elasticity of taxable income [Feldstein, 1995]. The elasticity quantifies the responsiveness of taxable income to tax rates without specifying the specific tax avoidance mechanisms corporations utilize. At the same time, the details of the underlying mechanisms have significant implications for economic activity, firm value, and reporting behavior. In this paper, we investigate (1) how responsive U.S. firms are to the U.S. corporate tax schedule, (2) whether cross-sectional variation in response by firm size and accounting method is consistent with available avoidance mechanisms, and (3) how much of this behavior is driven by economic responses and tax adjustments.

This research broadens prior work examining tax-induced earnings management [Scholes et al., 1992; Guenther, 1994; Maydew, 1997] and the elasticity of taxable income [Saez, 2010; Chetty, 2009; Kleven and Waseem, 2013; Kleven, 2016] in several ways.[1] First, we use administrative data from the Internal Revenue Service on all subchapter C corporations to examine the response of smaller and private firms that are often absent in other data sets. Second, using these data, we focus on responses driven by tax bracket thresholds over an eleven year period (2004–2014). Third, we develop a novel empirical approach that can be used to estimate firm responsiveness in many contexts where firms face reporting thresholds. Finally, we pair our estimates with a structural model of firm behavior to compare the magnitude of tax adjustments and economic responses.

Our method compares the distribution of firms with different levels of net operating losses near a tax bracket threshold, building on insights by Maydew [1997] and Saez [2010]. As we explain in more detail in Section 4, treatment and control firms realize the tax bracket threshold at different levels of net income due to variation in net operating loss deductions carried forward from previous tax periods. Both groups have similar net income and revenue, and realize the threshold at the same taxable income level. Despite these similarities, we observe substantial differences between the distribution of firms at tax bracket thresholds driven by differences of only a few thousand dollars in their accumulated stock of net operating losses. This difference provides visual evidence that firms respond to higher tax rates by reducing their taxable income. We quantify this response empirically.

We find that U.S. firms reduce taxable income by 8.9% at the first tax bracket threshold in the tax schedule. This finding indicates a much stronger corporate response to corporate tax rate changes than previous studies [Gruber and Saez, 2002; Devereux et al., 2014; Lediga et al., 2019]. Firm size and accounting method likely confer differential response mechanisms to higher tax rates. For example, small firms can elect cash or accrual accounting for tax reporting purposes. We find that small firms respond more to corporate tax rate changes than large firms and cash accounting firms respond more than accrual firms.[2] This leads to the natural question: By what means are firms responding to higher

[1] Other studies examine tax-induced earnings management due to the book income adjustment of the alternative minimum tax [Dhaliwal and Wang, 1992; Boynton et al., 1992].

[2] One reason small firms could be more responsive is due to differential audit rates, as suggested by Hoopes

tax rates?

We develop a structural model to investigate how firms are responding to variation in tax rates across different tax brackets. We separate responses into two categories: economics responses and tax adjustments following Slemrod [1992]. Economic responses are adjustments to equilibrium operations, such as reducing the scale of operations or investing less in property, plant, and equipment or research and development, due to the reduced after-tax rate of return. Tax adjustments describe changes to the timing of transactions, financial responses, and accounting responses. We find that 67% of the overall response to higher tax rates is due to tax adjustments, which is consistent with the hypothesis that private firms are sophisticated and tax aggressive. This evidence provides support for studies linking accounting practices to reporting and tax compliance (e.g., Blouin et al. [2010a], Towery [2015], and Gupta et al. [2014].

We transform firms' reduction in taxable income into an elasticity of taxable income with respect to the net of the tax rate. This transformation requires an estimate of the change in tax rates faced by firms on either side of the tax threshold. Previous calculations have relied on changes in statutory tax rates [Gruber and Saez, 2002]. We rely instead on expected marginal tax rates, following the insights of Shevlin [1990], Plesko [2003], Graham and Mills [2008], and Blouin et al. [2010a]. These studies show the importance of accounting for carried losses and credits in understanding the tax incentives facing corporations. We provide two different estimates of the expected marginal tax rate building on Graham and Kim [2009a] and Cooper and Knittel [2010]. We extend our approach by connecting the interest rates faced by firms to expected marginal tax rates. We show how the expected marginal tax rate changes as we vary the interest rate between 3% and 15%.

We find a corporate elasticity of taxable income (CETI) of 0.91.[3] In other words, firms reduce their taxable income by 9.1% in response to a 10% change in the net of tax rate. By comparison, Gruber and Rauh [2007] report an elasticity of 0.20, the only previously available empirical estimate for U.S. firms.[4] The difference between these estimates is likely due to differences in data, method, and firm samples.[5]

In this paper, we extend the literature in several ways and, as such, it is the first paper in several respects. We are the first to analyze the response of private firms in the U.S. to taxes using administrative tax data. We are also the first to show how the responsiveness of firms can be estimated by combining reporting thresholds with a control group—a method

et al. [2012]. For example, the average audit rates for firms with assets below $250,000 is less than 0.5% and less than 1% for assets of up to $1 million in many years. Our estimates are consistent with these low audit rates inducing smaller firms to be more tax aggressive.

[3]This assumes that firms face the average BBA Corporate Bond Rate during this time period.

[4]Other business estimates summarize responses in international contexts [Devereux et al., 2014; Lediga et al., 2019].

[5][Gruber and Saez, 2002] use financial data from Compustat for a sample of publicly traded firms, and use variation in effective tax rates driven by the firms' mix of assets and associated depreciation schedules. We use administrative tax data on smaller private corporations, as well as the expected tax rates, as described in Subsection 4.3. Compustat reports financial accounting data based on worldwide income, rather than consolidated tax groups in the U.S., and lacks the detail to compute taxable income [Plesko, 1999; Hanlon, 2003]. See Hanlon [2003] for a discussion of the difficulties in calculating taxable income from a firm's disclosed financial statements. Plesko [1999] as well notes that there is very little useful information about taxable income in public financial disclosures. As a result (p. 171), "...overall there appear to be limited usefulness of financial information in making inferences about the cross-sectional characteristics of firms' taxable income."

with wide application in the empirical accounting literature. In addition, we are the first to incorporate insights about loss carryforwards and expected tax rates to identify the corporate elasticity of taxable income. Finally, we are the first to empirically decompose the corporate elasticity of taxable income into economic responses and tax adjustments, a critical distinction for policy evaluation and welfare analysis.

Our paper proceeds as follows. In Section 2, we provide background information on the behavior of private firms, and models the response of firms to taxes. Section 3 provides details on important features of the U.S. corporate tax data. In Section 4, we describe our novel estimation strategy. In Section 5, we present our empirical estimates of the firm responses. In Section 6, we discuss and implement a structural model used to decompose the CETI into economic responses and tax adjustments. In Section 7, we present calculations of the effects of corporate taxes on distortions in the economy and firm value based on our estimates. Concluding remarks appear in Section 8.

2 Background

In this section, we provide the context of our study. We describe what is known in the literature, where the gaps are, and how we fill some of those gaps. We provide details of accounting methods for tax purposes. We develop a framework for understanding how firms respond to corporate tax rate changes, building on Allingham and Sandmo [1972], Slemrod [1992], Maydew [1997], and Dyreng and Maydew [2017]. Finally, we discuss the use of elasticities of taxable income in the literature.

2.1 Taxes and Corporate Behavior: Private Firms

In this paper, we focus on how private firms respond to corporate income tax rates. The extent to which private firms respond to these tax rates remains an open question [Graham, 2003]. On the one hand, private firms may respond *more* to corporate tax rates than a public firm if they (1) have different governance and agency costs [Crocker and Slemrod, 2005; Desai and Dharmapala, 2009], (2) face less scrutiny from the tax authorities, or (3) can use cash accounting for tax purposes that may, in some circumstances, be more flexible. On the other hand, private firms may respond *less* to corporate tax rates because they (1) have fewer options to locate taxable income elsewhere [Newberry and Dhaliwal, 2001; Blouin and Krull, 2009], (2) face minimal pressure from external capital markets (Beatty and Harris [1999]), and (3) have less tax expertise [Gomes, 2001; Almeida and Campello, 2007].

Private firms are overlooked in empirical research primarily due to data constraints. There are more data available on public than private firms because the Securities and Exchange Commission (SEC) requires that public firms disclose certain information. We rely on administrative tax data to observe the behavior of the universe of corporations, public and private.

Of the 1.5 million subchapter C corporations in the U.S. almost all are private; in fact, 99.5% have never been publicly traded.[6] Moreover, private corporations hold 30% of

[6]Subchapter C corporations are the subset of the corporate sector that is subject to the corporate income tax.

corporate assets, earn 30% of total corporate receipts, and represent 99.5% of corporate taxable income decisions. These statistics underscore the importance of empirical work focused on private firms. Indeed, as noted in Hanlon and Heitzman [2010] p. 129, "...more work on privately held firms may be important beyond using them as a comparison group for publicly held firms. These firms have different ownership structures, different financial reporting incentives, and constitute a large portion of our economy."

2.2 Accounting Methods and Tax Reporting: Cash and Accrual Accounting

The corporate tax code grants flexibility to small corporations in the choice of accounting method used to calculate taxable income. In particular, C corporations below a size threshold can employ a cash or accrual accounting method to determine when to report income and expenses.[7] For our sample period, firms earning less than $5 million in gross receipts were permitted to elect cash-accounting. This election is made on the first tax return and cannot thereafter be adjusted without formal approval from the IRS so long as the firm meets the size threshold. Firms that exceed the size threshold are required to calculate taxable income based on the accrual method.[8]

Much attention has been paid to the quality of information contained in cash flows as compared to accounting earnings. Accounting earnings are reported based on an accrual accounting method in accordance with GAAP. These standards provide guidance on the timing of cash-flow recognition. For example, expenses must generally be recognized in the accounting period in which the expense is incurred while revenues must be recognized in the period in which they are earned. Accrual accounting for the purposes of tax reporting strengthens book-tax conformity [Guenther et al., 1997]. By comparison, cash flow accounting suffers from classic timing and matching problems that can violate both the revenue recognition principle and the matching principle [Dechow, 1994]. Under cash accounting, income and expenses are recorded when cash "changes hands." In this way, cash accounting simply measures cash flows.

2.3 Taxes and Corporate Behavior

The corporate tax distorts firm behavior along many dimensions. Slemrod [1992] separates these into two buckets. First, firms can make adjustments to income that include alterations to the timing of transactions. For example, in response to tax rate changes, firms using cash accounting can advance payments or postpone receipts and firms using accrual accounting can make changes to how costs are capitalized and expensed. Second, firms can adjust economic decisions (e.g., firms can hire fewer workers). Maydew [1997] examines earnings management behavior induced by the Tax Reform Act of 1986, which reduced the corporate tax rate and adjusted net operating loss (NOL) carryback rules,

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The corporate sector also includes subchapter-S corporations, which are pass-through entities that pass income through to owners to face the individual income tax. We exclude these firms from our analysis. See section 3 for more details.

[7] With some exceptions, firms in general are required to use accrual accounting for certain specific expenses like inventory accounting.

[8] IRS Publication 538 provides detailed instructions regarding accounting methods.

finding empirical evidence of tax-induced earnings management. An interested reader can refer to Shackelford and Shevlin [2001], Hanlon and Heitzman [2010], and Dyreng and Maydew [2017] for extensive reviews of the deep empirical tax research examining these responses.

To clarify these behaviors, consider a firm that is owned by a single shareholder and begins period 1 with E retained earnings. In this model, capital proxies for all economic inputs employed by the firm. In period 1, the firm chooses the amount of capital to carry into period 2 and decides whether or not to undertake adjustments to taxable income. Capital is given by the amount of retained earnings the firm has plus new investment I; $K = E + I$.[9] In period 2, capital generates profits net of costs, including depreciation costs, according to a strictly concave production function with $e > 0$:

$$\pi(K) = \frac{1+e}{e} K^{\frac{e}{1+e}}. \tag{1}$$

Firm value depends on this production function, the corporate tax rate τ, and any adjustments to taxable income. In particular, we follow Allingham and Sandmo [1972] in assuming that the true measure of taxable income is only known to the taxpayer and is not costlessly observed by the tax authorities. In this case, the taxpayer has incentives to strategically shift income to reduce reported taxable income, albeit at a cost. The mechanisms by which firms adjust taxable income are similar to financial reporting adjustments, but the objective is different. For example, firms can inter-temporally shift revenues and/or costs to boost or smooth reported financial earnings or reduce and smooth their tax liability. The activities that boost and smooth financial earnings, however, often operate in the opposite direction from the tax objective by increasing tax liability. For example, Erickson et al. [2004] finds empirical evidence that firms paid millions of dollars in taxes on allegedly fraudulent, overstated earnings.

We summarize tax adjustment behaviors by the parameter $\rho > 0$, such that taxable income is given by $Y(K, \rho) = \pi(K) - \rho$. These activities come at a cost, $c(\rho)$, which is increasing, convex, and smooth.[10] For example, if firms make inter-temporal adjustments to taxable income, then ρ captures the amount of taxable income not included in this year's tax filing, and $c(\rho)$ captures the taxes due the next year (appropriately discounted), any potential tax penalties, and any cost associated with this adjustment (e.g., overtime for the firm's tax preparer). We focus on adjustments to taxable income that abstract away from earnings management because private firms are subject to less pressure to meet forecasts. For this reason, adjustments are more likely to be motivated by tax-related behavior.

Firms maximize firm value by choosing capital K and taxable income adjustments, ρ,

$$max_{K,\rho} \quad V = -rK + (1-\tau)Y(K, \rho) + \rho - c(\rho), \tag{2}$$

which we write in terms of period 2 value, net of period 1 capital, and where $r > 0$ represents the risk-free untaxed rate of return.[11]

[9] Investment is given by equity issuances minus dividend payments.

[10] These conditions ensure that $c'(\cdot)$ can be inverted.

[11] One way to rationalize this value function is to assume that shareholders may hold government bonds with an un-taxed rate of return of $r > 0$ and at the end of period 2, all firms liquidate, returning their principal and

The equilibrium level of capital and adjustments to taxable income are found from the first-order conditions:

$$\frac{\partial V}{\partial K} = -r + (1-\tau)\frac{\partial \pi(K)}{\partial K} = 0,$$

which produces the Hall-Jorgenson formula [Hall and Jorgenson, 1967], and

$$\frac{\partial V}{\partial \rho} = -(1-\tau) + 1 - c'(\rho) = 0.$$

By combining these first-order conditions, we find that the equilibrium capital, adjustments to taxable income, and taxable income are:

$$K^* = \left(\frac{(1-\tau)}{r}\right)^{1+e}, \qquad c'(\rho) = \tau, \qquad Y = \frac{1+e}{e} r^{-e}(1-\tau)^e - \rho(\tau). \quad (3)$$

The model characterized in equation (3) demonstrates how corporate taxes distort behavior. First, the equilibrium level of capital decreases as corporate taxes increase. This distortion to input factors is what Slemrod [1992] describes as adjustments to real decisions and what we refer to as economic responses. Second, the equilibrium level of adjustments to taxable income implicitly increases as corporate tax rates increase.[12] This adjustment to taxable income captures what Slemrod [1992] describes as the timing of transactions, financial responses, and accounting responses. Working through the economic responses and tax adjustments, corporate taxes distort the equilibrium amount of reported taxable income Y. Specifically, as the corporate tax rate increases, taxable income decreases. The first term of Y captures the economic responses and ρ captures the tax adjustments.

2.4 Elasticity of Taxable Income

The elasticity of taxable income encompasses both the economic responses and tax adjustments and characterizes the combined responsiveness of taxable income to the tax rate. The elasticity of taxable income has been a focal parameter in tax policy since Feldstein [1995] argued that it was a sufficient statistic for the deadweight loss caused by tax policies.[13] In a single parameter, it encapsulates all potential responses including inter-temporal shifting, tax evasion, and real economic changes, such as reduced capital input.

In Section 6, we disentangle the share of the elasticity of taxable income driven by economic responses and the share driven by adjustments to taxable income. We also consider whether different types of firms have different responses. For example, we consider whether firms that use cash accounting have a larger or smaller response to taxes than firms that use accrual accounting, and whether they are more prone to respond using economic responses or adjustments to income.

profits to their shareholders. The value of the firm with period 1 capital adds $(1+r)E$ to the expression, but as the initial retained earnings is exogenous, excluding it does not change the analysis.

[12] Note that income adjustments could affect capital by lowering a firm's tax rate.

[13] Several papers note that the elasticity of taxable income is an important parameter but question whether it is sufficient [Doerrenberg et al., 2015; Feldstein, 1995].

Heterogeneity in the timing of income and expenses across accounting methods suggests that there are differential costs to adjusting taxable income, as modeled in Subsection 2.3. Whereas accrual accounting is governed by GAAP standards, cash accounting is governed by cash flows. For this reason, we hypothesize that there is less room for managers to opportunistically manipulate taxable income under accrual accounting. Said differently, we hypothesize that cash firms are more elastic than accrual firms. We test this hypothesis in Section 5. This hypothesis is consistent with Guenther et al. [1997], who find that publicly traded firms that are forced to switch from cash to accrual accounting with the Tax Reform Act of 1986 accrue more income than firms that always employ an accrual accounting method.

3 U.S. Corporate Data

Our analysis relies on administrative corporate tax data from 2004–2014. These data include millions of firms across ten years and broadens the scope of questions that can be answered about firm behavior. We collect data on the components of a corporation's tax return that comprise taxable income, as well as several mechanisms that allow a firm to reduce taxable income. These fields are primarily contained on the front page of IRS Form 1120. We observe net income, net operating loss deduction, special deductions, and the stock of NOL carried forward from prior tax years.[14] For the purposes of this paper, profit is defined as net income less special deductions (line 28 – line 29(b)). *Taxable Income* is profit less any use of NOL deductions. By definition, taxable income must be non-negative.

Table 1 provides descriptive statistics for the pooled population of C corporations from 2004 through 2014, where columns (2) and (3) highlight key differences between the populations of public and private firms.[15] Unsurprisingly, public firms are significantly larger. For example, the median public firm earns $55 million per year in gross receipts and holds $208 million in assets, whereas the median private firm earns $229,000 per year in gross receipts and holds $85,000 in assets. A smaller size, however, does not mean that private firms are unimportant. In fact, private C corporations make up 99.5% of all C corporations (and make 99.5% of annual taxable income decisions), own 30% of corporate assets, and pay 30% of total corporate tax receipts. Understanding the behavior of private firms is critical towards understanding their tax incentives and responses to corporate tax rates.

Insert Table 1 about here.

[14]The fields are most commonly found on the following lines: net income [line 28], net operating loss deduction [line 29a], special deductions [line 29b], NOL stock [schedule K, line 12].

[15]Generally, the distribution of corporations by any measure of size, both public and private, has a long right tail. Given this, we avoid reporting mean statistics, which are not representative of the typical firm.

3.1 Evolution of Taxable Income

Prior to 2018, C corporations in the U.s. were subject to a highly kinked corporate tax schedule. There were eight brackets under this regime, with tax rates ranging from 15% to 39%.[16] When we analyze the distribution of corporate taxable income, we find that not only do most private corporations face the 15% marginal tax rate but also that all private firms have a substantial probability of being in the 15% tax bracket each year. Table 2 reports how firms transition between brackets using a Markov transition matrix.[17] For example, any firm in the full population of private firms has a 65% chance of earning $0 in taxable income. Moreover, even those firms in the top tax bracket, with taxable income greater than $18.3 million in period t have an 11% chance of earning $0 in period $t + 1$. In fact, any firm with positive taxable income in one year has at least an 11% chance of earning $0 in taxable income the following year. Because most firms report taxable income of around $0, and all firms have a substantial probability of reporting $0 in taxable income, our empirical analysis focuses on the kink at $0.

Insert Table 2 about here.

Although the majority of firms report low values of taxable income in any given year, taxable income can be very different from cash flow. In fact, between 2004 and 2014, 43% of private corporations with negative net income have positive earnings before interest, taxes, depreciation, and amortization (EBITDA). EBITDA measures profitability while holding constant capitalization and financing decisions. Moreover, interest paid and depreciation are among the largest deductions taken by corporations and are often the target of short-term tax policy, such as accelerated depreciation rules. There can be important differences, therefore, between taxable income and EBITDA. For instance, firms with negative net income earn an average net income of -$239,000, compared to an average EBITDA of $72,000.

3.2 Evolution of Net Operating Losses

Not only do most firms report taxable income (which cannot be negative) near $0, we find a substantial proportion of firms earn negative profits and generate NOLs. From 2004 to 2014, 41% of firms had negative profit in at least one year (i.e., were in a loss position).[18] Additionally, 20% of firms with a profit of less than $50,000 and 14% of firms with profit greater than $18.3 million in period t will have a loss in period $t + 1$. This reflects a considerable amount of churn in and out of loss for firms, regardless of size.

The tax data reveal the pervasiveness of loss carry-forwards. More than half of all private firms have a carry-forward of NOL stock in any given year between 2004 and 2014. Moreover, only 33% of private firms went through this decade without ever having

[16] Figure A.1 in the Appendix reports the distribution of private C corporations in 2014 according to taxable income (Panel A) and profits (Panel B) across corporate tax brackets.

[17] A Markov transition matrix provides the probability of a firm transitioning from one state to another from time t to $t + 1$. We define the states of income to be the tax brackets of the U.S. corporate tax code.

[18] Table A.1 in the Appendix provides a Markov transition matrix of profit across the various tax brackets for the period 2004 through 2014.

a stock of NOLs. In 2014, private firms held $1.2 trillion in carry-forward NOLs, worth a maximum of $420 billion in tax liability, and public firms held $0.9 trillion. Finally, losses are common across firm size. In 2014, 50% of large firms and 58% of small firms report holding NOLs.[19]

This evidence demonstrates that firms with NOLs are not the exception but the rule, reducing concerns that our reliance on NOLs for identification introduces omitted variable bias or external validity concerns. Further, NOLs are predetermined, meaning that firms cannot adjust their available stock of NOLs in response to their current tax position.

3.3 Defining the Sample

As described in detail in Section 4, our estimation strategy focuses on firms near a threshold, or kink, in the corporate tax schedule. We focus on the kink at $0 because the sample is much larger at this kink, satisfying the data requirements to implement our bunching estimator. The elasticity estimates we identify based on the first kink in the budget set are the cleanest because they do not require additional structure to account for the distortions caused by previous kinks. In practice, we define this sample to be those firms with profits between $1,000 and $30,000 per year and an NOL stock between $5,000 and $20,000.[20] To ensure we are capturing active enterprises, we apply the methodology in Knittel et al. [2011] to remove C corporations that do not possess the characteristics that define a "business," such as investment vehicles that conduct little or no business activity.

Columns (1)–(3) of Table 1 report summary statistics for the firms in our bunching sample from 2004 through 2014.[21] The median firm in the bunching sample is comparable in size to the median private firm in the population (Columns 4–6), based on size measures such as gross receipts, total income, and assets. More generally, the similarity of the bunching sample to the full sample of private firms based on a host of observable characteristics speaks to the generalizability of our elasticity estimate to the full population of private C corporations.

4 Estimating the Elasticity of Taxable Income

In this section, we develop our empirical method, which builds on the seminal work of Saez [2010] and Maydew [1997]. In particular, we extend the bunching method to the corporate setting (Subsection 4.1), and we improve estimation of the elasticity of taxable income by enhancing the estimation of the numerator (percentage change in taxable income in Subsection 4.2) and the denominator (percentage change in tax rates in Subsection 4.3). We provide additional details of the estimation in Subection 4.4 and Appendix A.3.

[19] Figure A.2 in the Appendix shows the fraction of firms in the population with a stock of NOLs in any given tax year and the total stock of NOLs that exist for C corporations.

[20] Unfortunately, there are generally very few public firms relative to the population of C corporations, and in particular, there are too few public firms to permit separate estimation of an elasticity via bunching methods.

[21] Table A.2 in the Appendix provides detailed descriptive statistics of our bunching sample in 2004, 2009, and 2014.

4.1 Corporate Elasticity of Taxable Income

The elasticity of taxable income summarizes the sensitivity of taxpayers to the tax rate by relating the percentage change in taxable income, $\Delta Y/Y$, with the percentage change in the net-of-tax rate, $ln(\frac{1-\tau_0}{1-\tau_1})$,

$$\varepsilon_Y = \frac{\Delta Y/Y}{ln(\frac{1-\tau_0}{1-\tau_1})}. \tag{4}$$

Saez [2010] demonstrates that the percentage change in taxable income (the numerator) can be estimated using the excess mass (bunching) of firms at a kink point in a tax schedule where the marginal tax rate increases. Specifically, firms that face a higher marginal tax rate due to being in a higher tax bracket respond by lowering their taxable income. This behavior causes there to be bunching in the distribution of firms at a kink point because firms at most reduce their taxable income to the kink in the tax schedule. More bunching, therefore, is associated with a larger percentage change in income and a larger elasticity.

In the corporate setting, we identify a few departures from the typical context in which Saez [2010] demonstrates how to estimate the elasticity based on variation in marginal tax rates (piecewise linear budget constraints). First, although firms all face the same tax schedule in taxable income, each firm experiences the kink in the tax schedule at different levels of net income due to the NOLs that firms carry forward. We exploit this fact to estimate the percentage change in taxable income (the numerator) via a control-group methodology, all of which we explore further in Subsection 4.2. Second, in the corporate setting, the percentage change in the net-of-tax rate (the denominator) is not merely the statutory rate change in the tax schedule [Shevlin, 1990]; we explore this further in Subsection 4.3.

4.2 Estimating the Change in Income

We estimate the change in firm income by comparing the excess mass at a kink point with the counterfactual distribution without the kink point. We estimate the excess mass at a kink point as the difference in the density of treatment firms (those that experience a change in marginal tax rates at that kink point) with the density of control firms (those that do not). Specifically, we exploit variation in kink points driven by variation in loss carryforwards. This method builds upon earlier work by Maydew [1997], who exploits variation in loss carrybacks to identify tax-induced earnings management driven by the Tax Reform Act of 1996. To fix ideas for our method, consider the following hypothetical example. All firms face a kink in the tax schedule at \$0 of taxable income. However, a firm with \$10,000 in NOLs carried forward from a previous tax year experiences this zero kink when it earns \$10,000 in the current period. In this example, firms with \$10,000 are our treatment firms and firms with slightly more than \$10,000 are our control firms.

Insert Table 3 About Here

Table 3 demonstrates the similarity of treatment and control firms with firm-specific kink points between \$5,000 and \$6,000 (columns 1-2) and between \$14,000 and \$15,000 (columns 3-4). Treatment firms with firm-specific kink points between $5,000 and $6,000 earn an average of $237,000 in total income, claim $228,000 in total deductions, and earn $7,000 in net income. This is very similar to control firms, which earn $242,000 in total income, claim $233,000 in total deductions and earn $8,000 in net income. Further, treatment firms are of similar size to control groups, when measured by total assets ($75,000 and $79,000 for treatment and control firms, respectively) and EBIDTA ($27,000 for treatment firms and $29,000 for control firms). Treatment and control firms are also very similar at firm-specific kink points between $14,000 and $15,000.[22]

Insert Figure 1 About Here

Figure 1 demonstrates how we estimate the change in income due to bunching using our control group. Panel A depicts the distribution of profit, defined as net income less special deductions, for firms with $10,250 in NOLs (the treatment group depicted with a solid black line), along with the distribution of profit for firms with $11,250, $12,250, $13,250, $14,250, and $15,250 in NOLs (the control group depicted with grey lines).[23] Notice, to the left of the kink, the distributions for each of these groups all look similar and each distribution exhibits a spike precisely where profit equals the firms' stock of NOLs, the firm-specific kink point. We exclude firms to the right of their kink point to restrict the control group to firms unaffected by a kink point.

Panel B of Figure 1 depicts the control group as a gray dot, with one dot for each NOL-taxable income pair. The distribution in the absence of the kink is estimated using the control group distributions to the left of their own kink, depicted as the dashed line in Panel B.[24] This creates a control group that does not include bunching to estimate the distribution in the absence of the kink. The vertical dashed lines delineate the bunching region for the target kink point for firms with $10,250 in NOLs.

Panel C of Figure 1 depicts the excess mass, given by the difference between the observed distribution and the estimated distribution, depicted as shaded region I. The change in taxable income ΔY is calculated using the estimated distribution $h^c(y,n)$ and bunching $B(\tau_0,\tau_1)$:

$$min_{\Delta Y} \quad \left(\sum_{y=\kappa+1}^{\kappa+\Delta Y} h^c(y,n) - B(\tau_0,\tau_1) \right)^2 . \tag{5}$$

Here, $h^c(y,n)$ is the number of firms in a $50 bin around taxable income y with NOLs n,

[22] Additionally, Figure A.3 in the Appendix shows the similarity in the distribution of total assets, gross receipts, labor deductions, and total income for treatment and control firms across all firm-specific kinks.

[23] For ease of exposition, we use groups of firms in $1,000 intervals for the figure, but in empirical application we rely on distributions of firms in $50 intervals. We choose $11,250, $12,250, $13,250, $14,250, and $15,250 to demonstrate that the observed bunching is not driven by a tendency to bunch at round numbers, divisible by $1,000.

[24] Each NOL-specific distribution in the control group is scaled to ensure that the distribution contains the same number of firms as the target distribution. We scale the *control* distributions at each income level by the ratio of the total number of firms to the left of the kink in the *target* distribution to the total number of firms to the left of the kink in the control distribution. The number of firms in each distribution is calculated over the income values within $+/-\$12,500$ of the kink point for the target distribution.

where the superscript c denotes the counterfactual nature of the distribution.[25] Equation (5) formally sets the area in shaded region II equal to the excess mass in region I. The change in taxable income ΔY is then given by the edge of region II, depicted in Panel C of Figure 1.

4.3 Estimating Marginal Tax Rates

To calculate the elasticity of taxable income, we must know the change in the marginal tax rate faced by the bunching firms. One approach would use the change in the statutory tax rate from 0% to 15%. Shevlin [1990], however, demonstrates that the marginal tax rates for corporations must take into account current and expected future taxes because corporations frequently carry losses and other credits forward, which reduce tax liability.[26] A second approach, and one more appropriate for corporations, is to estimate the change in expected marginal tax rates. Graham [1996a,b] build on Shevlin [1990] to develop an approach to estimate expected tax rates using simulations of future income. These methods have been improved by Graham and Kim [2009b] and Blouin et al. [2010a] by allowing for an AR(1) process instead of a random walk and by developing a non-parametric simulation for future income that allows for mean reversion.

We estimate the expected tax rates using two different procedures. First, we follow Graham and Kim [2009a] and estimate that the expected tax rate left of the kink is 5.9% and 15% right of the kink; the details are provided in Appendix A.2.2.[27] A second way to calculate expected marginal tax rates leverages the empirical patterns that reflect our data. For this method, we combine evidence on the probabilities that firms use losses, use carrybacks, and move from one bracket to another (see Table 2). We combine this with evidence from Cooper and Knittel [2010], who estimate the probability that firms use losses, and Zwick [Forthcoming], who estimates the probability that firms use of carry backs. The advantage of this approach is that it captures the empirical facts that firms with the opportunity to use carry back credits only do so 30% of the time [Zwick, Forthcoming] and a substantial amount of losses are never used [Cooper and Knittel, 2010].

The interest rate is a key parameter in the estimation of the expected marginal tax rate because the expected marginal tax rate incorporates discounted tax liability up to 20 years in the future. We consider a range of interest rates to account for variation that may be driven by firm size and ownership structure, among other things [Blackwell et al., 1998; Degryse and Van Cayseele, 2000; Saunders and Steffen, 2011; Cassar et al., 2015; De Franco et al., 2017]. We assume an interest rates of 3% when we calculate the expected tax rate following Graham [1996b]. We vary interest rates between 3% and 15% when we calculate the expected tax rate based on the firms in our estimation sample. The

[25] The $50 threshold ensures that bins are populated and sufficiently small. The estimates are not sensitive to this choice.

[26] There are many reasons why expected tax rates are not statutory tax rates. For example, Hanlon and Shevlin [2002] investigates employee stock options (ESOs). There is also substantial work comparing taxable income and information from financial statements, see Hanlon [2003], Plesko [2003], Mills and Plesko [2003], Mills and Newberry [2005], and others.

[27] We report the estimate of the average marginal tax rate using a random walk. In our context, the results are very similar to using an AR(1) process. Due to data limitations, we are unable to implement the method in Blouin et al. [2010a].

relationship between interest rates and expected tax rates is shown in Panel A of Figure 3. All told, we estimate that the expected tax rate lies between 5% and 7.5% for firms in our sample.

Insert Figure 3 about here.

The expected marginal tax rate is inversely related to the assumed interest rate. For intuition, consider the case of an infinitely large interest rate. In this case, firms do not value the ability to carry-forward their losses to future periods; therefore, the expected tax rate on an additional dollar earned for those in a loss position is zero. This is the implicit assumption underlying the use of the statutory tax rates in elasticity calculations.

4.4 Tuning Parameters

One of the advantages of our method is that our estimates are less sensitive to tuning parameters than are previous methods. For example, the excess mass is estimated as the difference between the observed and counterfactual distributions in the bunching region, depicted in Panel C of Figure 1 by two vertical lines. This range is defined by the parameters α_{ub} and α_{lb}, two tuning parameters. We must also determine the income window and upper and lower bounds of the NOLs used in the control group. We rely on machine learning algorithms to set these tuning parameters in a data-driven way. Appendix A.2 provides details of the tenfold cross-validation and other methods. These processes select a bunching region $\alpha = [\kappa - 600, \kappa + 100]$ and a control group consisting of firms with NOLs between \$500 and \$5,000 above the target distribution. For each kink point, we restrict our sample to firms with income between $\kappa - \$12,500$ and $\kappa + \$12,500$. While our estimates are not particularly sensitive to these tuning parameters (see the sensitivity analysis reported in Appendix A.2), there is value in using a data-driven method to determine these parameters.

Another advantage of our method is that, instead of one policy experiment, we have a series of experiments, consisting of firms bunching at different firm-specific kink points. We repeat our estimates across \$50 intervals in taxable income for firms with NOLs between \$5,000 and \$15,000, creating 201 separate elasticity estimates. We primarily report a weighted average of our 201 separate elasticity estimates, weighted by the number of firms with NOLs = κ. This weighting ensures that our average elasticity properly reflects population differences across NOL values. For example, in our data set, there are almost three times as many firms with NOLs near \$5,000 as there are firms with NOLs near \$15,000.

5 The Corporate Elasticity of Taxable Income

In this section, we report our estimates of how firms respond to an increase in the corporate tax rate. In particular, we show that private firms reduce taxable income to avoid higher marginal tax rates, and these responses differ according to the accounting method employed. We allow the interest rate that discounts future tax payments and determines the expected tax rates to differ by firm size—explaining variation in responses. The differences in responses by firm size and accounting method highlight that these firms have different mechanisms they can use to adjust their taxable income. We investigate this further in Section 6.

In particular, we estimate the percentage change in taxable income in response to increasing marginal tax rates at a kink in the marginal tax schedule. In addition, we estimate the expected tax rate faced by firms in our sample. We combine these two estimates to provide a measure of the CETI. These results leverage (1) enhanced methods for estimating how much firms change their taxable income in response to higher tax rates, (2) an application of expected tax rates, and (3) U.S. administrative data that gives us broad coverage and allows us to consider heterogeneity across firm size and accounting method. We show that our estimates would be substantially different without each of our improvements.

5.1 Firm Responsiveness to the Corporate Income Tax

Table 4 shows that firms reduced their taxable income by 8.93% in response to the increase in marginal tax rates created by the kink in the tax schedule at $0 (column 1, row 2). This estimate is stable over time, ranging between 8% and 9.8% (see Figure A.4 in the Appendix). The elasticity of taxable income scales this response by the percentage change in the net-of-tax rate faced by firms. A natural starting point for this scaling factor is based on the change in the statutory tax rate, which increases from 0% to 15% on the first dollar of taxable income. This results in a 16.25% decrease in the net-of-tax rate.[28] Taken together, these estimates imply a corporate elasticity of taxable income of 0.55 (column 1, row 1).

Insert Table 4 about here.

Importantly, the statutory change in the tax rate overstates the effective change firms experience. Expected marginal tax rates, by comparison, take into account the ability of a firm to use NOLs and tax credits (e.g., the Alternative Minimum Tax Credit, the Foreign Tax Credit, and the General Business Tax Credit) to reduce tax liability in addition to expectations about the likelihood that a firm is able to utilize business losses to offset future positive taxable income at some future date [Graham and Kim, 2009b; Blouin et al., 2010a]. In practice, these offsets are large, creating a large tax expenditure and substantially reducing taxable income. For example, in 2013, NOL deductions totaled $180 billion and general business credits totaled $142 billion. We estimate that the decrease in the net-of-*expected* tax rate is 9.76%, instead of the previously reported 16.25% change in the net-of-statutory tax rate (column 2, row 3). This important adjustment increases the estimated corporate elasticity of taxable income to 0.91 (column 2, row 1).

[28] Net-of-tax-rate = $\ln(\frac{1-\tau_0}{1-\tau_1}) = \ln(\frac{1}{0.85}) = 0.1625$, where $\tau_0 = 0$ and $\tau_1 = 0.15$—the statutory tax rate on the first $1 of taxable income.

A key parameter in determining the expected tax rate is the interest rate used to discount future taxes. Higher interest rates correspond to stronger discount factors and, therefore, smaller effective tax rates. When the change in the net-of-expected tax rate is smaller, the elasticity increases—a smaller tax rate change induces the same estimated change in income. The elasticity reported in columns (1) and (2) of Table 4, we assume that firms face the average corporate bond rate in our sample (6%). Columns (3)–(5) report elasticities based on various alternative interest rates to illustrate the impact of this parameter choice (14%, 9%, and 3%, respectively). Moreover, Figure 3 depicts the relationship between the elasticity and the interest rate. Despite relatively large changes in interest rates across columns (3)–(5), the elasticity is relatively invariant, ranging from 0.81 to 0.98.

Our estimate is a material improvement over previous empirical estimates of the corporate elasticity of taxable income. For example, the 0.2 prevailing empirical estimate based on U.S. companies is limited to publicly traded firms [Gruber and Rauh, 2007]. Additionally, this estimate is based on information reported in Compustat, and these data are known to contain imperfect measures of taxable income [Plesko, 2003]. Regardless of whether we use statutory or expected tax rates, our elasticity estimate is substantially larger. Other more recent estimates take place in non-U.S. contexts [Devereux et al., 2014; Lediga et al., 2019] and are based on changes in statutory tax rates.[29] Importantly, there is no a priori reason to expect parity in the corporate elasticity of taxable income for firms in different countries because the response mechanisms that are available to firms surely depend on many factors, including the local tax environment.

5.2 Heterogeneity in Firm Responsiveness: Firm Size and Interest Rates

Although not observable, the firms in our sample likely face wide heterogeneity in interest rates. This is consistent with the fact that larger firms are more likely to have diverse ownership and have access to large and liquid capital markets, among other things. At the same time, the available mechanisms by which firms adjust their taxable income likely differ by firm size. On the one hand, large firms are thought to be more sophisticated tax planners than smaller firms, increasing their responsiveness to higher tax rates. On the other hand, large firms are more likely to engage in regular financial and tax audits and are generally better monitored than smaller firms, reducing their responsiveness to higher tax rates [Hoopes et al., 2012]. For these reasons, the relative responsiveness of firms by firm size is an empirical question.

To answer this question, we cut our sample into thirds based on gross receipts. Columns (2)—(4) of Table 5 report the estimated change in taxable income for small, medium, and large firms, respectively. Here, we see a monotonic relationship between firm size and the taxable income adjustment: small firms reduce taxable income by 9.69%, medium firms reduce taxable income by 8.69%, and large firms reduce taxable income by 8.39%.

[29] A thorough comparison between our elasticity estimate and the one in Devereux et al. [2014] is given in Appendix A.2.

Table 5 about here.

As previously discussed, estimates in the change in net-of-tax rate faced by firms on either side of the kink are required to estimate the elasticity of taxable income. Because we cannot observe the interest rate, we decompose the elasticity of taxable income calculation into two steps. In step one, we hold the interest rate fixed at the average corporate bond rate (6%), and simply scale the $\%\Delta$ in Income (Panel A of Table 5). This guarantees that the relationship between the elasticity across firm size is driven by estimates of the percentage change in taxable income. In particular, smaller firms are the most responsive to the corporate tax rate, with an estimated elasticity of 0.99. Medium and large firms are slightly less elastic, with an elasticity of 0.89 and 0.86 respectively.

In step two, we allow for variation in the interest rate. There is a known empirical relationship between firm size and the cost of capital that supports a negative relationship between interest rates and firm size [Degryse and Van Cayseele, 2000; Saunders and Steffen, 2011; Cassar et al., 2015]. Thus, we assume that the smallest firms face the largest interest rate. Panel B of Table 5 reports the assumed interest rates and resulting estimated elasticities. Based on these interest rates, the change in expected tax rates for small firms is therefore larger than for medium or large firms (row 6). As a result, the elasticity for small, medium, and large firms is estimated to be 0.87, 0.84, 0.92, respectively. In other words, large firms have the largest elasticity even though they make the smallest adjustments to taxable income. The evidence in this table demonstrates the important variation in the elasticity of taxable income that is related to firm size and underscores the relationship between interest rate assumptions and the estimated elasticity of taxable income.

5.3 Heterogeneity in Firm Responsiveness: Accounting Method

Finally, we hypothesize that cash accounting firms are more responsive to higher tax rates than accrual accounting firms. Specifically, cash accounting allows for more discretion in the timing and recognition of income and expenses than accrual accounting. To investigate this, we estimate the change in income separately for cash and accrual accounting firms, limiting our analysis to firms that are eligible to elect cash accounting. Column (2) of Table 6 reports our results for eligible firms, and columns (3) and (4) report our results for cash and accrual firms, respectively. We estimate that cash accounting firms reduce income by 9.67% in response to higher tax rates, compared to a 7.25% reduction for accrual firms. Because we limit our analysis to eligible firms, we attribute this heterogeneity to accounting method, not firm size. If these firms face the same interest rate, the elasticity for cash accounting firms is substantially larger than for accrual firms (0.99 and 0.74, respectively).

Table 6 about here.

By design, the elasticity of taxable income is agnostic about the particular mechanism firms use to reduce taxable income. However, understanding whether and by how much this elasticity is driven by economic responses or tax adjustments is an important caveat to this estimate. For example, is the larger elasticity for cash accounting firms due to these firms being more nimble and better able to make economic adjustments than accrual firms? Or does cash accounting confer a reporting technology that leads to increased tax adjustments? More generally, how does the estimated elasticity of 0.91 for the full sample reflect these two response dimensions? In the next section, we introduce a structural model to disentangle our empirical estimate of the elasticity of taxable income into its underlying mechanisms: economic responses and tax adjustments.

6 CETI: Economic Responses and Tax Adjustments

In this section, we investigate how firms respond to corporate tax rates. We demonstrate that, with some additional assumptions, we can separate firm responses into economic responses and tax adjustments. For example, economic responses encompass new choices by firms that lower output and profit, such as hiring fewer people and investing less. Tax adjustments, in contrast, include shifting revenues to lower tax periods or costs to higher tax periods but do not fundamentally change input or output.

There are four traditional ways firms make tax adjustments to income. First, firms can shift income across time to take advantage of changes in tax rates and the time value of money. For example, paying taxes later by accelerating expenses or delaying revenue. Second, firms can shift income across jurisdictions (e.g., transfer pricing—both income and expenses). Third, firms can shift income across types of income. For example, carried interest allows a capital gains treatment of income that would otherwise be treated as ordinary income. Fourth, firms can shift income across types of entities. For example, subsidiaries of consolidated tax groups can be organized around certain income or expense sources to take advantage of preferential tax treatment (e.g., REITs). Large firms document these activities on IRS Schedule UTP if they confer an uncertain tax position and are above a de minimus amount.[30] The ability to adjust taxable income using these mechanisms differs by accounting method.[31]

Firms adjust their economic activity when they face higher or lower tax rates. This response is the basis for economic policies that lower the effective tax rates on investment, particularly in recessions (e.g.„ bonus depreciation). This response is also the basis for policy agendas to lower the corporate tax rate—to increase employment, wages, investment, output, and profits. Whether firm responses are primarily driven by economic responses or tax adjustments has different implications for the extent to which taxes distort firm value and economic output, explored more in Section 7.

[30]Towery [2017] finds that firms adjust their financial reporting to avoid Schedule UTP disclosure requirements.

[31]See Healy and Wahlen's 1999 survey for a more complete discussion. For approaches to decompose accruals into the nondiscretionary and discretionary components, see Jones [1991] and the subsequent modification in Dechow et al. [1995].

6.1 Separating the Economic Responses and Tax Adjustments

To separate the economic response from tax adjustments, we make some assumptions regarding the nature of these responses. We characterize economic responses as a reduction in income driven by a proportional reduction in inputs and outputs. This assumption holds for a wide range of models, including a standard model of firms with no market power and constant returns to scale.[32] This assumption has also been used extensively in the income shifting literature (see Klassen et al. [1993], Collins et al. [1998], and Klassen and Laplante [2012]). For these firms, the profit margin does not change with output.[33] Of course, the appropriateness of this assumption in the data is an empirical question. In our exploration, described in Section 6.4, we find substantive support for this assumption.

In contrast, we understand that tax adjustments cause a non-proportional change in revenue, deductions, and income, whether through lower reported revenues, higher reported deductions, or both. For example, any reduction in reported revenue, either through discretionary accruals or the timing of transactions, is associated with a dollar-for-dollar reduction in income. This is described in more detail in Appendix A.3.

To implement this strategy, we estimate:

$$ln\left(\frac{Y}{R}\right)_{i,t} = \beta_0 + \beta_1 1[Y \geq \kappa]_{i,t} + x_{i,t}\delta + \lambda_N + \lambda_I + \varepsilon_{i,t}, \tag{6}$$

where the dependent variable is the log profit margin and the independent variables include an indicator identifying firms that are in or to the right of the bunching region, and a set of income and NOL fixed effects, λ_N and λ_I respectively.[34,35] The coefficient, β_1, gives the percentage change in the profit margin as the statutory tax rate changes from 0% to 15%. Said differently, β_1 identifies the difference in profit margin that is due to the higher tax rate, holding income and NOLs constant.

The tax adjustment and economic response elasticities are:

$$e_\tau = \frac{\beta_1}{ln(\frac{1-\tau_0}{1-\tau_1})} \quad \text{and} \quad e_r = \varepsilon_Y - \frac{\beta_1}{ln(\frac{1-\tau_0}{1-\tau_1})}, \tag{7}$$

where $\beta_1 = dln(Y/R)$ is the coefficient from equation (6) and ε_Y is the corporate elasticity of taxable income.[36] If the ratio of taxable income to revenues is the same for firms

[32] The assumption that economic responses result in proportional changes in inputs and outputs, and therefore no change in profit margins, applies equally to cash basis firms and accrual firms. Cash accounting can result in a mismatch in the timing of costs and revenue across tax years, and this mismatch would result in a change in the profit margin. However, in the absence of tax adjustments, the timing of revenue and costs around the beginning and end of a tax year would be purely random. In expectation, any mismatch in the timing of revenue and costs net to zero.

[33] The profit margin, or corporate income as a share of revenue, is also commonly referred to as the capital share. Assuming profit maximization and constant returns to scale, the capital share is equal to the output elasticity of capital, which is invariant to the choice of output.

[34] We overcome the fact that the tax rate is not randomly assigned by splitting taxable income into a component based on current period income and previously determined NOLs. This allows us to isolate the effect of the tax rate on the profit margin by controlling for current period income and NOLs in our empirical specification.

[35] We impose one additional sample restriction: limiting our sample to firms with taxable income between -\$10K and +\$10K. Profit margins are stable in this region, but begin to fall with taxable income below -\$10K, leading to a spurious correlation between profit margins and tax rates.

[36] The derivation of equation (7) is in Appendix A.3.

right and left of the kink, our estimate of $\beta_1 = dln(Y/R)$ would be zero. In this case, the tax adjustments would be estimated as zero because we find no disproportional change in the profit margin for firms that face higher marginal tax rates. In contrast, if $\beta_1 < 0$, this suggests that firms that experienced higher marginal tax rates, but the same change in income, experience a lower profit margin. We characterize this decrease in profit margin as a tax adjustment.

6.2 Economic Response and Tax Adjustment Elasticities

To estimate the tax adjustment elasticity, we combine our estimate of the percentage change in taxable income with equation (7). The results are reported in Table 7. We find that firms reduce taxable income by 2.96% due to economic responses and 5.96% due to tax adjustments (columns 1 and 4, row 2). Assuming that firms face the average corporate bond rate, we find an economic response elasticity of 0.30 and a tax adjustment elasticity of 0.61 (columns 1 and 4, row 1). Said differently, 67% of the elasticity of taxable income, or nearly $4 billion in taxable income in 2013, is due to mechanisms related to tax adjustments. Two-thirds of this response is along tax adjustment margins, which is consistent with a hypothesis that private firms are sophisticated and tax aggressive.

Table 7 About Here

To put these estimates into further context, our economic response elasticity of 0.30 is larger than the prevailing CETI estimate of 0.2 in Gruber and Saez [2002]. The economic response elasticity is also larger than the mean elasticity of personal taxable income estimate of 0.25 in Saez et al. [2012]. Thus, we conclude that corporate taxes have an effect on economic behavior that is larger than previously thought.

There are two concerns worth noting when interpreting the economic response elasticity. First, as equation (6) makes clear, the economic response is not estimated directly; it is the remainder when the tax adjustment elasticity is subtracted from the overall elasticity. Thus, any bias in the estimate of either the overall elasticity or the tax adjustment elasticity will directly bias our estimate of the economic response elasticity.[37] For instance, attenuation bias in the estimate of β_1 due to measurement error would result in a proportional increase in the economic response estimate.

Second, we caution that our estimates may characterize a lower bound for the long-run economic response to the corporate tax schedule. Estimates based on kink-points typically capture the effect of short-term tax responses on short-term tax revenue. This is particularly true for the economic response elasticity estimate, which likely reflect large underlying frictions. For example, if firms face a 10% lower tax rate that they anticipate will be indefinite, their investment and employment responses are likely to be larger.

6.3 Heterogeneous Responses: Accounting Method

Accounting methods are first-order candidates for explaining variation in firm responsiveness to the tax system. Table 7 reports the economic response (columns 2 and 3) and tax

[37] A similar problem exists for a multiple regression specification. Bias in any one coefficient estimate will cause bias in all other coefficient estimates.

adjustment elasticities (columns 5 and 6) for cash and accrual accounting firms. The cash accounting firms have an economic response that is almost twice as large as accrual accounting firms: 3.13% versus 1.64%, respectively (columns 2 and 3, row 2).[38] While the economic response is substantial, it is less than half of the total response, regardless of accounting method. In particular, cash and accrual accounting firms use tax adjustments to reduce taxable income by 6.55% and 5.61%, respectively (columns 5 and 6, row 2). Recall that cash accounting firms report taxable income and deductions based on the tax year in which cash was received, whereas accrual firms must report income and deductions based on the tax year in which products are conveyed and services are rendered. In this regard, cash firms are granted greater flexibility in the timing of income and deductions based on their ability to shift payments divorced from real activity, and this is consistent with the larger elasticity of tax adjustments for cash accounting firms (0.67 vs. 0.57, columns 5 and 6, row 1). The evidence we provide builds on prior empirical and theoretical analyses demonstrating that tax compliance is linked to accounting rules [Blouin et al., 2010b; Gupta et al., 2014; Towery, 2015, 2017].

6.4 Evidence on Proportional Changes

We next investigate the plausibility of the assumption that revenue and deductions change proportionally, at least locally, for the firms in our sample. Specifically, we test for proportional changes for a subsample of firms with positive current income and sufficient NOLs to remain below the kink for two consecutive years. These firms are less likely to face incentives for tax adjustments from one year to the next; therefore, changes in revenue and deductions reflect only changes in economic activity, along with random fluctuations. Figure 2 gives the scatter plot of the log changes in revenue and deductions for this sample. The 45 degree line in dark gray represents the hypothesis of perfectly proportional changes in revenue and deductions, while the connected dots represent the mean values of the log change in revenue within bins of log change in deductions. Panel A includes the full sample, while Panels B and C are restricted to cash accounting and accrual accounting firms, respectively. Panel D provides a comparison of cash and accounting firms, demonstrating that the constant returns assumption seems appropriate for both samples. Using this log-log specification, we estimate that a 1% year-over-year change in revenue is associated with a 1.007% year-over-year change in deductions.[39] That is, on average, changes in economic activity result in proportional changes in revenue and deductions, leaving the profit margin unchanged.[40]

Insert Figure 2 About Here

[38] We attribute the statistical insignificance of the economic response for accrual firms to the smaller sample size for this subset of firms.

[39] The standard error for this estimate is 0.0007.

[40] A related concern is that firms to the left and right of the kink differ in some other, unmeasured characteristics that drive the observed difference in the profit margin. Figure A.6 in the Appendix shows the distribution of the one-year-lagged log profit margin for both the treatment and control groups. The similarity between their distributions suggests that any difference in profit margins is driven by changes in tax rates, not omitted variables.

Finally, we perform several placebo tests, which we report in Table A.3 in the Appendix.[41] Using the subsample of firms below the zero kink, we test for profit margin differences above and below arbitrary taxable income cutoffs of -2,000, -4,000, -6,000, and -8,000, where no kink exists. In each placebo test, the coefficient of interest is statistically insignificant and close to zero in magnitude, suggesting that our results are not driven by a spurious correlation.

7 Application

In this section, we demonstrate that the effect of corporate income taxes depends on how firms respond, characterized by three factors: (1) the economic response elasticity, e_r, (2) the tax adjustment elasticity, e_τ, and (3) the corporate elasticity of taxable income, ε_Y. We build on the model in Section 3, derive conditions for how total economic value changes as a function of these elasticities, and estimate how firm value would change if tax rates dropped 10 percentage points.

Building on the model is Section 3, we define the tax adjustment elasticity as the percentage change in taxable income, Y, due to changes in tax adjustments, ρ, divided by the percentage change in the net-of-tax rate, $e_\tau = -(d\rho/Y)(1-\tau)/(d(1-\tau)) > 0$. Similarly, we define the economic response elasticity as the percentage change in taxable income due to changes in profit, π, divided by the percentage change in the net-of-tax rate, $e_r = (d\pi/Y)(1-\tau)/(d(1-\tau)) > 0$. Together, the economic response and tax adjustment elasticities determine the total percentage change in corporate taxable income or the elasticity of taxable income: $\varepsilon_Y = e_\tau + e_r$.

7.1 Distortions to the Economy

Total value in the economy includes the value of the firm (in brackets below), tax revenue collected, and the cost of tax adjustments that is a transfer to accounting firms:[42]

$$TV = \{-rK + (1-\tau)Y(K,\rho) + \rho - c(\rho)\} + \tau Y(K,\rho) + \mu c(\rho). \tag{8}$$

The distortion of total value in the economy due to the corporate tax is captured by the elasticity of taxable income e_Y and the tax adjustment elasticity e_τ :

$$\frac{dTV}{d(1-\tau)} = Y(\varepsilon_Y - \mu e_\tau). \tag{9}$$

(i) If the cost of tax adjustments is a resource cost ($\mu = 0$), then

(a) the elasticity of taxable income is a sufficient statistic for the distortion to total value.

(ii) If the cost of tax adjustments is partially a transfer ($\mu > 0$), then

[41] Identification of the real effect and tax adjustments elasticities relies on the assumption that there is no correlation between the profit margin and taxable income, conditional on controlling for income and NOL fixed effects, λ_N and λ_I in equation (6).

[42] This derivation follows the insights of Chetty [2009] and customizes them for the context of corporate taxes.

(a) the elasticity of taxable income is an upper bound on the distortion to total value, and

(b) the distortion to total value decreases with the tax adjustment elasticity, e_τ.

This result demonstrates the importance of separately identifying the economic response and tax adjustment elasticities. In particular, the cost to the economy is substantially less than would be implied by the elasticity of taxable income if firms respond to corporate income taxes by doing more tax adjustments and the cost of tax adjustments is partially a transfer. In fact, we find that the tax adjustment elasticity is large (see Table 7 and Section 6.2), which suggests the deadweight loss from the corporate income tax is less than implied by solely considering the elasticity of taxable income.

While we do not mean to be provocative, our finding that a substantial increase in tax rates is unlikely to fully generate the expected increase in tax revenue is highly pertinent to the current policy landscape.

7.2 Change in Firm Value

We can calculate the change in firm value due to a change in tax rates with the added structure that the cost of tax adjustments is given by $c(\rho) = \rho^2/(2\phi\pi)$, where the cost decreases with some fraction ϕ of profits.[43] The change in firm value due to a change in corporate tax rate from τ_0 to τ_1 is captured by:

$$\frac{V(\tau_1) - V(\tau_0)}{V(\tau_0)} = \frac{(1-\tau_1+\tau_1 e_\tau)(1-\tau_1)^{\theta_1} + e_\tau \tau_1^2 \theta_1 (1-\tau_1)^{\theta_1 - 1}}{(1-\tau_0+\tau_0 e_\tau)(1-\tau_0)^{\theta_0} + e_\tau \tau_0^2 \theta_0 (1-\tau_0)^{\theta_0 - 1}} - 1, \qquad (10)$$

where, $\theta_i = 1 + e_r(1-\tau_i)/(1-\tau_i+\tau_i e_\tau)$.

In Panel A of Table 8, our economic response and tax adjustment elasticity estimates suggest that lowering the corporate tax rate from 35% to 25% would increase firm value by 13.84% (column 1).[44] The increase in firm value from a decrease in corporate tax rate is combination of the direct effect of allowing firms to keep more after-tax profit and the indirect effect of decreasing the distortion to investment and costs of tax adjustments. The distortion in firm value due to corporate taxes increases with the economic response elasticity and decreases with the tax adjustment elasticity.

If corporate decisions are not distorted by the corporate tax rate, firm value would increase by 33% as a result of the reduced tax liability. In addition, firms increase real activity in response to lower tax rates, which increases firm value by 5%. Diminished shifting activity, however, dampens the effect of a tax rate decrease and reduces the increase in firm value to 13.84%.[45]

[43] The effect on firm value of the corporate income tax abstracts from agency costs due to the use of tax adjustments. For a discussion of these agency costs, see Desai and Dharmapala [2006] and Desai and Dharmapala [2009].

[44] We consider a basic discounted cash flow model as an external check on our estimate that firm value would decrease by 13.84% from a reduction in tax rate from 35% to 25%. While this model does not incorporate economic responses or tax adjustments, it is nonetheless consistent with our estimate. Specifically, with a tax change from 35% to 25%, the cash flow model would estimate a change of 15.3% = (1-25%)/(1-35%).

[45] In Appendix A.1, we consider different tax rate changes. For more comparative statics, see Table A.4 in the Appendix.

The change in firm value due to a change in the corporate tax rate differs across firm type because their economic response and tax adjustment elasticities differ. For example, cash accounting firms have a larger tax adjustment elasticity than accrual accounting firms. This difference implies that cash accounting firms would experience a smaller increase in firm value (12.45% vs. 14.21% for accrual firms; columns 2 and 3).

8 Conclusion

One and a half million private C corporations, many of which have different ownership structures and financial reporting incentives than public firms, paid a total of $100 billion in U.S. corporate taxes in fiscal year 2014. These firms make up a considerable fraction of the U.S. economy. Yet our understanding of their behavior in response to the tax structure has been hindered by doubtful methods and a lack of accessible data. In this paper, we develop a new bunching method, assemble administrative data on the universe of private C corporations that file an IRS Form 1120, and exploit a kink in the corporate tax schedule to precisely estimate the responsiveness of private firms to corporate tax rates.

We find that private firms are very responsive to increased corporate tax rates. Private firms, on average, reduce taxable income by 8.9% in response to higher tax rates, which implies a 0.91 corporate elasticity of taxable income. Moreover, 67% of this response is due to changes in tax adjustments and 33% is due to economic responses. Our estimates suggest that corporate tax rates affect private firms more than implied by previous studies examining public firms and statutory tax rates.

We find economically material differences in the response of firms across firm size and accounting methods. For example, cash accounting firms are more responsive to corporate taxes than firms that use accrual accounting. We also find that cash accounting firms employ tax adjustments more than accrual accounting firms. Our findings suggest that cash accounting firms may have lower agency costs or lower frictions to intertemporally shift revenues and costs.

Our control group method can be used to estimate firms' responsiveness to reporting thresholds. For example, this method provides a tool to transform the empirical irregularity that firms bunch at thresholds into parameter estimates of how responsive firms are to different reporting incentives. Alternatively, this method could be adapted to address questions about the magnitude of the incentives to report just above or below a threshold.

Our estimates are based on firms located near the zero kink in taxable income. In 2017, the corporate tax regime in the U.S. was modified for the first time in thirty years. Instead of a progressive marginal tax schedule with a top rate of the 35%, U.S. corporations now face a flat marginal tax schedule with a rate of 21%. Said differently, the U.S. corporate tax schedule now only contains one statutory kink: the zero kink, where a firm faces a 21% tax rate on the first dollar of taxable income earned. In light of this, our estimate is uniquely situated to speak to the behavior of firms under the new corporate tax regime.

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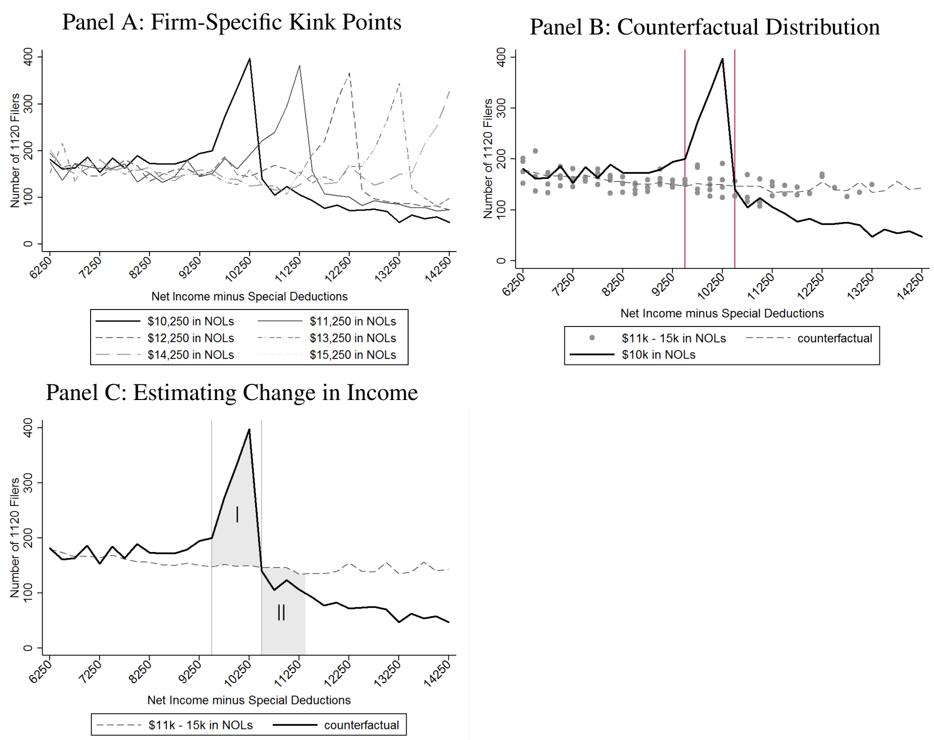
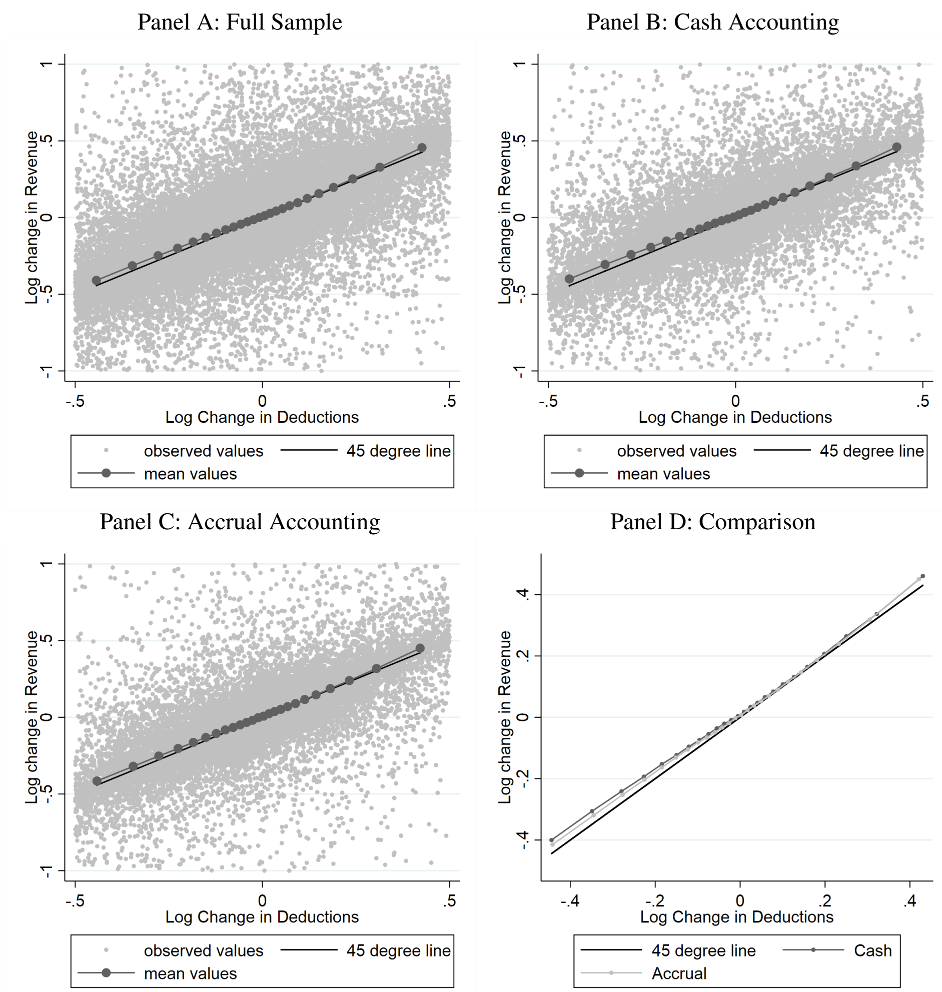
FIGURE 1: Constructing the Counterfactual



Note: This figure depicts the estimation strategy employed to estimate the change in income undertaken by firms in response to changes in tax rates. See Subsection 4.2 for more details.

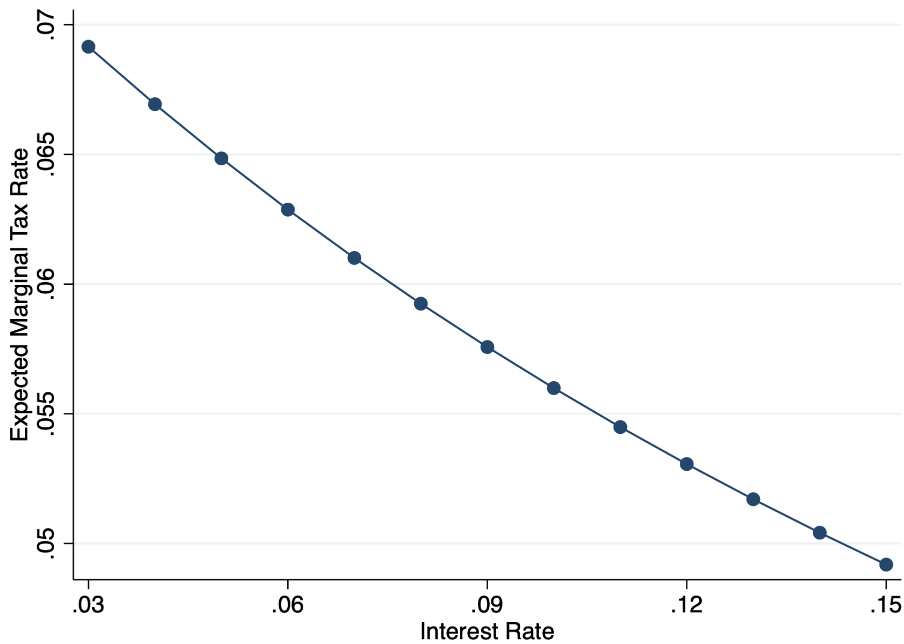
FIGURE 2: Log Change in Revenue and Deductions



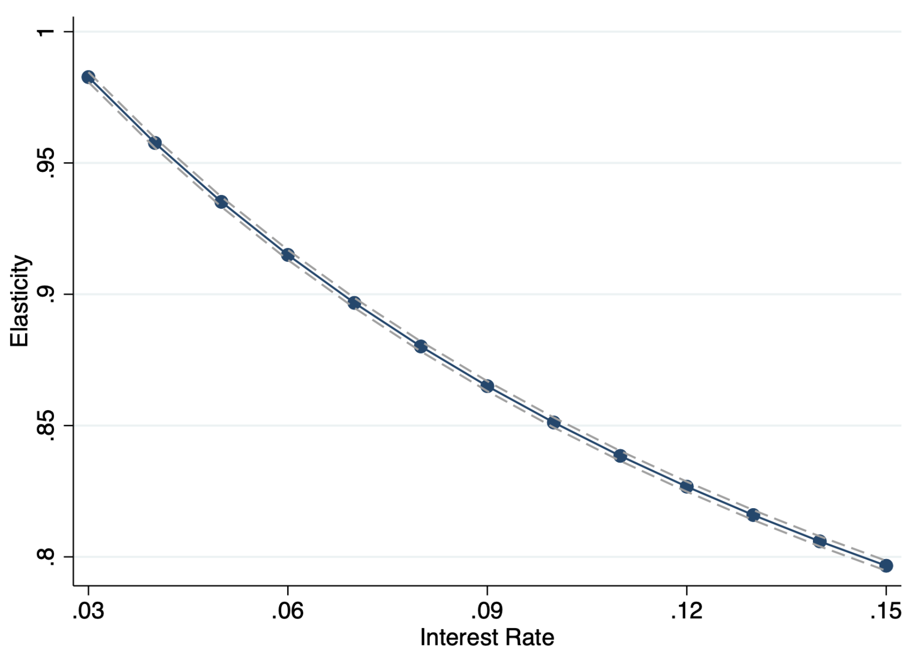
Note: The panels show log change in revenue and log change in deductions for 5,024,837 firm-year observations from 2004 to 2014 in which the firm is non-taxable (below the zero kink) for two consecutive years. This ensures no behavioral response to a change in tax liability. Mean values of log change in revenue are plotted for 25 equal bins of log change in deductions. The scatter plots are a random 1% sample. The 45 degree line reflects the prediction under constant returns to scale.

FIGURE 3: Marginal Tax Rates, Interest Rates, and the Elasticity of Taxable Income

Panel A: Interest Rates vs. Marginal Tax Rates



Panel B: Interest Rates vs Elasticity of Taxable Income



Note: In Panel A, we plot the estimated relationship between the assumed interest rate and the estimated effective tax rates. For details, see Subsection 4.3. In Panel B, we combine the estimated effective tax rates and the change in income (8.93%, Table 4) to calculate the elasticity of taxable income for interest rates that range between 1% and 15%. 95% confidence intervals are marked by the dashed line.

TABLE 1

Corporate Descriptive Statistics by Decile: 2004-2014

All variables are measured at the firm-year level for 2004–2014. Values are reported in thousands of 2014 dollars based on the CPI-U. Bunching sample statistics are based on administrative tax data, while Private and Public sample statistics are based on the IRS Statistics of Income Corporate Sample. Reported values for percentiles are averages of the five closest observations in order to mask confidential tax return data. Public firms are identified based on responses in the Form 1120 Schedule M. Firms that are not identified as public according to the tax data are deemed to be private. "Ever Public" is the sample of firms that are public at least once between 2004 and 2014. We report the following IRS Form 1120 line Numbers: Gross Receipts (line 1c), Total Income (line 11), Net Income (line 28), Taxable income (line 30), Total Deductions (line 27), Officer Pay (line 12), Salaries and Wages (line 13), Cost of Goods Sold (line 2), Assets (Sch L line 15), NOL Deduction (line 29a), Stock of NOLs (Sch K line 12), Cash Accounting (Sch K Line 1).

	Bunching Sample ($1000s)			Always Private ($1000s)			Ever Public ($1000s)		
	10th (1)	50th (2)	90th (3)	10th (4)	50th (5)	90th (6)	10th (7)	50th (8)	90th (9)
Panel A: Measures of Income									
Gross Receipts	37	226	1,007	0	229	3,336	0	55,120	2,404,601
Total Income	39	153	658	2	161	1,648	859	47,868	1,313,021
Net Income	2	7	18	-45	0	72	-24,437	1,133	156,132
Taxable Income	0	0	7	0	0	47	0	0	124,181
Panel B: Detailed Economic Activity									
Total Deductions	31	145	647	5	165	1,661	3,638	50,177	1,170,910
Officer Pay	0	13	165	0	0	231	0	1,408	14,735
Salary and Wage Deductions	0	4	160	0	2	423	189	11,052	293,584
Cost of Goods Sold	0	9	419	0	0	1,605	0	10,459	1,163,109
Assets	0	22	321	0	85	1,629	8,530	207,818	4,994,023
Panel C: Net Operating Losses and Taxes									
NOL Deduction	2	7	13	0	0	13	0	0	7,186
Stock of NOLs	6	10	15	0	0	190	0	3,183	183,419
Total Taxes Paid	0	0	1	0	0	7	0	8	33,000
Share Cash Accounting		0.61			0.50			0.01	
Firm-Year Observations		565,020			18,281,096			77,577	

TABLE 2

Markov Transition Matrix: Private C Corporations, Taxable Income

This table shows the probability of transition across corporate tax brackets for private C corporations between 2004 and 2014. Firms are grouped according to their taxable income, which cannot be negative. Rows represent initial values, while columns represent the conditional probability of reporting income in the specified range in the following period. Probability values in rows may not sum to 1 due to rounding.

t t+1	$0k	< $50k	$50k - $75k	$75k - $0.1m	$0.1m - $0.35m	$0.35k - $10m	$10m - $15m	$15m - $18m	> $18m
$0	0.86	0.11	0.01	0	0.01	0	0	0	0
< $50k	0.31	0.60	0.05	0.02	0.02	0	0	0	0
$50k - $75k	0.19	0.35	0.25	0.10	0.10	0.01	0	0	0
$75k - $0.1m	0.18	0.23	0.18	0.19	0.20	0.03	0	0	0
$0.1m - $0.35m	0.18	0.13	0.08	0.09	0.41	0.11	0	0	0
$0.35m - $10m	0.14	0.03	0.01	0.01	0.13	0.64	0.01	0	0.01
$10m - $15m	0.12	0	0	0	0.01	0.35	0.27	0.10	0.15
$15m - $18m	0.11	0	0	0	0	0.23	0.18	0.15	0.32
> $18m	0.11	0	0	0	0	0.09	0.05	0.05	0.70
Total	0.65	0.24	0.03	0.02	0.03	0.02	0	0	0

TABLE 3

Comparison of Treatment and Control Firms

All variables are measured at the firm-year level for years 2004–2014. Values are reported in thousands of 2014 dollars based on the CPI-U. EBITDA statistics are based on the IRS Statistics of Income Corporate Sample, while all other sample statistics are based on administrative tax data. Inclusion in the treatment or control group is determined as described in Section 3. We report the following IRS Form 1120 Line Numbers: Total Income (line 11), Salaries and Wages (line 13), Total Deductions (line 27), Net Income (line 28), and Assets (Sch L line 15).

	Firm Specific Kinks $5k–$6k		Firm Specific Kinks $14k–15k	
	Treated (1)	Control (2)	Treated (3)	Control (4)
Total Income	237	242	268	268
	(248)	(250)	(260)	(260)
Labor Cost	36	38	44	44
	(65)	(67)	(73)	(72)
Total Deductions	228	233	258	258
	(247)	(248)	(259)	(259)
Net Income	7	8	11	11
	(5)	(5)	(6)	(6)
EBITDA	27	29	31	34
	(26)	(26)	(24)	(26)
Total Assets	75	79	95	97
	(129)	(131)	(142)	(143)
Observations	68,950	293,656	35,816	174,398

TABLE 4

Firm Responses to Corporate Tax Rates

This table reports elasticity estimates from the specifications derived in equation (4). Columns (1) and (2) report the elasticity of taxable income using statutory and expected tax rates, respectively. Columns (3), (4), and (5) report variation in the estimated elasticity based on variation in assumed interest rates. Expected tax rates account for the dynamic nature of corporate taxes and are reported at the bottom of the table. We calculate expected tax rates following the method by Graham [1996a] and Graham [1999], explained in more detail in Appendix A.2.2. This estimation relies on several tuning parameters, which we choose through cross validation and other data-driven methods, see Appendix A.2. These include: the income window (+/-$12,500), the bunching region (-$600, $100), the counterfactual region ($500, $5,000), and the bin width ($50). All estimates are statistically significant at the 1% level, *t*-statistics for all pairwise comparisons are reported in Table A.6 in the Appendix. Bootstrapped standard errors are in parentheses.

	Statutory	Expected	Alternative Interest Rates		
	(1)	(2)	(3)	(4)	(5)
Elasticity	0.55	0.91	0.81	0.87	0.98
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\%\Delta$ Income	8.93	8.93	8.93	8.93	8.93
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
$\%\Delta(1-\tau)$	16.25	9.76	11.08	10.32	9.09
Interest Rate	-	0.06	0.14	0.09	0.03
Observations	565,020	565,020	198,068	175,935	172,709

TABLE 5

Differences in Firm Responses by Size

This table reports heterogeneity in the estimated elasticity based on firm size. Column (1) reports the elasticity for the full sample of firms. Columns (2), (3), and (4) report the elasticity by firm size. Asset thresholds used to divide firms into thirds are reported at the bottom of the table. Expected tax rates account for the dynamic nature of corporate taxes and are reported at the bottom of the table, explained in more detail in Appendix A.2.2. The assumed interest rate faced by firms is reported at the bottom of the table. This estimation relies on several tuning parameters, which we choose through cross validation and other data-driven methods, see Appendix A.2. These include: the income window (+/-\$12,500), the bunching region (-\$600, \$100), the counterfactual region (\$500, \$5,000), and the bin width (\$50). All estimates are statistically significant at the 1% level, *t*-statistics for all pairwise comparisons are reported in Table A.6 in the Appendix. Bootstrapped standard errors are in parentheses.

		Firm Size		
	Full Sample (1)	Small (2)	Medium (3)	Large (4)
Panel A: Fixed Interest Rate				
Elasticity	0.91	0.99	0.89	0.86
	(0.01)	(0.02)	(0.02)	(0.02)
$\%\Delta$ Income	8.93	9.69	8.69	8.39
	(0.10)	(0.18)	(0.18)	(0.17)
$\%\Delta(1-\tau)$	9.76	9.76	9.76	9.76
Interest Rate	0.06	0.06	0.06	0.06
Panel B: Varying Interest Rate With Size				
Elasticity	0.91	0.87	0.84	0.92
	(0.01)	(0.02)	(0.02)	(0.02)
$\%\Delta$ Income	8.93	9.69	8.69	8.39
	(0.10)	(0.18)	(0.18)	(0.17)
$\%\Delta(1-\tau)$	9.76	11.08	10.32	9.09
Interest Rate	0.06	0.14	0.09	0.03
Assets Threshold	-	$\leq$ \$0	$\leq$ \$69,191	$>$ \$69,191
Observations	565,020	198,068	175,935	172,709

TABLE 6

Differences in Firm Responses by Accounting Method

This table reports heterogeneity in the estimated elasticity estimates based on accounting method. Column (1) reports the elasticity for the full sample of firms. Columns (2), (3), and (4) report the estimated elasticity for the subsample of firms that are eligible for a cash accounting election, cash accounting firms, and accrual accounting firms, respectively. Expected tax rates account for the dynamic nature of corporate taxes and are reported at the bottom of the table, explained in more detail in Appendix A.2.2. The assumed interest rate faced by firms is reported at the bottom of the table. This estimation relies on several tuning parameters, which we choose through cross validation and other data-driven methods, see Appendix A.2. These include: the income window (+/-$12,500), the bunching region (-$600, $100), the counterfactual region ($500, $5,000), and the bin width ($50). All estimates are statistically significant at the 1% level, t-statistics for all pairwise comparisons are reported in Table A.6 in the Appendix. Bootstrapped standard errors are in parentheses.

		$<$ \$5 million Gross Receipts		
	Full Sample (1)	Subsample (2)	Cash (3)	Accrual (4)
Elasticity	0.91	0.91	0.99	0.74
	(0.01)	(0.10)	(0.01)	(0.02)
$\%\Delta$ Income	8.93	8.93	9.67	7.25
	(0.10)	(0.97)	(0.13)	(0.17)
$\%\Delta(1-\tau)$	9.76	9.76	9.76	9.76
Interest Rate	0.06	0.06	0.06	0.06
Observations	565,020	565,012	321,867	183,694

TABLE 7

Economic Responses and Tax Adjustments

This table reports elasticity estimates broken down into economic responses and tax adjustments, as described in Section 6. Columns (1) and (4) report the economic response and tax adjustment response, respectively, for the full sample of firms. Likewise, columns (2) and (5) report these responses for cash accounting firms and columns (3) and (6) for accrual accounting firms. Expected tax rates account for the dynamic nature of corporate taxes and are reported at the bottom of the table, explained in more detail in Appendix A.2.2. The assumed interest rate faced by firms is reported at the bottom of the table. This estimation relies on several tuning parameters, which we choose through cross validation and other data-driven methods, see Appendix A.2. These include: the income window (+/-$12,500), the bunching region (-$600, $100), the counterfactual region ($500, $5,000), and the bin width ($50). All estimates are statistically significant at the 1% level, *t*-statistics for all pairwise comparisons are reported in Table A.6 in the Appendix. Bootstrapped standard errors are in parentheses.

	Economic Responses			Tax Adjustments		
	Full	Cash	Accrual	Full	Cash	Accrual
	(1)	(2)	(3)	(4)	(5)	(6)
Elasticity	0.30	0.32	0.17	0.61	0.67	0.57
	(0.07)	(0.08)	(0.11)	(0.07)	(0.08)	(0.11)
$\%\Delta$ Income	2.96	3.13	1.64	5.96	6.55	5.61
	(0.64)	(0.80)	(1.06)	(0.64)	(0.80)	(1.07)
$\%\Delta$ (1 - τ)	9.76	9.76	9.76	9.76	9.76	9.76
Interest Rate	0.06	0.06	0.06	0.06	0.06	0.06
Observations	455,174	260,878	146,005	455,174	260,878	146,005

TABLE 8

Change in Firm Value

This table reports the change in firm value using the specification derived in equation (10) and our estimates of the economic response and tax adjustment elasticities. Column (1) reports the percentage change in firm value for the full sample. Columns (2) and (3) report the percentage change in firm value for cash and accrual accounting firms. This calculation assumes a change of tax rate from 0.35 to 0.25. All calculations are based on expected tax rates based on the parameters reported at the bottom of the table.

		Accounting	
	Full Sample	Cash	Accrual
	(1)	(2)	(3)
$\%\Delta$ Firm value	13.84%	12.45%	14.21%
Tax Adjustments e_τ	0.61	0.67	0.57
Real Responses e_r	0.30	0.32	0.17
τ_0	0.35	0.35	0.35
τ_1	0.25	0.25	0.25

TABLE A.1

Markov Transition Matrix: Private C Corporations, Pre Tax Profit

This table shows the probability of transition across corporate tax brackets for private C corporations between 2004 and 2014. Firms are grouped according to their pre-tax profit, which can be either positive or negative. Rows represent initial values, while columns represent the conditional probability of reporting income in the specified range in the following period. Probability values in rows may not sum to 1 due to rounding.

	< -$10k	-$10k - $0k	$0k	< $50k	$50k - $75k	$75k - $0.1m	$0.1m - $0.35m	$0.35k - $10m	$10m - $15m	$15m - $18m	> $18m
< -$10k	0.51	0.11	0.01	0.24	0.03	0.02	0.05	0.02	0	0	0
-$10k - $0k	0.16	0.38	0.03	0.41	0.01	0	0.01	0	0	0	0
$0	0.11	0.14	0.46	0.24	0.02	0.01	0.01	0	0	0	0
< $50k	0.14	0.18	0.03	0.58	0.04	0.01	0.02	0	0	0	0
$50k - $75k	0.18	0.05	0.02	0.36	0.19	0.09	0.1	0.01	0	0	0
$75k - $0.1m	0.18	0.04	0.02	0.26	0.15	0.15	0.19	0.02	0	0	0
$0.1m - $0.35m	0.2	0.03	0.01	0.15	0.08	0.08	0.35	0.1	0	0	0
$0.35m - $10m	0.18	0.01	0.01	0.04	0.02	0.01	0.13	0.59	0.01	0	0.01
$10m - $15m	0.16	0	0	0	0	0	0.01	0.32	0.23	0.09	0.18
$15m - $18m	0.15	0	0	0	0	0	0.01	0.21	0.16	0.12	0.34
> $18m	0.17	0.07	0.03	0.09	0.01	0	0.01	0.05	0.03	0.02	0.52
Total	0.24	0.18	0.04	0.4	0.04	0.02	0.05	0.03	0	0	0

TABLE A.2

Sample Descriptive Statistics: 2004, 2009, 2014

Sample statistics are drawn from administrative tax data, are rounded to the nearest thousand, and have been trimmed at the 95th percentile to reduce the impact of outliers. Values are reported in 2014 dollars based on the CPI-U and are rounded to the nearest thousand.

	10th	25th	50th	75th	90th	Mean	Std Dev
Panel A: 2004 ($1,000s)							
Total Income	46	87	189	406	777	326	381
Total Deductions	38	78	179	394	766	316	380
Taxable Income	0	0	0	1	8	2	4
Total Taxes Paid	0	0	0	1	2	1	1
Gross Receipts	45	115	285	653	1,206	475	512
Assets	0	21	78	215	475	190	347
Stock of NOLs	7	9	12	15	17	12	4
Observations				41,139			
Panel B: 2009 ($1,000s)							
Total Income	37	67	143	312	621	258	317
Total Deductions	30	60	134	302	610	250	316
Taxable Income	0	0	0	0	6	1	3
Total Taxes Paid	0	0	0	0	1	<1	1
Gross Receipts	36	84	207	479	935	366	421
Assets	0	0	11	98	296	104	255
Stock of NOLs	6	8	10	13	15	10	4
Observations				39,787			
Panel C: 2014($1,000s)							
Total Income	34	61	129	279	547	231	282
Total Deductions	27	54	121	270	538	223	281
Taxable Income	0	0	0	1	7	2	3
Total Taxes Paid	0	0	0	0	1	< 1	1
Gross Receipts	31	76	190	445	872	336	387
Assets	0	0	25	102	280	107	258
Stock of NOLs	6	7	9	12	14	9	4
Observations				37,134			

TABLE A.3

Placebo Tests

This table reports the placebo tests of our empirical estimates reported in section 5, examining the real effect and earnings management elasticities. In our placebo tests make two modifications to the regression used to identify the change in income driven by an earnings management response, equation (6). First, we restrict the sample to only those firms with taxable income (current income - NOLs) less than -$1,000. Second, we create new placebo indicators for a series of negative income values where no kink exists. In particular, we run the same analysis with placebo kink points at $2,000, $4,000, $6,000, and $8,000 below the true zero kink. The first row reports our baseline estimate of the percentage change in income from an earnings management response. The next four rows report the placebo test results, each from a separate regression. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Taxable Income Kinks				
	$0	-$2,000	-$4,000	-$6,000	-$8,000
	(1)	(2)	(3)	(4)	(5)
%Δ Income	6.0***	0.1	0.1	0.5	0.1
	(0.6)	(0.7)	(0.7)	(0.8)	(0.8)
Observations	455,174	300,164	300,164	300,164	300,164

TABLE A.4

Change in Firm Value: Comparative Statics

This table provides additional estimates of the percentage change in firm value for different earnings management and real elasticity estimates. The elasticities and tax rates used in the calculation are reported at the bottom of the table.

	Economic Responses		Tax Adjustments		Low Base		Interaction		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
%Δ firm value	51.00	41.79	7.12	16.65	35.45	11.36	9.69	19.69	20.23
Tax Adjustments e_m	0	0	0.88	0.44	0	0.88	0.88	0.44	0.88
Economic Responses e_r	0.88	0.44	0	0	0.88	0	0.88	0.44	0.88
τ_0	0.35	0.35	0.35	0.35	0.1	0.1	0.35	0.35	0.1
τ_1	0.25	0.25	0.25	0.25	0	0	0.25	0.25	0

TABLE A.5

Comparison of Elasticity Estimates and Sensitivity

In Panel A, we compare the point estimates of the elasticity and percentage change in income between methods with and without a control group. For comparability, we use the change in statutory tax rates for both elasticity estimates. In Panel B, we compare the sensitivity of the estimates when the tuning parameters are shocked by $+/-$ 50%. Each reported value is the standard deviation across elasticity estimates when the relevant combination of tuning parameters is shocked. All Parameters is the standard deviation when all relevant tuning parameters are shocked. For Counterfactual, only the upper and lower bounds of the counterfactual region are shocked. For Bunching region, only the upper and lower bounds of the bunching region are shocked. Income Window reports the standard deviation when the income window is shocked. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Elasticity and Change in Income Estimates and Variation (standard deviation).

	With Control Group		Without Control Group	
	Elasticity	Δ Income	Elasticity	Δ Income
Point Estimates	(1)	(2)	(3)	(4)
Full Sample	0.548***	8.91%***	0.644***	10.47%***
	(0.006)	(0.10%)	(0.005)	(0.08%)

Panel B: Sensitivity to Tuning Parameters.

	With Control Group	Without Control Group
Variation Across		
All Parameters	0.088	0.132
Counterfactual	0.047	N/A
Bunching region	0.083	0.117
Income window	0.008	0.069

TABLE A.6

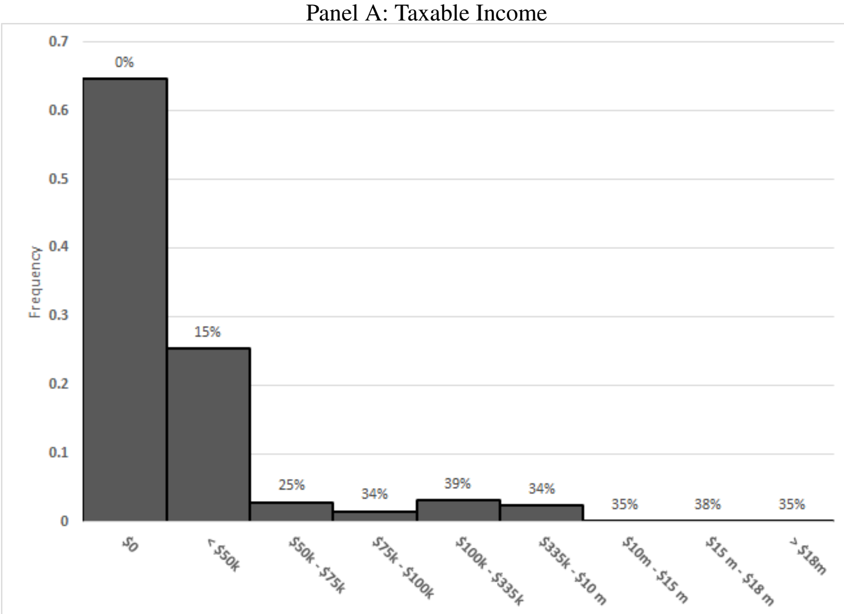
Statistical Difference Between Estimates

This table reports the t-statistic for the 153 pairwise difference for every pair of estimates in the paper. Panel A reports the comparisons of the %Δ in Income estimates with all other estimates. This includes the estimates for cash and accrual accounting firms and small, medium, and large firms. Similarly, Panels B and C report the statistical test for the comparisons of economic responses and tax adjustments. None the 66 pairwise differences are statistically significant at all conventional levels.

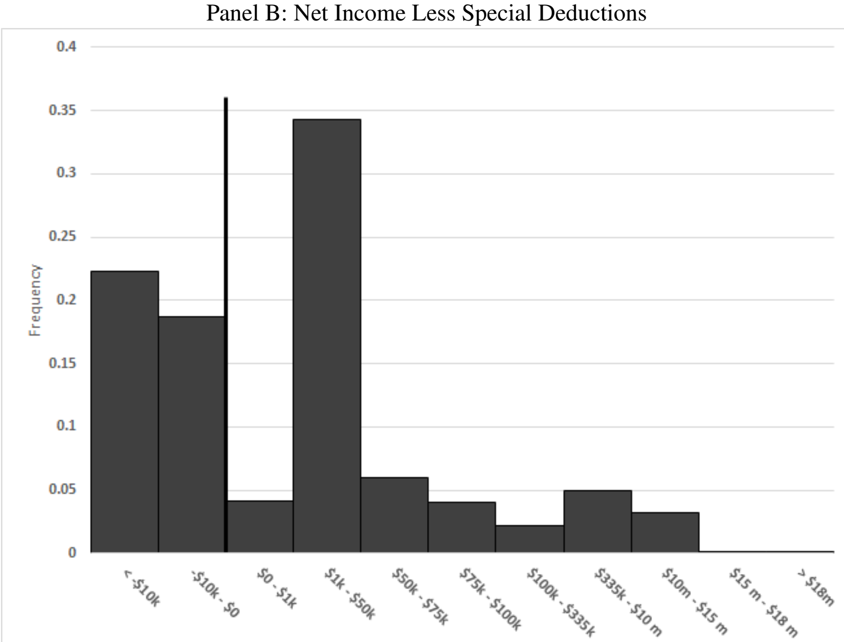
	%Δ In Income						Economic Response			Tax Adjustment		
		Accounting		Size				Accounting			Accounting	
	Base	Cash	Accrual	Small	Medium	Large	Base	Cash	Accrual	Base	Cash	Accrual
Panel A: Corporate Elasticity of Taxable Income												
Base												
Cash	-2838											
Accrual	4086	5359										
Small	-1808	-41.89	-4358									
Medium	543	2048	-2499	1720								
Large	1242	2708	-1994	2254	507							
Panel B: Real Elasticity												
Base	6209	6854	4165	6511	5495	5220						
Cash	3705	4150	2562	4074	3439	3256	-89					
Accrual	2633	2895	2008	2881	2519	2412	452	468				
Panel C: Earnings Management Elasticity												
Base	3089	1983	1598	3611	2617	2334	-2230	-1553	-1478			
Cash	1511	1446	4506	1952	1325	1140	-1959	-1549	-1544	-318		
Accrual	1174	42323	2561	1443	1087	981	-893	-773	-1007	121	293	

FIGURE A.1: 2014 Distribution of Private Corporations by Tax Bracket

Panel A: Taxable Income

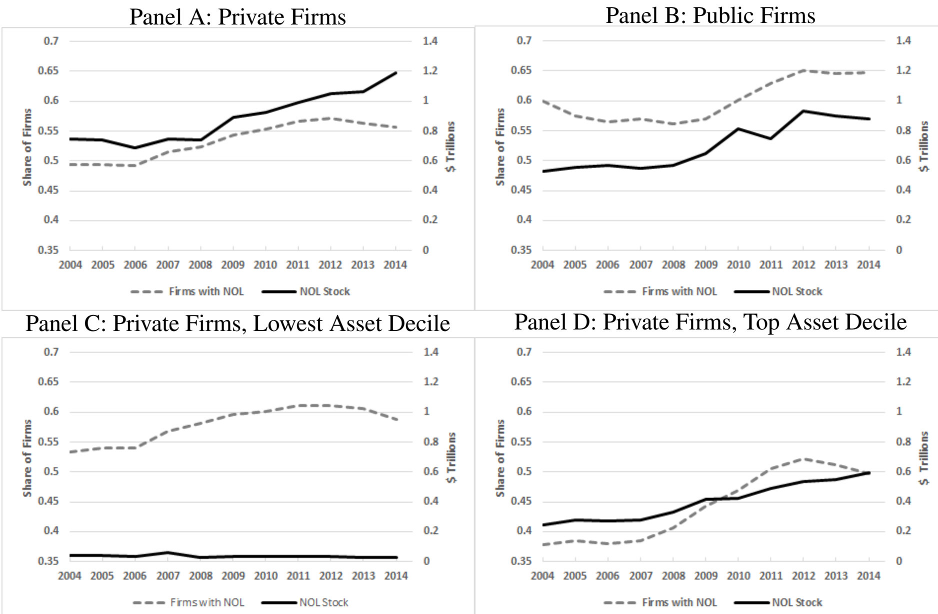


Panel B: Net Income Less Special Deductions



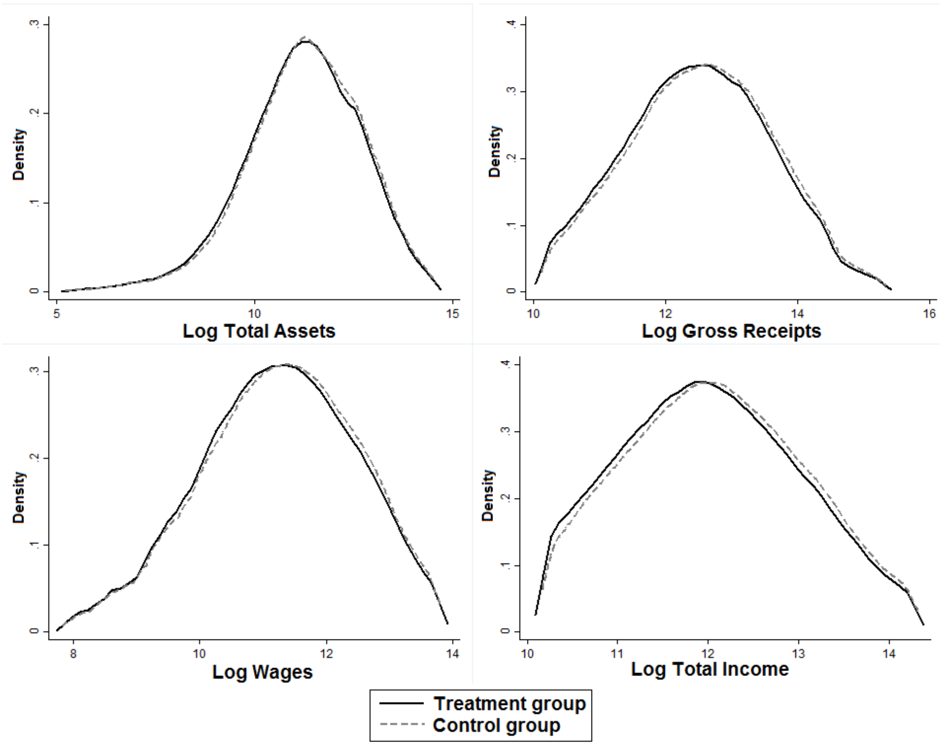
Note: Panel A shows the distribution of private corporations based on Taxable Income, which is reported on Form 1120, line 30 and cannot be less than $0. Panel B shows the distribution of private firms based on Profits, which is calculated as Net Income (Line 28) - Special Deductions (Line 29b). All dollar values are reported in thousands.

FIGURE A.2: Net Operating Loss Accumulation and Ownership: 2004 – 2014



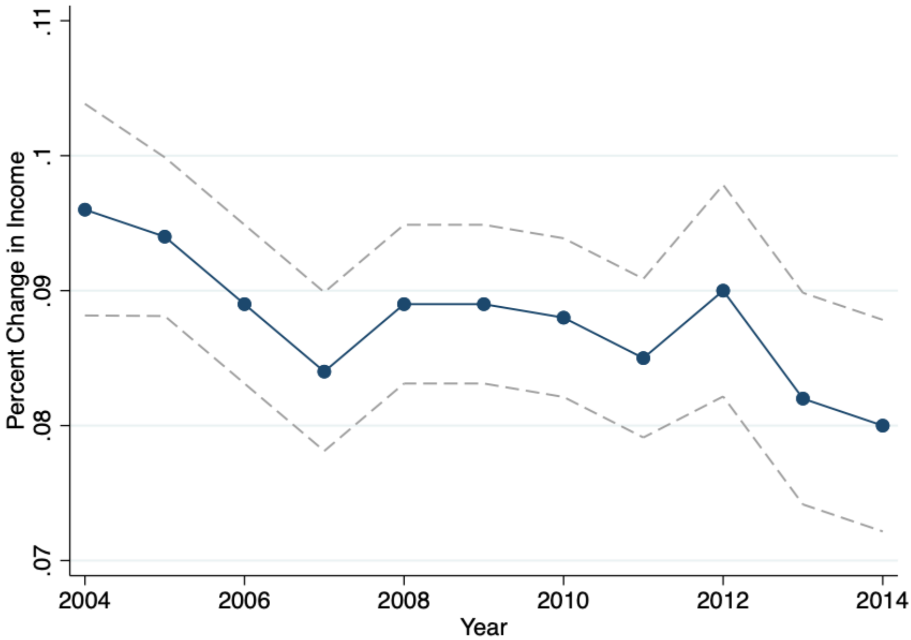
Note: This figure shows the evolution of the Net Operating Loss (NOL) for C corporations. The dashed line reports the share of firms with a positive NOL stock, and the solid line reports the stock of NOLs in $ trillions. Panel A depicts private C corporations, Panel B depicts public C corporations, and Panels C and D depict the smallest and largest private C corporations based on total assets, respectively.

FIGURE A.3: Treatment and Control Firms: Current Period Economic Activity



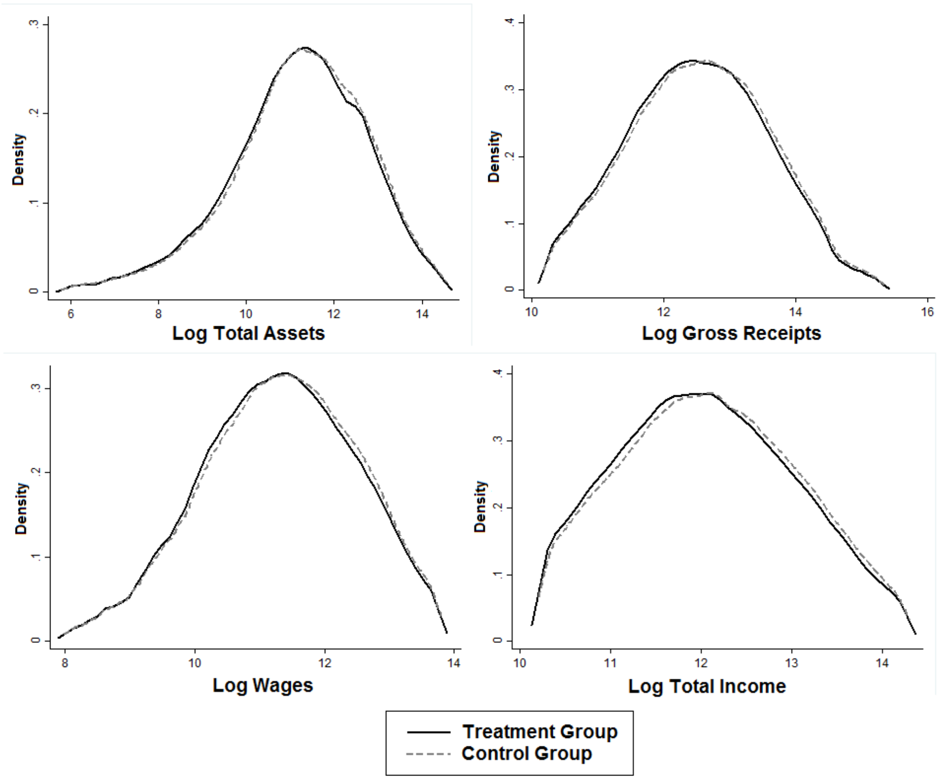
Note: In this figure, we compare the distribution of total assets, gross receipts, wages, and total income, Panels A–D respectively, for treatment and control firms. Inclusion in the treatment or control group is determined as described in Sections 4.2 and 4.4.

FIGURE A.4: Firm Response Across Years



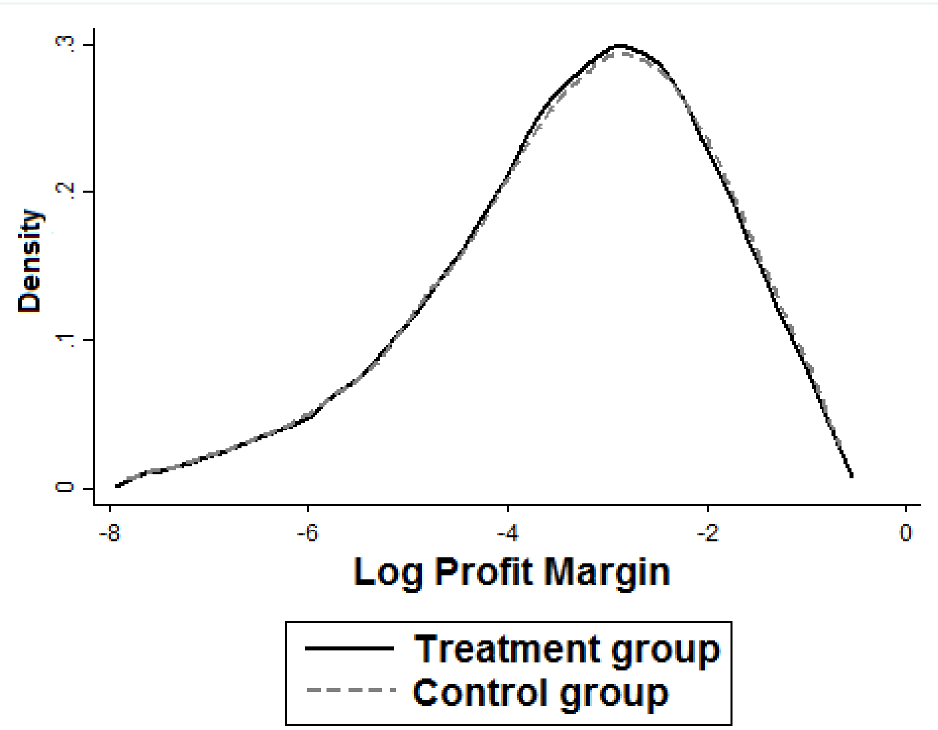
Note: This figure reports annual estimates of % change in income, as described in Section 4.2. Dashed lines depict 95% confidence intervals.

FIGURE A.5: Treatment and Control Firms: Lagged Economic Activity



Note: In this figure, we compare the lagged distribution of total assets, gross receipts, wages, and total income, Panels A–D respectively, for treatment and control firms. Inclusion in the treatment or control group is determined as described in Sections 4.2 and 4.4.

FIGURE A.6: Treatment and Control Firms: Lagged Profit Margin



Note: In this figure, we compare the lagged profit margin of treatment and control firms. Inclusion in the treatment or control group is determined as described in Sections 4.2 and 4.4.

A.1 Additional Estimates

A.1.1 Additional Estimates of Changes in Firm Value

In this subsection, we provide a discussion of additional estimates our application to changes in firm value. These estimates are reported in Table A.4. Columns (1) and (2) report the change in firm value if the entire elasticity of taxable income was a economic response, of 0.88 and 0.44, respectively. The percentage change in firm value is massive, 51% and 42%, respectively. In contrast, columns (3) and (4) report the change in firm value if the entire elasticity of taxable income was a tax adjustment, of 0.88 and 0.44, respectively. The percentage change in firm value is 7% and 17%, respectively, which is considerably less than if the response is due to real changes in investment and employment.

Columns (5) and (6) report a tax change from 10% to 0% to show the impact of the tax rate level. The percentage increase in firm value is smaller in column (5) than in column (1) and larger in column (6) than in column (3). This suggests that the percentage change in firm value increases in the tax rate level for real responses and decreases for reporting responses. Finally, columns (7) through (9) consider both real and reporting responses for a decrease in tax rate from 35% to 25% (columns (7) and (8)) and from 10% to 0% (column (9)).

A.1.2 Placebo Tests

In this subsection, we describe the results of placebo tests for our empirical estimates reported in Section 5, examining the real and reporting elasticities. Our placebo tests take the regression used to identify the change in income driven by a reporting response, equation (6), and makes two modifications. First, we restrict the sample to only those firms with taxable income (current income - NOLs) less than -$1,000. Second, we create new placebo indicators for a series of negative income values where no kink exists. In particular, we run the same analysis with placebo kink points at $2,000, $4,000, $6,000, and $8,000 below the true zero kink. The results are reported in Table A.3. The first row reports our baseline estimate of the percentage change in income from a reporting response. The next four rows report the placebo test results, each from a separate regression. Across each placebo test, we find the coefficients on the variables of interest are statistically insignificant and quite close to zero.

A.2 Estimation

A.2.1 Estimating the Elasticity of Taxable Income

In this subsection we explain our estimation of marginal tax rates. We approach this by implementing two separate methods. First, we follow, exactly, the procedure outlined by Graham [1996a,b], and Graham [1999]. Blouin et al. [2010a] provide a nonparametric method, unfortunately, due to data limitations we are unable to implement it. The goal of this method is to account for NOLs, the progressivity of the statutory tax code, and uncertainty about future tax rates. Due to loss carrybacks and carryforwards a firm's effective marginal tax rate may be lower. Graham [1999] provides a simple example that motivates the desirability of considering past and forecasted income when calculating effective marginal tax rates. The limitation of this calculation is that it prescribes firm behavior around taking losses that while rational, does not match observed behavior. To account for the observed loss behavior of firms, our method combines empirical patterns described by Cooper and Knittel [2010], Zwick [Forthcoming], and our our own empirical evidence. In the second approach, we estimate expected tax rates and accounts for variation in interest rates faced by firms. We describe each of these methods in turn.

A.2.1.1 Graham Expected Tax Rate

The first step in this estimation method is to forecast taxable income for the years $t + 1$ through $t + 18$. We do this by assuming taxable income follows a pseudo-random walk with drift:

$$\Delta TI_{i,t} = \mu_i + \varepsilon_{i,t},$$

where the first difference in taxable income is given by $\Delta TI_{i,t}$, $\mu_i = max(\Delta TI_i, 0)$, and the error term is distributed normally with mean zero and variance equal to that of $\Delta TI_{i,t}$.

We use taxable income as reported on the IRS Form 1120, instead of having to estimate it using Compustat data as do Graham [1996a,b], and Graham [1999].

The second step is to calculate the present value of the tax bill from $t-3$ (to account for carrybacks) through $t+18$ (to account for carryforwards). Taxes in years $t+1$ through $t+18$ are discounted using the average corporate bond yield.

The third step is to add $10,000 to taxable income in year t and recalculate the present value of the tax bill. To calculate an effective marginal tax rate for each firm i and year t, we take the difference in tax bills (divided by $10,000).

The fourth step is to repeat this process 50 times to obtain 50 estimates of the expected tax rate for firm i in year t, each with a new forecast of 18 years. Note, Graham [1996b] shows that tax rates based on 50 simulations per firm-year produce similar estimates to tax rates based on 1,000 simulations per firm-year.

This process is repeated for each firm-year in our sample. We then take the average for firms left of the kink and firms right of the kink to produce our estimate of the difference in tax rates firms face at the kink.

A.2.1.2 Expected Tax Rate and Interest Rates

In our second approach, we calculate the expected tax rate on an additional dollar of loss based on empirical evidence without forecasting taxable income.

First, we assume that a dollar of loss earned by a firm today would be used with some probability p_t according to the pattern documented in Cooper and Knittel [2010]. Second, we impose the incomplete use of corporate carry-backs documented by Zwick [Forthcoming], $\zeta_{-1} = 0.3$. Finally, we use average tax rates from our calculations of firms in our data. Specifically, losses used in future periods face an average tax rate of $\tau_{ATR} = 0.18$. This rate is the expected tax rate based on our Markov transition probabilities in Table 2 conditional on the firm being taxable. The expected tax rate faced by firms combines each of these elements based on the discounted value of the loss:

$$E[\tau] = (p_{-1} \times \zeta_{-1} \times \tau_{ATR}) + \sum_{t=0}^{10} \frac{p_t \times \zeta_t \times \tau_{ATR}}{(1-r)^t} .$$

In our calculations, we allow the interest rate faced by firms, r, to vary between 1% and 15%.

A.2.2 Effective Tax Rates

This section explains our estimation of marginal tax rates. We approach this by implementing two separate methods. First, we follow, exactly, the procedure outlined by Graham [1996a], Graham [1996b], and Graham [1999]. Blouin et al. [2010a] provide a nonparametric method, unfortunately, due to data limitations we are unable to implement it. The goal of this method is to account for net operating losses, the progressivity of the statutory tax code, and uncertainty about future tax rates. Due to loss carrybacks and carryforwards a firm's effective marginal tax rate may be lower. Graham [1999] provides a simple example that motivates the desirability of considering past and forecasted income when calculating effective marginal tax rates. The limitation of this calculation is that it prescribes firm behavior around taking losses that while rational, does not match observed behavior. To account for the observed loss behavior of firms, we develop a method that combines empirical patterns described by Cooper and Knittel [2010], Zwick [Forthcoming], and our our own empirical evidence. This second approach estimates expected tax rates and accounts for variation in interest rates faced by firms. We describe each of these methods in turn.

A.2.2.1 Graham Expected Tax Rate

The first step in this estimation method is to forecast taxable income for the years $t + 1$ through $t + 18$. We do this by assuming taxable income follows a pseudo-random walk with drift:

$$\Delta TI_{i,t} = \mu_i + \varepsilon_{i,t},$$

where the first difference in taxable income is given by $\Delta TI_{i,t}$, $\mu_i = max(\Delta TI_i, 0)$, and the error term is distributed normally with mean zero and variance equal to that of $\Delta TI_{i,t}$. We use taxable income as reported on the IRS Form 1120, instead of having to estimate it using Compustat data as do Graham [1996a], Graham [1996b], and Graham [1999].

The second step is to calculate the present value of the tax bill from $t - 3$ (to account for carrybacks) through $t+18$ (to account for carryforwards). Taxes in years $t+1$ through $t + 18$ are discounted using the average corporate bond yield.

The third step is to add \$10,000 to taxable income in year t and recalculate the present value of the tax bill. To calculate an effective marginal tax rate for each firm i and year t, we take the difference in tax bills (divided by \$10,000).

The fourth step is to repeat this process 50 times to obtain 50 estimates of the expected tax rate for firm i in year t, each with a new forecast of 18 years. Note, Graham [1996b] shows that tax rates based on 50 simulations per firm-year produce similar estimates to tax rates based on 1,000 simulations per firm-year.

This process is repeated for each firm-year in our sample. We then take the average for firms left of the kink and firms right of the kink to produce our estimate of the difference in tax rates firms face at the kink.

A.2.2.2 Expected Tax Rate and Interest Rates

Our second approach calculates the expected tax rate on an additional dollar of loss based on empirical evidence without forecasting taxable income.

First, we assume that a dollar of loss earned by a firm today would be used with some probability p_t according to the pattern documented in Cooper and Knittel [2010]. Second, we impose the incomplete use of corporate carry-backs documented by Zwick [Forthcoming], $\zeta_{-1} = 0.3$. Finally, we use average tax rates from our calculations of firms in our data. Specifically, losses used in future periods face an average tax rate of $\tau_{ATR} = 0.18$. This rate is the expected tax rate based on our Markov transition probabilities in Table 2 conditional on the firm being taxable. The expected tax rate faced by firms combines each of these elements based on the discounted value of the loss:

$$E[\tau] = (p_{-1} \times \zeta_{-1} \times \tau_{ATR}) + \sum_{t=0}^{10} \frac{p_t \times \zeta_t \times \tau_{ATR}}{(1-r)^t}$$

In our calculations, we allow the interest rate faced by firms, r, to vary between 1% and 15%.

A.2.3 Tuning Parameters

Our estimation strategy relies on five free parameters that are selected prior to model estimation rather than estimated empirically. These include the income window, IW, the upper and lower bounds of the bunching region (α_{ub} and α_{lb}), and the upper and lower bounds of the counterfactual region, CF_{ub} and CF_{lb}. The income window is defined as the window on either side of the kink. The bunching region, which is allowed to be asymmetric, is defined as the region in which we calculate excess mass. The counterfactual region defines our control group, specifically the range of NOL values from which we draw the counterfactual distribution.

To select the optimal values of the the income window and the counterfactual region, we rely on tenfold cross-validation, a data-driven method commonly used for model validation and variable selection.

First, we randomly assign firms from our sample into ten equal-size subsamples, indexed by k. We then construct a distribution dataset that gives the number of firms in each (income–NOL) bin for each subsample, k. Next we choose the values of each tuning parameter to be included in the cross validation. We test three or four values of each tuning parameter, for a total of 36 unique tuning parameter vectors, indexed by i. The tuning parameter values included in the cross validation are:

$IW : 7500, 10000, 12500, 15000$

$CF_{lb} : 400, 500, 600$

$CF_{ub} : 4000, 5000, 6000$

Each tuning parameter is measured with respect to the kink point, κ. For instance, $CF_{lb} = 500$ means that we include firms in our counterfactual with no less than $\kappa + \$500$ in NOLs. The income window, IW, is the positive or negative distance from the kink defining the sample for each elasticity estimate.

For each tuning parameter vector, we pool $k - 1$ subsamples for use as the training dataset, which we use to construct our counterfactual distribution and training set elasticity estimate, E_T. We then use the remaining subsample as the validation set, estimating the elasticity, E_V, using as inputs the observed distribution of the validation set and the counterfactual distribution from the training set. This process is repeated ten times so that each subsample, k, is used as the validation set exactly once.

We select the vector of tuning parameters that results in the lowest coefficient of variation (COV) across subsamples k. The mean squared error is a more common selection criterion. It is inappropriate in our context, however, because the mean squared error favors estimates that are biased toward zero. As an example, suppose that the vector j is the "optimal" set of tuning parameters, leading to the best possible estimate of the elasticity,

E_j. Now we test model j against a suboptimal model, which is simply $E_j/2$. The mean squared error for the suboptimal model is necessarily lower than the mean squared error for the optimal model. However, the COV is the same for both models.

To estimate the coefficient of variation, we begin by estimating the mean squared bias for each tuning parameter vector, i:

$$Bias_i^2 = 1/K \sum_k^K (E_{ik}^T - E_{ik}^V)^2, \tag{A.2.1}$$

and the variance of validation set estimates:

$$Variance_i = 1/K \sum_k^K (E_{ik}^V - \bar{E_i^V})^2. \tag{A.2.2}$$

Finally, the coefficient of variation is the square root of the mean squared bias plus the variance divided by the mean training set elasticity estimate:

$$COV_i = \frac{\sqrt{Bias_i^2 + Variance_i}}{\bar{E_i^T}}. \tag{A.2.3}$$

We rely on a separate data-driven method to choose the upper and lower bounds of the bunching region, α_{ub} and α_{lb}. Excess mass near the kink exists when the observed distribution near the kink rises above the counterfactual distribution. Therefore a natural choice for the upper and lower bounds of the bunching region is the closest income level on either side of the kink where the counterfactual distribution is above the observed distribution. Specifically, for each kink point, κ, and for each pair of candidate values of α_{ub} and α_{lb}, we calculate the income level on either side of the kink where the counterfactual distribution first rises above the observed distribution. We then choose the pair of tuning parameter values that most closely match the weighted average of observed income levels across 201 kink points.

A.2.4 Bunching Methods in Previous Studies

In this subsection, we explain the estimation procedure for estimating elasticities using bunching at kink points without a control group and compare it to our control-group method.

Previous studies also need to estimate the change in income ΔY to calculate elasticities. Most make the assumption that the distribution is uniform around the kink. This allows them to write the distribution $h(z)$ as simply $h(\kappa)$, and critically, the change in income as the ratio of excess mass to the distribution, $\Delta Y = B(t_0, t_1)/h(\kappa)$. This simplified expression can be substituted into the equation (4) to produce the expression:

$$\varepsilon_Y = \frac{B(t_0, t_1)/h(\kappa)}{\kappa ln\left(\frac{1-t_0}{1-t_1}\right)}, \tag{A.2.4}$$

which corresponds to equations (3), (6), (13), and (4) in Saez [2010], Chetty et al. [2011], Devereux et al. [2014], and Weber [2016], respectively.

The amount of bunching is estimated as the difference between the observed distribution and the estimated distribution in the absence of the kink in a designated bunching region. To determine the change in income caused by the discontinuity, the amount of bunching is divided by the estimated distribution in the absence of the kink, $h(\kappa)$. The identification therefore relies heavily on the estimation of the distribution.

The estimation of the distribution in the absence of the kink is typically done in two steps. First, a flexible polynomial in taxable income is fitted, excluding points in the bunching region but including points to the right of the bunching region. Second, the distribution is projected out of sample into the bunching region and the average density in this region is used as the estimate of the density assuming a uniform distribution.

There are several complications to the credibility of the estimation of the distribution in the absence of the kink. First, there is often bunching at round numbers and discontinuities are often at round numbers. Second, the estimation uses data to the right of the discontinuity, which is distorted by the discontinuity. Third, the out-of-sample projection is sensitive to the size of the bunching region, the order of polynomial used to estimate the distribution, and the income window used to estimate the distribution.

To address round-number bunching, Kleven and Waseem [2013] suggest using bunching at non-discontinuity round numbers. This method has been followed by subsequent studies, for example Kopczuk and Munroe [2014] and Devereux et al. [2014].

To address the distortion of the distribution to the right of the discontinuity, Chetty et al. [2011] suggests a correction that iteratively increases the density to the right of the discontinuity by the bunching amount. For example, if there are 100 firms to the right of the discontinuity and 10 firms are estimated to be bunching, then the number of firms to the right of the discontinuity are scaled by 1.1, such that there are 110 firms to the right of the discontinuity. This raises the distribution and shrinks the estimated amount of bunching. This method is sensitive to the income window, which defines the number of firms to the right of the discontinuity, and the original estimate of the distribution. This method has been followed by subsequent studies, for example Devereux et al. [2014].

Prior to our work, no method exists to address the out-of-sample prediction of the distribution. Our control-group method simultaneously addresses all three of these concerns.

A.2.5 Comparison of Results With and Without a Control Group

In this subsection, we compare the elasticity estimate we propose with an alternative estimate that does not rely on a control group, typical of previous bunching studies. Wherever possible, we adhere to the code used in Devereux et al. [2014]. In Panel A of Table A.5, we compare the point estimates with and without a control group. The estimate without a control group is 17% higher than our baseline estimate.

Nest, we test the sensitivity of the estimates to changes in tuning parameters and report the results in Panel B of Table A.5. Weber [2016] finds that elasticity estimates from bunching methods are quite sensitive to the choice of tuning parameters, enough to affect the qualitative implications of the estimates. The tuning parameters we use in the baseline estimates are determined by two data-driven methods explained in Appendix B. To test the sensitivity of the estimates to the tuning parameters, we shock each tuning parameter by $+/$ 50%. These tuning parameters include the upper and lower bounds of the bunching region, the upper and lower bounds of NOLs used in the control group, and the income window used in fitting the distributions. These tests provide 243 separate tuning parameter combinations.

Elasticity estimates without a control group are more sensitive to tuning parameters than estimates with a control group. The variation (standard deviation) in estimates with a control group is 34% smaller across all tuning parameters. Variation in estimates with a control group is 29% smaller across bunching region parameters and 89% smaller across income window parameters.

A.3 Model Derivations

A.3.1 Preliminary Derivations

We find the elasticity of taxable income with respect to the corporate tax rate by optimizing shareholder value in equation (2). The first-order conditions with respect to capital (net equity issuances) and shifting are:

$$\frac{\partial V}{\partial K} = -r + (1-\tau)\frac{d\pi(K)}{dK} = 0,$$

which produces the familiar Hall-Jorgenson formula, and

$$\frac{\partial V}{\partial \rho} = -(1-\tau) + 1 - c'(\rho) = 0.$$

By combining these first-order conditions, we find that the equilibrium capital, shifting, and taxable income are:

$$K^* = \left(\frac{A(1-\tau)}{r}\right)^{1+e}, \qquad c'(\rho) = \tau, \qquad Y = \frac{1+e}{e}A^{1+e}r^{-e}(1-\tau)^e - \rho.$$

A.3.2 Distortions to the Total Value in the Economy

Total value in the economy is given by,

$$TV = \{-rK + (1-\tau)Y(K,\rho) + \rho - c(\rho)\} + \tau Y(K,\rho) + \mu c(\rho),$$

where firm value is given in brackets. The change in total value with respect to the net-of-tax rate is given by,

$$\frac{dTV}{d(1-\tau)} = -Y + Y + \tau\frac{dY}{d(1-\tau)} + \mu c'(\rho)\frac{d\rho}{d(1-\tau)}.$$

Using the relationship from the first-order condition from the firm, $c'(\rho) = \tau$, the change in total value can be rewritten as,

$$\frac{\tau}{1-\tau}Y\left(\frac{dY}{d(1-\tau)}\frac{1-\tau}{Y} + \mu\frac{d\rho}{d(1-\tau)}\frac{1-\tau}{Y}\right),$$

which then can be written, as in the text,

$$\frac{dTV}{d(1-\tau)} = \frac{\tau}{1-\tau} Y(e_Y - \mu e_m).$$

A.3.3 Changes in Firm Value

We can find the change in firm value for a change in tax rates with the added structure that the cost of tax shields is given by $c(\rho) = \rho^2/(2\phi\pi)$. From the first-order condition, we find that the equilibrium shifting increases in the corporate tax rate and profits, $\rho = \phi\pi\tau$. The value of the firm, net of initial capital, can be written as:

$$\begin{aligned} V(\tau) &= -rK + (1-\tau)\pi + \tau\rho - c(\rho) \\ &= \frac{1-\tau}{1+e}\pi + \frac{e_m \tau^2}{2(1-\tau+\tau e_m)}\pi \\ &= A^{1+e} r^{-e} \frac{1+e}{2e} \left(\frac{(1-\tau)^{1+e}}{1+e} + e_m \frac{\tau^2 (1-\tau)^e}{1-\tau+\tau e_m} \right) \\ &= A^{1+e} r^{-e} \frac{1+e}{2e} \left((1-\tau+\tau e_m)(1-\tau)^{1+e} + e_m (1+e) \tau^2 (1-\tau)^e \right). \end{aligned}$$

The change in firm value due to a change in corporate tax rate from τ_0 to τ_1 is captured by:

$$\frac{V(\tau_1) - V(\tau_0)}{V(\tau_0)} = \frac{(1-\tau_1+\tau_1 e_m)(1-\tau_1)^\theta + e_m \tau_1^2 \theta (1-\tau_1)^{\theta-1}}{(1-\tau_0+\tau_0 e_m)(1-\tau_0)^\theta + e_m \tau_0^2 \theta (1-\tau_0)^{\theta-1}} - 1, \quad \text{(A.3.1)}$$

where the parameter, $\theta = 1 + e_r(1-\tau)/(1-\tau+\tau e_m)$.

A.3.4 Tax Adjustment Elasticity

This subsection, we derive the tax adjustment elasticity where the numerator is $d\rho/Y$ and the denominator is the percentage change in the net-of-tax rate, $log((1-\tau_0)/(1-\tau_1)$. We estimate the numerator using the specification in equation (6), where the dependent variable is the log of the ratio of taxable income to revenues. We use the change in tax rates at the kink to estimate $\beta_1 = dlog(Y/R)$, by including as an independent variable an indicator for being at or above the kink.

To show that $\beta_1 = -d\rho/Y$, we rely on our model and the assumption that the percentage change in revenues equals the percentage change in deductions. The model provides the expressions for taxable income and reporting responses; $Y = R - C - \rho$, where R is revenue, C is deductions, and $\rho = \phi\pi\tau$ is all reporting responses. When we evaluate $dlog(Y/R)$ at $\tau = 0$, this implies $\rho = 0$. Thus, as an approximation, in our empirical strategy we assume the marginal tax rate is zero for firms to the left of the kink. With these expressions, we find that:

$$\begin{aligned}
\beta_1 = dlog(Y/R) &= \frac{dY}{Y} - \frac{dR}{R} \\
&= \frac{R}{Y}\frac{dR}{R} - \frac{C}{Y}\frac{dC}{C} - \frac{d\rho}{Y} - \frac{dR}{R} && \text{using} \quad Y \equiv R - C - \rho \\
&= \frac{R - C - Y}{Y}\frac{dR}{R} - \frac{d\rho}{Y} && \text{using assumption} \quad \frac{dC}{C} = \frac{dR}{R} \\
&= -\frac{d\rho}{Y} && \text{evaluating at} \quad \tau = 0.
\end{aligned}$$

To test the plausibility of our assumption that $\frac{dC}{C} = \frac{dR}{R}$, Figure 2 gives the scatter plot of the log change in revenue and deductions. Supporting this assumption, the points closely align with the 45 degree line. To test the joint plausibility of the appropriateness of evaluating the system at $\tau = 0$ and the assumption that $\frac{dC}{C} = \frac{dR}{R}$, we perform a series of placebo tests at arbitrary taxable income cutoffs where no kink exists. Supporting these specifications, the coefficient of interest is statistically insignificant and close to zero in magnitude. Appendix A.2 provides a larger discussion on these tests.