Sharing Risk with the Government: How Taxes Affect Corporate Risk-Taking * †

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Abstract

Using a natural experiment in the form of 113 staggered changes in corporate income tax rates across U.S. states, we provide evidence on how taxes affect corporate risk-taking decisions. Higher taxes reduce expected profits more for risky projects than for safe ones, as the government shares in a firm's upside but not in its downside. Consistent with this prediction, we find that risk-taking is sensitive to taxes, albeit asymmetrically: the average firm reduces risk in response to a tax increase (primarily by changing its operating cycle and reducing R&D risk) but does not respond to a tax cut. We trace the asymmetry back to constraints on risk-taking imposed by creditors. Finally, tax loss-offset rules moderate firms' sensitivity to taxes by allowing firms to partly share downside risk with the government.

Key words: Risk-taking, corporate taxes, natural experiments.

JEL classification: G32, H32.

Taxation is one of the most important tools governments use to influence the economy. Taxes affect many aspects of economic activity, from individuals' labor supply, consumption, and savings decisions to companies' hiring, location, and capital investment choices. In this paper, we ask how taxes on corporate income affect corporate risk-taking. Risk-taking is essential for long-run growth at both the firm and the national level (Solow 1957). However, if excessive, risk-taking can cripple a firm and potentially the entire economy, as evidenced by the recent financial crisis (Kashyap 2010; White 2016).

Income taxes affect corporate risk-taking because they induce an asymmetry in a firm's payoffs. This basic insight can be traced back to early work on *individuals*' risk-taking choices in response to *personal* income taxes (Domar and Musgrave 1944; Feldstein 1969; Stiglitz 1969) and to subsequent applications to the corporate setting (Green and Talmor 1985). A simple numerical example serves to illustrate the logic of the approach. Suppose there are two projects (A and B) and two equally likely outcomes ("good" and "bad"). Project A yields a profit of $40 in both scenarios; project B yields a profit of $100 in the good scenario but a loss of $20 in the bad scenario. Project risk is idiosyncratic and hence diversifiable. Absent taxes, the expected profit of each project is $40 and so a risk-neutral firm will be indifferent between the projects.

Now suppose the tax rate increases from zero to 30%. This reduces the expected after-tax profit of both projects, but risky project B is more affected than safe project A: B's expected profit falls to $25 while A's falls to only $28.[1] The greater reduction (of $3) in project B's expected profit stems from the fact that the government shares in the profit but not in the loss. Given this asymmetry, a risk-neutral firm will now prefer the safe project to the risky project.[2] Generalizing from the example, we predict that firms should respond to a tax increase by

[1] For project A, $40×(1–0.3) = $28; for project B, 0.5×[(1–0.3)×$100–$20] = $25.
[2] Firms are commonly modeled as being risk-neutral, but this is not crucial to our analysis.

choosing safer projects and thereby reducing the risks they take.

As Domar and Musgrave (1944) argue, introducing loss-offsets into the tax code can modify this prediction. Consider the extreme case in which losses can be completely written off against past or future profits. In this case, the pre-tax and post-tax ordering of the two projects are identical because both the upside and the downside are reduced at the same tax rate.[3] In practice, the tax code permits at most a partial offset of losses, in which case the upside is reduced by more than the downside. A tax increase will then reduce the expected profit of the risky project by more than that of the safe project and firms should respond by reducing risk.

Absent other frictions, these arguments apply symmetrically to tax increases and tax cuts, so firms should respond to cuts by increasing risk. In practice, there is reason to expect asymmetry. As the literature on risk-shifting emphasizes, higher risk reduces the value of claims held by creditors. Whether a firm can respond to a tax cut by increasing risk then depends on the extent to which creditors constrain its behavior, e.g., by means of debt covenants. In the presence of such constraints, the effect of a tax cut on risk-taking is likely attenuated for many firms.

A key challenge when testing how taxes affect corporate policies is that a firm's tax status is often endogenous to its policies (Graham 2013). For example, a firm's choice of investment projects will affect its future marginal tax rate. The literature confronts this identification challenge in various ways. One approach is to exploit changes in federal income tax rates. Unfortunately, federal tax changes suffer from two shortcomings: they are few and far between, and they affect virtually all firms in the economy at the same time, making it difficult to find control firms with which to establish a plausible counterfactual. A second approach is to exploit cross-country differences in tax policies. This typically results in a larger number of tax "shocks" than in studies using federal tax changes, but often requires implausible assumptions about

[3] In our numerical example, project B's expected profit with full loss offsets is $28, the same as A's.

treated firms and their controls being comparable despite operating in different countries.

We adopt a third approach, pioneered by Asker, Farre-Mensa, and Ljungqvist (2015), Heider and Ljungqvist (2015), and Farre-Mensa and Ljungqvist (2016). The approach exploits the fact that U.S. companies pay not only federal income tax but also taxes in the various states in which they operate. As Heider and Ljungqvist note, state taxes are a meaningful part of U.S. firms' overall tax burden, accounting for about 21% of total income taxes paid in Compustat.[4]

State taxes have four desirable features for identification purposes. First, unlike federal taxes, state tax rates change frequently: over our sample period (fiscal years 1990–2011), there were 113 changes in state corporate income tax rates. Power is thus not an issue. Second, state tax changes are staggered over time. This staggering helps disentangle the effects of tax changes from other macro-economic shocks that affect firms' risk-taking. Third, state tax changes affect only a subset of firms at a time. This feature allows us to establish a plausible counterfactual: what level of risk would firms have chosen absent the tax change? The counterfactual is based on firms that experience the same economic conditions (in time, space, and industry) but are not themselves subject to a tax change. Our empirical strategy is thus essentially a difference-in-differences approach.[5] Fourth, there is evidence that state taxes follow a random-walk (see Ljungqvist and Smolyansky 2016), making tax changes unanticipated shocks.

Our baseline specifications proxy for firms' risk-taking using earnings volatility, measured as the standard deviation of seasonally adjusted quarterly pre-tax returns either on total assets or on invested capital.[6] We find that firms respond to tax increases by reducing the amount of risk they

[4] Note that variation in state tax rates directly translates into variation in the total taxes a firm pays, and it is the magnitude of this variation that is relevant for our experiment. In our sample, the average treated firm experiences a tax increase of 136 basis points and a tax cut of 53 basis points, both of which are economically significant.
[5] To isolate the effect of taxes on risk-taking, we further remove unobserved firm fixed effects by first-differencing and time-varying firm-level confounds by including a comprehensive set of time-varying firm characteristics. We also control for time-varying shocks at the industry level and state-level variation in economic conditions.
[6] Results are similar when we use measures of equity volatility instead.

take, consistent with the intuition derived from the literature on individual investor behavior. To illustrate, a treated firm reduces its earnings volatility by around 2% for every one-percentage-point increase in its home-state tax rate, compared to other firms in the same industry that are not subject to a tax change in their headquarter state that year. Given an average tax increase of 136 basis points in our sample, the average treated firm thus reduces its risk by 2.6%. This effect is estimated over the 3 years following a tax increase. It becomes stronger when we give firms more time to adjust their risk profiles. Over the 6 years following a tax increase, for example, the average treated firm reduces its risk by a cumulative 4.8%.

Under federal and state law, U.S. firms are taxed in every state in which they have operations (their so called "nexus" states). For a multi-state firm, a given state's tax change will therefore apply to less than the firm's entire tax base. This implies that tests that ignore the geographic distribution of firms' tax bases will understate the sensitivity of treated firms' risk-taking to corporate income taxes. To address this issue, we construct a measure of state tax changes that takes into account each treated firm's tax exposure to each state. Using this alternative measure of the magnitude of tax shocks, we show that a one-percentage-point increase in a firm's nexus-weighted tax rate reduces risk-taking by between 2.4% and 3.2% over 3 years. In other words, the estimated tax sensitivities are indeed larger when we condition on a firm's tax footprint.

Investigating possible channels, we find that the main ways in which firms achieve these risk reductions are efforts to shorten their operating cycles (which puts less capital at risk, in particular in the form of inventories) and to find less risky ways to commercialize their R&D projects. We find no evidence that firms tinker with their operating leverage, nor that they change the level of their capital expenditures or R&D spending in response to state tax changes.

In contrast to their response to tax increases, firms do not, on average, respond significantly to tax cuts. This asymmetric tax sensitivity is consistent with our argument that firms face constraints on their ability to increase risk, for example, in the form of covenants imposed by their creditors. If so, we expect firms with low financial leverage to face fewer constraints and so to be more responsive to tax cuts. Consistent with this conjecture, we find that low-leverage firms increase risk in response to tax cuts, whereas high-leverage firms do not.

We conduct a battery of robustness tests. We provide evidence that treated and control firms exhibit similar trends in risk-taking before the state tax rate changes, supporting the parallel-trends assumption that is critical for identification in a diff-in-diff setting. In addition, to better control for unobserved changes in local economic conditions that could confound our findings, we restrict the sample of controls to firms in states neighboring treated firms' home states. On the assumption that economic conditions are similar in neighboring states while tax policies stop at the state's border, we can then difference away unobserved confounding effects, such as from local business cycles. Our results are robust to this design. State corporate income tax changes occasionally coincide with changes in state taxes on bank profits (which could affect the supply of bank loans) and investment incentive programs (such as tax credits for investment, R&D, and job creation). When we control for these directly, we continue to find that corporate risk-taking is sensitive to corporate income tax increases but not to corporate income tax cuts.

To test Domar and Musgrave's (1944) argument that the ability to offset losses against past or future profits should weaken the negative effect of income taxes on risk-taking, we collect detailed information on how state tax loss carryback and carryforward rules have evolved over our sample period. We use these data to condition how firms respond to changes in state tax rates. We also test how firms respond to the rule changes themselves using a diff-in-diff setup.

The results are consistent with Domar and Musgrave's (1944) prediction. First, when we sort firms by their ability to offset tax losses, we find that the negative effect of tax increases on risk-taking is largely driven by firms with a limited ability to offset losses. (The effect of tax cuts on risk-taking continues to be insignificant.) Second, firms' responses to changes in offset rules broadly mirror their responses to changes in tax rates. In particular, they asymmetrically reduce risk when their ability to carry back losses is reduced.

Our study makes three main contributions. First, it contributes to the literature on the effect of taxes on corporate policies by showing that taxes affect risk-taking decisions.[7] Second, our study relates to the literature on corporate risk-taking by identifying taxes as a key determinant. A parallel literature on risk management shows that firms hedge to reduce income volatility with a view to increasing debt capacity (Smith and Stulz 1985; Graham and Rogers 2001). It is possible that increased hedging contributes to the tax-induced reduction in risk-taking we observe. This would be interesting because the hedging literature finds little support for taxes being a reason why firms hedge. Third, our study has potential policy implications. While raising taxes can increase the government's revenue, it may have the side effect of dulling risk-taking incentives in the corporate sector, which in turn may adversely affect innovation and economic growth. Moreover, if the government wishes to encourage risk-taking, our findings suggest that merely reducing tax rates is unlikely to be effective without other policy changes.

1. Related Literature

Taxes affect various corporate decisions (Shackelford and Shevlin 2001; Hanlon and Heitzman 2010; Graham 2013; Scholes et al. 2014), such as capital structure (Graham 1996; Heider and Ljungqvist 2015), investment (Asker, Farre-Mensa, and Ljungqvist 2015; Tsoutsoura

[7] Prior literature on the effects of taxes on corporate choices largely focuses on debt policy and investment. Since Modigliani and Miller's (1958) seminal article, a large body of work has examined how tax incentives affect firms' optimal capital structures. The literature on corporate investment decisions is smaller and largely studies the relation between tax policy and aggregate levels of investment (Hall and Jorgenson 1967; Summers 1981; Edgerton 2010).

2015), dividend payouts (Moser 2007), compensation (Graham, Lang, and Shackelford 2004; Dhaliwal, Erickson, and Heitzman 2009), hedging policies (Graham and Smith 1999; Graham and Rogers 2002), and organizational form and corporate restructuring (Shevlin 1987; Ayers, Cloyd, and Robinson 1996; Erickson 1998; Maydew, Schipper, and Vincent 1999).

Prior literature on the link between income taxes and corporate investment focuses on the effect of taxes on the *level* of investment.[8] In the model of Hall and Jorgenson (1967), taxes increase the cost of investment, while allowances for depreciation and investment tax credits reduce it. Summers (1981) extends the *q* theory of investment to include taxes. Using aggregate investment data and relying on time-series changes in tax rates or tax regimes, early studies fail to find evidence of a link between taxes and investment. Hines (1998) comments, "The apparent inability of tax incentives to stimulate aggregate investment spending is one of the major puzzles in the empirical investment literature." Exploiting variation in corporate tax rates at the state level, Asker, Farre-Mensa, and Ljungqvist (2015) find that privately held firms increase investment spending in response to tax cuts and reduce it in response to tax increases, whereas stock market-listed firms' investment spending is insensitive to tax changes. We extend this stream of literature on the link between taxes and the level of corporate investment by investigating the effect of corporate taxes on stock market-listed firms' choice of risk.

Our focus on the effect of corporate income taxes on risk-taking has a parallel in the literature investigating the link between personal income taxes and individual risk-taking pioneered by Domar and Musgrave (1944), Feldstein (1969), and Stiglitz (1969).[9] To guide our analysis, we apply the logic of Domar and Musgrave's model of individuals to the context of

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[8] See Hassett and Hubbard (2002), Desai and Goolsbee (2004), Hassett and Newmark (2008), and Hanlon and Heitzman (2010) for reviews of the literature on taxes and corporate investment.
[9] Gentry and Hubbard (2000) and Cullen and Gordon (2007) apply the logic of these models empirically to individuals' decisions to become entrepreneurs in the U.S.

firms. In their model, an investor weighs the advantage of a greater return ("yield") against the disadvantage of a possible loss ("risk"). Taxes reduce yields. How they affect risk depends on the extent to which losses are tax deductible. Without tax loss-offset, the investor will reduce risk once taxes are imposed.[10] The rate of loss-offset attenuates the negative relation between taxes and risk. These predictions translate naturally to the corporate setting.[11] In addition, we conjecture that constraints imposed by a firm's creditors make it harder to increase risk than to reduce it, resulting in an asymmetric sensitivity of corporate risk-taking to tax changes.

Our paper adds a new angle to the literature on corporate risk-taking. Prior research has studied several determinants of corporate risk-taking, including managerial risk aversion and career concerns (May 1995; Gormley and Matsa 2016), the sensitivity of CEO wealth to stock volatility (Coles, Daniel, and Naveen 2006), stock option compensation (Rajgopal and Shevlin 2002; Gormley, Matsa, and Milbourn 2013), inside debt (Cassell, Huang, Manuel Sanchez, and Stuart 2012; Choy, Lin, and Officer 2014), corporate governance (John, Litov, and Yeung 2008), Sarbanes–Oxley (Bargeron, Lehn, and Zutter 2010), creditor rights (Acharya, Amihud, and Litov 2011), and diversification (Faccio, Marchica, and Mura 2011).

Most related to our study is a working paper by Langenmayr and Lester (2015), which also analyzes the economic effects of tax rules on corporate risk-taking. We view our paper as complementary to theirs. Langenmayr and Lester's best identified evidence comes from a rule change affecting a limited sample of small Spanish firms. Using a sharp regression discontinuity design, Langenmayr and Lester find that Spanish firms with revenues just above EUR 20 million

[10] In Domar and Musgrave's (1944) framework, this prediction is called the substitution effect (i.e., substituting safer investments for riskier ones). Domar and Musgrave also discuss an income effect: because taxes reduce expected returns, individuals may take on more risk to restore their desired rates of return. Domar and Musgrave suggest that the substitution effect likely dominates the income effect in practice. In the context of corporate risk-taking, the income effect, if present, works against us finding a significant substitution effect. Note also that reducing risk would reduce the value of shareholders' option to default; hence shareholders would only have an incentive to reduce risk-taking when the tax benefits of doing so more than offset the reduction in option value.

[11] For a formal theoretical application to the corporate setting, see Green and Talmor (1985).

significantly reduced their risk-taking when their ability to offset losses was limited in 2011, as compared to firms just below the revenue threshold. One of our empirical findings is similar, in that U.S. firms reduce risk when state-level offset rules become less generous.

In contrast to Langenmayr and Lester (2015), our main focus, motivated by the analysis of Domar and Musgrave (1944), is not on variation in tax loss-offset rules but on variation in tax rates. Specifically, we focus on the sensitivity of risk-taking to tax rates, on the way tax loss-offset provisions moderate this sensitivity, and on asymmetry in this sensitivity in the presence of constraints imposed by creditors on a firm's ability to increase risk.

Compared to the extant literature, our main advantage is identification: our diff-in-diff methodology not only establishes a set of plausible counterfactuals taken from the same legal, regulatory, and business environment, but it also eliminates, when paired with a focus on adjacent states, omitted-variable biases resulting from the confounding influence of unobservable variation in, for example, local economic conditions.[12] Thus, we can interpret our results as plausibly causal, which is critical for academic research to be informative to policymakers (Leuz and Wysocki 2016). In addition, our setting allows us to separately investigate the effects of tax increases and tax cuts and thereby to shed light on the effectiveness of fiscal policy changes.

2. Sample and Data

2.1 Sample

Our sample begins with all firm-year observations in the merged CRSP-Compustat database for fiscal years 1990 to 2011. The 1990 start date is chosen because one of our control variables

[12] To illustrate this methodological advantage, consider Langenmayr and Lester (2015). In addition to the RD design, the authors estimate cross-country regressions. This amounts to comparing treated firms in one country to control firms in another. As the authors acknowledge, "other unobserved factors could influence [the] results." In contrast, we exploit state-level variation within the U.S., which allows us to hold constant many salient aspects of the legal, regulatory, and business environments treated and control firms operate in. This methodological difference might explain why Langenmayr and Lester find that changes in tax rates are associated with changes in risk-taking of the *same* sign, albeit only for firms with high offset ability, whereas we find that the relation is negative and asymmetric and holds only for firms with low offset ability (consistent with Domar and Musgrave 1944).

requires two lags of cash flow statement data, and cash flow data are only available since 1988. The sample ends in 2011 to give firms time to adjust their risk profiles after taxes change.

We exclude financial firms (SIC=6; 27,197 observations), utilities (SIC=49; 7,174 observations), public-sector entities (SIC=9; 2,187 observations), non-U.S. firms (17,289 observations), and firms headquartered outside the U.S. (954 observations). We delete firms without stock return data, firms not traded on a major U.S. stock exchange (NYSE, Amex, or Nasdaq), and firms with a CRSP share code >11 (47,666 observations). Firm-year observations with negative or missing total assets (30,281 observations) are also excluded. Requiring non-missing data for our risk measures and control variables and their lagged values leaves us with a final panel of 64,447 firm-year observations for 8,046 firms.

2.2 State corporate income taxes

2.2.1 Changes in state tax rates

To examine the effect of taxes on risk-taking, we exploit staggered changes in state corporate income tax rates across U.S. states over the period 1990 to 2011. Appendix A provides details of these changes. Panel A lists 40 tax increases in 24 states (including DC) affecting 1,152 sample firms in fiscal years 1990–2011, while Panel B lists 73 tax cuts in 27 states (including DC) affecting 4,920 firms in fiscal years 1990–2011.[13] The average tax shock increases tax rates by 93 basis points and the average tax cut reduces tax rates by 55 basis points.

Our main variables of interest are the *magnitude of tax increase* and *magnitude of tax cut* in a firm's headquarter state in a given fiscal year, in each case measured as the absolute value of the

[13] In coding which firms are affected by tax changes when, we are careful to capture whether a tax change affects firms with fiscal years *ending* or *beginning* on or after the effective date. This affects when it makes sense for a firm to react. We lose 8 of Heider and Ljungqvist's (2015) 121 tax changes, partly because our sample starts later, partly because two of their tax changes (in North Dakota in 2007 and 2009) affect none of the firms satisfying our sampling criteria, and partly because we lack a clear prediction for how changes from gross receipts taxes to income taxes (or vice versa) affect firm risk-taking.

difference between this year's and last year's tax rate. From time to time, firms move their headquarters from one state to another. Compustat provides information only on a firm's current headquarter state. To remedy this flaw, we use Heider and Ljungqvist's (2015) hand-collected data on firms' historical headquarter states. Based on these data, the average (median) treated firm experiences a tax increase of 136 (106) basis points and a tax cut of 53 (44) basis points.

In the U.S., firms are taxed in every state in which they have a physical presence (their so called "nexus" states).[14] To reduce the scope for profit-shifting and tax arbitrage, states do not attempt to measure actual profits earned in-state. Instead, under the 1957 Uniform Division of Income for Tax Purposes Act, a multi-state firm's federal taxable income is apportioned to each nexus state using a formula based on an average of the fractions of the firm's total payroll, sales, and property located in that state. This has two consequences for our analysis. First, it is not necessary for us to map a firm's projects to a specific state (which data limitations prevent us from doing): a firm can respond to a tax change in state A by changing the risk profile of its projects in *any* state it operates in. Second, the extent to which a multi-state firm is exposed to a given state income tax change depends on the extent of its nexus to that state.

To measure the magnitude of tax shocks experienced by multi-state firms more accurately, we approximate the geographic distribution of their tax liabilities using location data for their subsidiaries, branches, and plants. Specifically, we match Compustat firms by name to the National Establishment Time Series (NETS) database, which contains a comprehensive record of all business establishments in the U.S. since 1989.[15] We then calculate the weighted change in state tax rates in a firm's nexus states in a fiscal year as follows:

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[14] As of 2011, three states (Nevada, South Dakota, and Wyoming) do not impose income taxes, and three states (Ohio, Texas, and Washington) impose gross receipts taxes rather than income taxes.

[15] Neumark, Zhang, and Wall (2007) assess NETS along various dimensions and conclude that it is generally reliable.

$$\Delta tax\ rate_{i,t} = \sum_{s}\left(\frac{1}{2}\frac{employees_{i,s,t}}{employees_{i,total,t}} + \frac{1}{2}\frac{sales_{i,s,t}}{sales_{i,total,t}}\right)\Delta T_{s,t}\ , \quad (1)$$

where $employees_{i,s,t}$ and $sales_{i,s,t}$ are firm *i*'s number of employees and sales in state *s* in year *t*, respectively, and $employees_{i,total,t}$ and $sales_{i,total,t}$ are the corresponding firm totals across all nexus states in year *t*, respectively. $\Delta T_{s,t}$ is the change in the corporate income tax rate in state *s* in year *t*. Eq. (1) approximates a firm's nexus with each state using a 50/50 average of the fractions of the firm's total employment and sales in that state. Based on the magnitude and sign of the weighted tax change in Eq. (1), we define two alternative variables of interest: *nexus-weighted tax increase* and *nexus-weighted tax cut*, in each case measured in absolute terms.

2.2.2 Tax loss carryback/carryforward rules

The effect of taxes on risk-taking is moderated by tax loss-offset provisions (Domar and Musgrave 1944). Most U.S. states have loss-offset rules. For example, in 2011, about a third of U.S. states allow firms to offset current losses against income earned in the past 2 or 3 years, and all U.S. states allow firms to carry current losses forward, for periods ranging from 5 to 20 years. To examine heterogeneous treatment effects, we collect data on state tax loss carryback/ carryforward rules over our sample period. We also use changes in these rules as an alternative source of policy shocks to examine the effects of corporate taxation on firm risk-taking.

Appendix B provides details of changes in state tax loss carryback/carryforward rules for our sample period. Panel A lists 15 increases in the loss carryback period in 11 states (including DC) affecting 430 sample firms in fiscal years 1990–2011, while Panel B lists 36 reductions in the loss carryback period in 26 states (including DC) affecting 1,164 firms. At the state-level, the average increase is 2.13 years while the average reduction is 1.75 years. The average (median) treated firm experiences an increase of 2.04 (2) years and a reduction of 1.83 (1) years.

Panel C lists 47 increases in the loss carryforward period in 37 states (including DC) affecting 5,349 sample firms in fiscal years 1990–2011, while Panel D lists 10 reductions in the loss carryforward period in eight states affecting 1,828 firms. The variation in carryforward periods is larger than for carryback periods. At the state-level, increases average 6.43 years, while reductions average 8.2 years. The average (median) treated firm experiences an increase in the carryforward period of 6.65 (5) years and a reduction of 9.58 (10) years.

2.2.3 State-level confounds

Our identification strategy requires that state corporate income tax changes do not coincide systematically with variation in local business cycles or other tax or non-tax state policies that might independently affect firms' risk-taking. For example, if states raise taxes in economic downturns, and economic downturns motivate firms to reduce risk-taking, we could observe a spurious correlation between taxes and risk-taking. We address this potential problem in two ways. First, we include controls for observed variation in state economic conditions in our regressions. Second, in a separate robustness check, we restrict the sample of control firms to those in neighboring states to control for unobserved variation in local economic conditions.

Appendix C shows that changes in state corporate income tax rates and loss-offset rules rarely coincide with each other or with changes in investment incentive programs (i.e., tax credits for investment, R&D, and job creation). The only area of overlap we find is with bank taxes: 28 of the 40 corporate tax increases coincide with increases in bank taxes and 56 of the 73 corporate tax cuts coincide with cuts in bank taxes. Since changes in bank taxes could result in changes in the supply of bank loans, we verify that our results are robust to controlling for changes in bank taxes.[16]

[16] Banks have a unique status for state tax purposes (Koch 2005). They are taxed on a different schedule from corporations and so are subject to their own tax changes. When a state increases its bank tax, it reduces the after-tax profit on every loan made to borrowers located in the state, regardless of the lender's own location. Variation in a state's bank taxes can thus induce variation in the supply of loans available to firms located in the state.

Overall, we conclude that changes in state corporate income tax rates and loss-offset rules appear plausibly exogenous to firms' risk-taking decisions. Section 3.5 considers the extent to which state corporate tax changes are unanticipated.

2.3 Risk-taking measures

We view a firm as a portfolio of projects. Projects can have different risks. At each instant, the firm can close down existing projects and add new ones. While we do not observe these project-level choices, we do observe the aggregate cash flows they generate. We thus measure corporate risk-taking as the firm-level volatility of aggregate cash flows, defined in two different ways. Our first measure of risk-taking, *ROA volatility*, is the standard deviation of seasonally adjusted quarterly pre-tax returns on assets (*ROA*) over a three-year period from year *t* to *t*+2 (Correia, Kang, and Richardson 2015). Seasonally adjusted pre-tax *ROA* for firm *i* in quarter *q* of year *t* is computed $\Delta ROA_{i,t,q} = ROA_{i,t,q} - ROA_{i,t-1,q}$, where pre-tax *ROA* is operating income after depreciation (i.e., earnings before interest and taxes) divided by the book value of total assets.

Our second measure of risk-taking, *ROIC volatility*, is the standard deviation of seasonally adjusted quarterly pre-tax returns on invested capital (*ROIC*) over a three-year period from year *t* to *t*+2. Following Lundholm and Sloan (2012), we compute *ROIC* as operating income after depreciation divided by the sum of debt, minority interests, preferred stock, and common stock.[17]

Note that because both variables are measured before interest and taxes, they capture business (or asset) risk rather than the effects of financing risk. This is important because it is well-known that tax changes can prompt firms to change their financial leverage. Our measures are thus designed to isolate the effects of taxes on the real (rather than financial) risks firms take.

[17] *ROIC* is also called return on net operating assets (*RNOA*). Some researchers view non-operating cash as negative debt and subtract total cash from invested capital in computing *ROIC*. However, in the presence of financial frictions, non-operating cash should not be viewed as negative debt (Acharya, Almeida, and Campello 2007). Moreover, firms generally do not disclose how much cash they hold for non-operating purposes (Lundholm and Sloan 2012).

In a robustness test, we use two market-based measures as alternative measures of risk-taking, namely, the standard deviation of stock returns and the de-leveraged standard deviation of stock returns. We prefer the earnings-based risk measures because they more likely reflect a firm's choice of risk (stock returns not being under the firm's control).

2.4 Control variables and descriptive statistics

Following prior research (e.g., Coles, Daniel, and Naveen 2006), we control for the following firm characteristics: age, size, market-to-book ratio, book leverage, cash surplus, loss carry-forward, sales growth, and annual stock return. (See Appendix D for definitions.) Table 1 presents summary statistics. The average (median) *ROA volatility* is 6.8% (3.8%), and the average (median) *ROIC volatility* is 10.6% (5.3%). Given the skewed distribution of these two risk measures, we use their log-transformed values in our regression analysis. The average firm in our sample is 19.6 years old and has total assets of $1,755.2 million.

We also control for two state-level variables: the real growth rate in gross state product (GSP) and the state unemployment rate. The mean home-state GSP growth rate is 2.7% and the mean unemployment rate is 5.9%. We consider further state-level controls in robustness tests.

3. Empirical Strategy and Results

3.1 The effect of tax changes on risk-taking

We use a diff-in-diff framework to identify the effect of changes in state corporate income tax rates on firms' risk-taking choices. Specifically, we estimate the following regression model:

$$\Delta Risk_{i,j,s,t} = \beta \Delta T^{+}_{s,t} + \gamma \Delta T^{-}_{s,t} + \theta \Delta Z_{s,t} + \delta \Delta X_{i,t-1} + \alpha_{j,t} + \varepsilon_{i,j,s,t}, \qquad (2)$$

where *i*, *j*, *s*, and *t* index firms, industries, states, and years, respectively. Δ is the first-difference operator. $Risk_{i,j,s,t}$ is a measure of risk-taking (*ROA volatility* or *ROIC volatility*). The first difference of *ROA* (*ROIC*) *volatility* for year *t* is the log-transformed standard deviation of seasonally adjusted quarterly pre-tax *ROA* (*ROIC*) computed over years t to t+2 minus the log-transformed standard deviation of seasonally adjusted quarterly pre-tax *ROA* (*ROIC*) computed over years t–3 to t–1.[18] In our baseline models, $\Delta T^{+}_{s,t}$ is the *magnitude of tax increase* in a firm's home state and $\Delta T^{-}_{s,t}$ is the *magnitude of tax cut* in a firm's home state in year t. Since each is measured in absolute terms, firm risk is reduced in response to a tax increase if $\beta<0$ and increased in response to a tax cut if $\gamma>0$.

$Z_{s,t}$ represents the state-level control variables in year t (the state's real GSP growth and unemployment rate). $X_{i,t-1}$ is the vector of time-varying firm-level control variables, measured as of t–1.[19] The $\alpha_{j,t}$ are SIC4 industry-year fixed effects, which remove unobserved time-varying industry shocks. Essentially, industry-year fixed effects allow us to compare treated and control firms in the same industry at the same point in time. $\varepsilon_{i,j,s,t}$ is the usual error term. Given the state-level nature of the variation we exploit, we cluster standard errors by state (Petersen 2009). As Table IA.1 in the Internet Appendix shows, our results are robust to alternative approaches.

Estimating Eq. (2) in first-differenced form removes firm-specific fixed effects and potential confounding effects from time-invariant state-level conditions or policies (e.g., political parties or fiscal policies). An advantage of a first-differenced specification over a levels specification with firm fixed effects is that first-differencing can accommodate repeated treatments, treatment reversals, and firms' asymmetric responses to tax changes, all of which exist in our setting.

To illustrate our identification strategy, consider Pennsylvania. In 1991, PA raised its top corporate income tax rate from 8.5% to 12.25%. Following this tax increase, stock market-listed firms headquartered in PA reduced risk by about 10% on average. From the point of view of an

[18] To construct these measures, we use data from Compustat Quarterly for fiscal years 1987 to 2013.
[19] Consistent with prior research, we use beginning-of-year (i.e., year t–1) values for the firm-level controls as these variables are likely affected by a firm's concurrent risk-taking choices (Gow, Larker, and Reiss 2016).

individual firm in PA, this tax shock is plausibly exogenous: presumably, no firm would have lobbied for the tax increase. Exogeneity with respect to individual firms' characteristics is not, however, sufficient to establish causality: other coincident developments, such as changes in investment opportunities in PA, could be responsible for the reduction in corporate risk-taking.

To control for such contemporaneous developments, we compare risk changes among PA firms to the contemporaneous risk changes among firms located in other states without a tax change in 1991, say, in New York. To the extent that PA firms and NY firms are faced with similar changes in their prospects, the contemporaneous change in risk among NY firms provides a counterfactual estimate of how PA firms' risk choices would have evolved absent the tax increase. The difference-in-differences, that is, the difference across firms in different states of the within-firm risk change around the tax increase, gives the desired estimate of the tax sensitivity of corporate risk-taking.

Eq. (2) generalizes this illustrative example in that it exploits variation in taxes across many states and years. For any change in corporate income taxes in state *s* and year *t*, the potential control states are all those states that did not change their corporate income taxes in that year. In addition to this, Eq. (2) also controls for time-varying firm and state factors, as well as unobserved time-invariant firm characteristics and time-varying industry shocks.

Table 2 reports the results of estimating Eq. (2). Columns 1 and 2 model how firms respond to tax changes in their headquarter states. In the regression with *ROA volatility* as the dependent variable (column 1), the coefficient on *magnitude of tax increase* is -0.019 (p=0.007), suggesting that firms reduce risk-taking in response to a tax increase. The effect is both statistically and economically significant. The point estimate suggests that the average treated firm, whose home-state tax rate increases by 136 basis points, reduces its risk-taking by 2.6% relative to other firms in the same industry that are not subject to tax changes in their own home state that year. In column 2, where we use *ROIC volatility* as the dependent variable, the coefficient on *magnitude of tax increase* is -0.020 (p=0.006) – nearly identical to the point estimate in column 1.

The models shown in columns 1 and 2 relate the difference in volatility measured over fiscal years t to t+2 and volatility measured over fiscal years t–3 to t–1 to tax changes occurring in fiscal year t. In columns 3 and 4, we lag the tax changes by one year to allow for delays in firms' responses to tax changes. This produces stronger results for *ROA volatility* and similar results for *ROIC volatility*: *ROA volatility* falls by 2.6 percentage points for every one-percentage-point increase in the tax rate (p<0.001), while *ROIC volatility* falls by 1.9 percentage points (p=0.047).

Columns 5 and 6 of Table 2 model how firms respond to contemporaneous changes in their nexus-state weighted income tax rates. As discussed earlier, the weighted tax-change measures arguably better capture the shock to a firm's actual state-tax burden. In column 5, where the dependent variable is *ROA volatility*, the coefficient on *nexus-weighted tax increase* is -0.024 (p=0.011), suggesting that a one-percentage-point increase in a firm's nexus-weighted tax rate reduces its risk-taking by 2.4% relative to control firms in the same industry and year. In column 6, the coefficient on *nexus-weighted tax increase* is -0.032 (p=0.005) when we use *ROIC volatility* as the dependent variable. Overall, the effects estimated for nexus-weighted tax changes are larger than those for home-state tax changes, confirming our prediction that ignoring the geographic distribution of firms' tax bases understates the tax sensitivity of firms' risk-taking. Results using home-state tax changes are hence conservative.[20]

[20] Among the control variables, we find that risk increases by less as the firm ages or grows in size. Firms with a higher market-to-book ratio take more risk, while firms with higher financial leverage, more cash surplus, and higher stock returns take less risk. Firms with higher sales growth rates and loss carryforwards have higher risk. The two state-level control variables are also marginally significant. Firms increase risk as the GSP growth rate falls and as the state unemployment rate increases.

3.2 Asymmetry

The contemporaneous effect of tax cuts is to increase risk-taking. The effect is large, but unlike the effect of tax increases, it is not statistically significant. For example, in column 1, the coefficient on *magnitude of tax cut* is 0.016 with a *p*-value of 0.322. The results for *ROIC volatility* or when using nexus-weighted tax changes show a similar pattern. When lagged, the effect of tax cuts on risk-taking is close to zero. While the difference in the sensitivity to tax increases and to tax cuts is small and not statistically significant for contemporaneous tax changes, it is economically large and statistically significant for *ROA volatility* when we use lagged tax changes. This reduced sensitivity to tax cuts is not due to tax cuts being smaller, on average, than tax increases in our sample: as Table IA.2 in the Internet Appendix shows, similar results obtain when we focus on large tax cuts.

These findings suggest a degree of asymmetry in firms' responses to tax changes: firms more strongly and more consistently respond to tax increases than they do to tax cuts. Asymmetry suggests that firms face external constraints on their ability to increase risk. A natural source of constraints is their creditors; after all, the value of creditors' claims falls as corporate risk-taking increases. To test whether this channel can explain asymmetry, we sort firms into those with low financial leverage (which face fewer constraints) and those with high leverage (which face more constraints), measured as of the end of the fiscal year before a tax change. Table 3 reports the results. Consistent with our prediction, firms with low leverage do, in fact, increase risk-taking in response to a tax cut, whereas firms with high leverage do not.[21]

[21] Table 3 also shows that firms' sensitivity to tax *increases* does not vary with their leverage. This rules out an alternative interpretation of our baseline results, namely that firms reduce risk when taxes increase not because their tax function has become more convex but simply because doing so allows them to more easily increase their financial leverage.

3.3 Pre-trends, delayed responses, and reversals

A causal interpretation of the effect of tax changes on risk-taking requires that treated and control firms follow parallel trends absent the tax change. To test for parallel trends, Table 4 includes lead terms of the tax change variables. These are measured as of year *t*+3, given that we use 12 quarters of earnings data to construct our volatility measures. The point estimates for the lead terms are economically tiny and not statistically different from zero, suggesting that risk follows parallel trends at treated firms and controls before state income tax rate changes. One implication of these findings is that firms do not anticipate future changes in state income taxes (or if they do, that they wait to change risk until the tax changes affect shareholder wealth).

Table 4 also allows for potential delays in firms' responses to tax cuts and post-shock reversals in the effect of tax increases by including three-year lags. The coefficient for lagged tax increases is negative, indicating that firms do not subsequently reverse the reduction in risk following a tax increase. Given the relatively large point estimate, the effect of a tax increase appears not only persistent but also increasing over time. In column 1, the cumulative effect is -0.035 (p<0.001), suggesting that a one-percentage-point increase in the state corporate income tax rate in year *t* reduces *ROA volatility* by 3.5% over the next six years (i.e., *ROA volatility* measured over years *t* to *t*+2 and over years *t*+3 to *t*+5). Given an average tax increase of 136 basis points, the average treated firm thus reduces its risk by a cumulative 4.8%. For tax cuts, the coefficient on the lag term is economically small and statistically insignificant.

3.4 Local business cycle effects and other state-level confounds

Our baseline regression model includes GSP growth rates and state unemployment rates to control for time-varying state-level economic conditions. In addition, by first-differencing, we have removed unobserved cross-state differences in rules or laws affecting business, to the extent that these rules or laws are persistent over time. There remains the possibility that unobserved changes in local economic conditions coincide with, or even drive, state changes in tax rates, and that it is these unobserved changes that cause firms to change their risk-taking.

To further address this potential omitted-variables problem, we drop far-away control states and restrict the set of control firms to those located in states neighboring the treated state.[22] The essence of a neighboring-state test is to exploit a policy discontinuity along a geographic boundary under the maintained assumption that there exists an unobserved time-varying confound which might bias the treatment effect of interest.[23] The aim is to difference away the confound in order to obtain an unbiased estimate of the treatment effect. In our setting, the policy in question is a tax change ΔT_A in state A which applies only in state A but not in neighboring state B (this is the policy discontinuity). The outcome variable is the change in risk, ΔR. The potential time-varying confound (denoted by ΔY) could, for example, be business cycle variation.

The identifying assumption in this type of test is that $\Delta Y_A \approx \Delta Y_B$ (both states are exposed to roughly the same business cycle variation). Under this identifying assumption, and suppressing time subscripts, $(\Delta R_A|\Delta T_A, \Delta Y_A) - (\Delta R_B|\Delta Y_B)$ is a consistent estimate of the effect of taxes on risk-taking, given that $\Delta Y_A - \Delta Y_B \approx 0$, and so the unobserved confound can be differenced away. Economically speaking, the cross-border neighbors establish the counterfactual risk-taking response to the local business cycle variation of firms not affected by a tax increase, and this counterfactual response is then subtracted from the treated firms' response to the treatment. In other words, comparing treated firms to their immediate neighbors helps ensure that trends are

[22] Note that, in so doing, we drop observations for states that are treated in another year but are not the neighbor of a treated state in the current year.
[23] See Holmes (1998), Huang (2008), Dell (2010), and Dube, Lester, and Reich (2010).

parallel after removing the effects (if any) of variation in local conditions.[24]

Table 5 reports the results. A one-percentage-point increase in the corporate tax rate reduces *ROA volatility* and *ROIC volatility* by 2.1% (p=0.001) and 2.2% (p=0.003), respectively, compared to firms in the neighboring state. Thus, controlling for unobserved local business cycles increases the point estimates a little compared to the baseline results reported in Table 2. Tax cuts continue to have no effect on risk-taking. Overall, these patterns confirm that our findings are not driven by any source of unobserved variation that coincides with the tax changes but diffuses across state borders.

This leaves confounds whose variation coincides with the tax changes and whose influence stops at the state border, such as the state-level policy changes listed in Panel A of Appendix C. To address concerns stemming from the fact that corporate tax changes occasionally coincide with changes in state taxes on bank profits or in investment incentive programs (i.e., tax credits for investment, R&D, and job creation), columns 3 and 4 of Table 5 control explicitly for these concurrent changes.[25] Doing so leaves the estimated effect of tax increases largely unchanged. The effect of tax cuts, while still statistically insignificant, changes sign. The difference between the two tax sensitivities is economically large and statistically significant (p=0.012 in column 3 and p=0.037 in column 4). This asymmetric response of firms' risk-taking is consistent with our earlier argument that risk is easier to reduce than to increase: creditors stand to lose out when risk increases and so have an incentive to constrain the firm's ability to increase risk unduly.

Columns 3 and 4 reveal two further patterns. First, lower taxes on bank profits are associated with significantly greater corporate risk-taking, possibly because they stimulate bank lending

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[24] The neighboring-state test does not assume that neighboring states have the same or similar policies. Assume there is variation in policies across neighboring states. If these policies do not themselves change at the time of the tax change, they are differenced away by our first-difference research design and so cannot confound the results.

[25] Inspecting the political economy of the major tax changes, Heider and Ljungqvist (2015) find no evidence that they coincide systematically with other policy changes that plausibly affect firm behavior independently.

which in turn allows firms to take greater risks. Second, reductions in R&D tax credits are associated with reduced risk-taking, consistent with the intuition that less generous R&D tax credits dampen firms' incentives to invest in potentially risky R&D projects. Overall, the results in Table 5 support a causal interpretation of the estimated effect of tax increases on firm risk-taking and confirm that firms respond to tax changes asymmetrically.

A remaining challenge to our identification is that there could be an interaction between unobserved time-varying business cycle variation and a state's time-invariant policies. For example, say states A and B are exposed to the same business cycle variation but state A is a business-friendly state while state B believes in heavy regulation. Then firms in state A will be more sensitive to the common business cycle variation than firms in state B. This, in turn, would violate a version of the identifying assumption, namely that *absent the tax change in state A*, $\Delta R_A|\Delta Y_A \approx \Delta R_B|\Delta Y_B$. In this scenario, our test would wrongly attribute the difference in risk-taking, $(\Delta R_A|\Delta T_A, \Delta Y_A) - (\Delta R_B|\Delta Y_B)$, to the tax change rather than to the moderating effect on ΔY_B of state B's heavy regulatory burden.

For such an interaction between time-varying business cycle variation and time-invariant policies to spuriously produce our results, it would have to be the case that firms' risk choices were systematically more sensitive to changes in economic conditions in tax-increasing states than in neighboring control states. We view this as unlikely for two reasons. First, while it is conceivable that a particular constellation of policy differences across neighboring states and the local business cycle could produce this identification challenge in some place at some point in our data, it is much less likely to systematically confound our results, given that we exploit not one but 113 tax changes that are neither clustered in time nor in space. Second, the large number of tax changes means that every state (bar Montana) that is treated at some time also acts as a control state at some other time in our panel. The effects of cross-state differences in the sensitivity of risk-taking to economic conditions thus cancel out.[26]

A related concern is that tax changes in one state trigger changes in the behavior of firms in a neighboring state. To investigate such cross-border spillovers, we conduct a test parallel to Table 5 that restricts the set of control firms to those located in states *not neighboring* the treated state. As Table IA.3 in the Internet Appendix shows, our inferences are unchanged.

3.5 Anticipation Effects

If firms plan their current policies based on the tax rates they expect to face in the future, their observed responses to an actual tax change may not uncover the causal effect of taxes on their behavior. To see why, consider a tax increase that turns out smaller than expected. This may cause corporate policy to change in a way normally expected after a tax *cut* (since the tax rate increased by less than expected), which in turn would confound the interpretation of the observed treatment effect (as the econometrician does not observe the firm's expectations).

As Hennessy and Strebulaev (2015) note, this identification challenge arises only when the corporate policy in question is subject to adjustment costs, so that the firm must plan ahead in order to reach its desired position over time given its expectations. The next subsection explores empirically various mechanisms by which firms may change risk-taking in response to tax changes. Some of these are more plausibly subject to adjustment costs than others. The one that we find to be strongest in the data is a short-term mechanism with few obvious adjustment costs.

There is one (somewhat obvious) scenario, besides the absence of adjustment costs, for when anticipation effects do not pose an identification challenge: if policy changes are unanticipated. More formally, a necessary and sufficient condition for correct inference about causal effects is

[26] If risk-taking in business-friendly state A always responds to the business cycle while risk-taking in state B does not, then the treatment effect is (A–B) when A is treated and (B–A) when B is treated, so that the overall treatment effect averages zero (i.e., (A–B)+(B–A)=0). Our results reject this null hypothesis, at least for tax increases.

that the policy variable is a Martingale (Hennessy and Strebulaev 2015), which in our context means that state tax rates follow a random walk. Using three unit root tests, Ljungqvist and Smolyansky (2016) largely fail to reject the null hypothesis of a random walk.[27]

Specifically, in separate augmented Dickey-Fuller tests on each state's time series of tax rates from 1969 to 2013, Ljungqvist and Smolyansky (2016) fail to reject the presence of a unit root in each state and DC, suggesting corporate tax rates follow a random walk in every state. Realizing that some states condition their tax policy on the tax policies of their neighbors (Heider and Ljungqvist 2015), Ljungqvist and Smolyansky also test the null hypothesis that each state in a given regional "cluster" has a unit root while allowing for cross-sectional dependence in tax rates across states. Clusters are defined either as a state and its contiguous neighbors (giving 49 clusters, including DC's but excluding Alaska and Hawaii) or as states that are located in a given Census region. The null cannot be rejected at standard significance levels except in Connecticut and in Massachusetts and their respective contiguous neighbors. Within Census regions, the null is never rejected at the 5% level; it is rejected at the 10% level in New England.

To see whether anticipation effects in states whose tax rates do not follow a random walk may confound our results, Table 6 excludes firms headquartered in Connecticut or Massachusetts (columns 1 and 2) or in New England as a whole (columns 3 and 4). Doing so marginally reduces the magnitude of the treatment effect of tax increases, to between -0.014 and -0.018 ($p<0.05$). Tax cuts continue to have no significant effect on the average firm's choice of risk.

An alternative to this econometric way of classifying tax changes as potentially anticipated is the "narrative approach" of Romer and Romer (2010). Heider and Ljungqvist (2015) examine the political economy events surrounding all state tax changes affecting at least 100 firms since 1989 to identify potentially anticipated tax changes. Based on their findings, columns 5 and 6 of Table

[27] These findings echo Barro (1990), who reports that federal taxes follow a random walk.

6 exclude firms headquartered in Colorado, Connecticut, Minnesota, or New York (all of which experienced sequences of tax cuts). This yields sensitivities to tax increases of between -0.016 and -0.019 ($p<0.05$), again marginally smaller than those reported in our baseline tests.

Collectively, the results in Table 6 suggest that anticipation effects do not play a major role in contaminating our findings. This, in turn, increases our confidence in the external validity of our findings: to the extent that state tax rates truly follow a random walk, the patterns we document should apply more broadly than just in the setting and time period we study.

3.6 Mechanisms

By what means do firms reduce risk in response to state corporate income tax increases? The reasonably fast increase in earnings volatility (measured over the three-year period from *t* to *t*+2) suggests that firms change the risk profile of their existing operations. One way to do so is to make changes to the operating cycle: the process by which cash is transformed into raw materials, work in progress, finished goods, accounts receivable, and eventually back into cash. Shortening the operating cycle (for example, by reducing the amount of cash tied up in inventory that could go unsold) puts less capital at risk and so reduces earnings volatility. Essentially, the firm can reduce its operating risk by reducing its investment in working capital, and it can do so relatively quickly and, potentially, without incurring substantial adjustments.

Panel A of Table 7 provides evidence of such reductions in operating risk. In the year following a tax increase, we see firms reducing their operating cycles by an average of 1.7 days and 3.05 days for every one percentage-point increase in their home-state or nexus-weighted tax rate, respectively. (Tax cuts have no effect on operating cycles.) Relative to the sample average operating cycle of 83.6 days, this implies a reduction of 2% to 3.6% for the average treated firm. About half of this reduction comes from a reduction in inventory holding periods, which fall by an average of 0.72 to 1.47 days in columns 2 and 5.[28]

Another way firms could reduce operating risk is by reducing operating leverage, that is, the sensitivity of profits to changes in output. In practice, reducing operating leverage requires turning fixed costs into variable costs. Whether the tax shocks are on average large enough to justify the expense involved in making costs more flexible is an open question. For example, making labor costs more flexible may involve protracted negotiations with unions and increase the risk of strikes (a form of adjustment cost). As columns 3 and 6 of Panel A show, we fail to find evidence of firms changing their operating leverage in response to state tax changes.[29]

Given the further reduction in risk-taking observed over the medium term (i.e., the three-year period *t*+3 to *t*+5 in Table 4), firms may also change the risk profiles of their investment projects. Panel B of Table 7 begins by showing that firms do not adjust the *level* of their capital expenditures or R&D spending in response to state tax changes: the tax sensitivity of either is both economically and statistically zero, consistent with Asker, Farre-Mensa, and Ljungqvist (2015).[30] This finding leaves open the possibility that firms instead respond to tax increases by changing project risk. For example, firms may choose safer R&D projects (say, to enhance the quality or variety of their existing products) over riskier ones (say, to invent new products).

Project risk is not directly observable, but its effect on cash flow is potentially measurable. To see how, start from the observation that R&D has an asymmetric effect on sales: all else equal, successful R&D projects boost the firm's sales while failed R&D projects have no (immediate) effect. This insight gets around the problem that accounting data reveal only R&D inputs (i.e.,

[28] Though not shown to conserve space, the two other components of the operating cycle, the average number of days to collect receivables and pay payables, do not change significantly.

[29] Another way firms can fine-tune their risk profiles in response to state tax rate changes is hedging (Graham and Smith 1999; Graham and Rogers 2002). Data on hedging activities are not systematically available.

[30] As Table IA.4 in the Internet Appendix shows, we similarly find no evidence that firms change their M&A activities or reduce risk by engaging in diversifying acquisitions.

spending), not R&D outputs (i.e., new products or processes that generate sales): an increase in the sensitivity of sales to R&D spend implies an increase in R&D outputs for a given amount of R&D spend. Next, consider a mean-preserving increase in R&D risk. This would increase the sensitivity of sales to R&D spend if the project succeeds and leave it unchanged if the project fails. On average, therefore, an increase in R&D risk results in an increase in the sensitivity of sales to R&D spend. The opposite holds for a reduction in R&D risk.

Using a measure called the Research Quotient™ (available on WRDS), Panel B shows that the sensitivity of sales to R&D spend falls after a tax increase, consistent with firms reducing R&D risk. The effect is not immediate – it takes on average between one and three years for a tax increase to reduce the R&D sensitivity of sales – and not overly strong statistically.

A cautious interpretation of the findings in Table 7 is that the most prominent mechanism by which firms reduce risk in response to state corporate income tax increases involves making changes to the operating cycle. Since such changes should be relatively easy to reverse, they should not involve substantial adjustment costs, reducing concerns about anticipation effects that are not already allayed by Ljungqvist and Smolyansky's (2016) finding that state tax rates mostly follow a random walk or by the auxiliary evidence reported in our previous subsection.

3.7 Robustness Tests

Before turning our attention to the moderating effect of tax loss-offset rules, we briefly consider two robustness tests.

Our baseline tests use *ROA volatility* and *ROIC volatility* to measure firm risk. Prior research on corporate risk-taking often uses stock return volatility to measure a firm's choice of risk. Table IA.5 in the Internet Appendix shows that our findings are robust to using equity volatility instead of earnings volatility: a firm's annual stock return volatility falls by around 2% following a tax increase and is invariant to tax cuts, and the difference between the two tax sensitivities is economically large and statistically significant.

Our results may be driven by tax-related changes in earnings management.[31] To investigate this concern, we test if a firm's performance-matched discretionary accruals (Kothari, Leone, and Wasley 2005) vary with tax changes, but find no evidence that they do (see Table IA.6 in the Internet Appendix). This is consistent with Graham's (2006) observation that "tax incentives appear to be a second-order consideration, rather than a dominant influence on earnings management" (p. 663). In addition, equity-based measures of risk-taking, such as those modeled in Table IA.5, are not affected by earnings management, further alleviating this concern.

4. State Tax Carryback/Carryforward Rules

4.1 Heterogeneous treatment effects

According to Domar and Musgrave's (1944) theory, the effect of personal income taxes on individual risk-taking is negative in the absence of loss-offsets. The same is true in the corporate arena. However, if firms can offset losses against past or future profits, the effect of taxes on risk-taking becomes more complex. On the one hand, income taxes discourage risk-taking by reducing the per-unit benefit of risk-taking. On the other hand, loss-offset rules essentially make the government shoulder part of the losses. Thus, both the benefit of risk-taking and the level of after-tax cash flow risk are reduced. If complete offset of losses is possible, variation in tax rates may have no net effect on risk-taking.

To test this prediction, we partition the sample based on the carryback and carryforward rules in effect in each firm's home state in a given fiscal year. Specifically, we code firms as having a low ability to offset losses when their home state allows no loss carrybacks and no more than 10

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[31] Scholes, Wilson, and Wolfson (1992) find that firms respond to anticipated reductions in federal tax rates by delaying recognizing income. Maydew (1997) provides evidence that firms shift income to benefit from loss-offsets.

years of loss carryforwards. Otherwise, we code firms as having a high ability to offset losses.[32]

Table 8 presents the results of estimating Eq. (2) in the partitioned samples. For firms with a low loss-offset ability, the sensitivity of *ROA volatility* and *ROIC volatility* to a tax increase is -0.026 (p=0.010 in column 1) and -0.033 (p=0.008 in column 3), respectively. For firms with a high loss-offset ability, the sensitivity is -0.010 (p=0.391 in column 2) and -0.004 (p=0.817 in column 4), respectively.[33] These results suggest that the negative effect of tax increases on risk-taking is largely driven by firms located in states with weak loss-offset provisions, consistent with the prediction that the effect of income taxes on risk-taking is attenuated by the ability to offset tax losses against past or future profits.

4.2 State loss-offset rules and risk-taking

Our baseline tests investigate firms' responses to tax rate changes while our tests of heterogeneous treatment effects examine if firms' responses to tax rate changes are moderated by tax loss-offset rules. We next test if changes in loss-offset rules affect risk-taking independently. A reduction in the number of years that losses can be carried back or forward essentially reduces the extent to which the government shares in a firm's risks, analogous to a tax rate increase. Thus, we expect that reductions in the generosity of carryback or carryforward rules lead to lower risk-taking. The opposite argument can be made for an increase in the length of carryback or carryforward periods (subject to creditors constraining firms' ability to increase risk).

Table 9 examines loss-offset rule changes both in a firm's home state (in Panel A) and across its nexus states (in Panel B).[34] We allow for asymmetric responses by separately including

[32] These cutoffs are arbitrary but, as Table IA.7 in the Internet Appendix shows, not selective.
[33] The difference between the coefficients on *magnitude of tax increase* in the two subsamples, although economically large, is only statistically significant when we use *ROIC volatility* as the dependent variable.
[34] For the latter, we estimate nexus-weighted changes in the length of tax loss carryback/carryforward periods using Eq. (1) (i.e., the formula used to estimate nexus-weighted changes in tax rates), after replacing tax rate changes with changes in the length of loss carryback/carryforward periods.

increases and reductions in the length of loss carryback or carryforward periods. For both home-state and nexus-weighted changes, and whether we model risk as *ROA volatility* or *ROIC volatility*, we find an asymmetric response to changes in carryback rules: firms reduce risk-taking as carryback rules are made less generous but do not respond when the rules become more generous.[35] Since a shorter carryback period amounts to a tax increase, these patterns are consistent with our baseline finding that firms reduce risk-taking in response to an increased tax burden but do not significantly increase risk-taking in response to a reduced tax burden.

The response to changes in carryforward rules is different: firms respond to more generous carryforward rules by increasing risk (sometimes significantly so). However, these effects are economically small. Firms do not respond when carryforward rules become less generous.

The contrast between firms' risk-reducing response to less generous carryback rules and their indifference to less generous carryforward rules is consistent with claims in the literature that carrybacks allow firms to claim cash taxes back immediately when incurring losses whereas the benefit of carryforwards is more uncertain (Langenmayr and Lester 2015).

Overall, using changes in state tax loss-offset rules yields results that reinforce our conclusion from using tax-rate changes that increasing a firm's tax burden reduces its willingness to take risk.

5. Conclusions

We ask whether and how corporate income taxes affect firms' risk-taking. Based on theories of the effect of personal income taxes on individual risk-taking, we predict a negative effect of corporate income taxes on corporate risk-taking. Using a large set of natural experiments in the form of 113 staggered changes in corporate income tax rates across U.S. states, we provide

[35] The results are stronger for nexus-weighted changes than for home-state changes. They are robust to controlling for the tax rate changes from our baseline tests (see columns 3 and 4). This is not surprising: as Appendix C shows, changes in state corporate income tax rates rarely coincide with changes in state tax loss-offset rules.

evidence that firms reduce risk-taking in response to income tax increases, by shortening their operating cycles and by reducing the risks they take in their R&D projects. Consistent with the interpretation that creditors use restrictive covenants to prevent firms from increasing risk ex post, we show that only firms with low financial leverage increase risk in response to tax cuts.

In addition to using a difference-in-differences regression with a comprehensive set of firm-level and state-level control variables, we employ a battery of refinements to establish causality: including industry-year fixed effects to control for time-varying industry shocks, adding lead terms to confirm parallel trends, using neighboring states to control for local economic cycles, and controlling for other coincident state-level policy changes. Finally, when we allow for heterogeneous treatment effects, we find that the effect of tax increases on risk-taking is largely driven by firms located in states with few loss-offsetting opportunities, as predicted.

Our study contributes to the broad literature investigating how taxes affect corporate policies. Motivated by the theoretical framework of Modigliani and Miller (1958, 1963) and Miller and Modigliani (1961), most research in this literature examines how taxes affect corporate financial decisions. Several prior studies examine the effects of taxes on the level of corporate investment using aggregate data, with mixed results. Our research extends this line of research by examining the effects of taxes on individual firms' risk-taking decisions.

As in Heider and Ljungqvist (2015), an important caveat concerns the external validity of our findings. The state-level tax changes in our sample are generally small in magnitude, and it is possible that firms would respond differently if the tax shocks were larger. With this caveat in mind, we believe that the evidence documented in this study represents an important contribution to the tax literature.

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Appendix A. List of Changes in State Corporate Income Tax Rates.

Panel A. List of Tax Increases.

This table lists all U.S. state corporate income tax increases in calendar years 1989–2012 affecting firms in fiscal years 1990-2011. In states with more than one tax bracket, we report the change to the top bracket. Tax changes are identified from the Tax Foundation (an abbreviated version of which is available at http://www.taxfoundation.org), the *Book of the States*, a search of the "Current Corporate Income Tax Developments" feature published periodically in the *Journal of State Taxation*, and state tax codes accessed through Lexis-Nexis.

State	Year	Description	No. of affected sample firms
IL	1989	Increase in top corporate income tax rate from 4% to 4.8%	6
KY	1989	Increase in top corporate income tax rate from 7.25% to 8%	7
NJ	1989	Introduction of 0.375% tax surcharge	7
RI	1989	Increase in top corporate income tax rate from 8% to 9%	7
CT	1990	Introduction of 20% tax surcharge, increasing top marginal tax rate from 11.5% to 13.8%	64
MO	1990	Increase in top corporate income tax rate from 5% to 6.5%	34
MT	1990	Introduction of 5% tax surcharge on tax liability	2
NE	1990	Increase in top corporate income tax rate from 6.65% to 7.24%	5
OK	1990	Increase in top corporate income tax rate from 5% to 6%	27
AR	1991	Increase in top corporate income tax rate from 6% to 6.5%	14
ME	1991	Introduction of 10% tax surcharge on tax liability	3
NC	1991	Increase in top corporate income tax rate from 7% to 7.75% and introduction of 4% tax surcharge on tax liability	53
NE	1991	Increase in top corporate income tax rate from 7.24% to 7.81% and introduction of 15% tax surcharge on tax liability	9
PA	1991	Increase in top corporate income tax rate from 8.5% to 12.25%	132
RI	1991	Introduction of 11% tax surcharge on tax liability	12
DC	1992	Introduction of 2.5% surcharge on tax liability	4
KS	1992	Increase in top corporate income tax rate (including surcharge) from 6.75% to 7.35%	19
KY	1992	Increase in top corporate income tax rate from 8% to 8.25%	9
MT	1992	Re-introduction of tax surcharge on tax liability at 2.3% rate	1
MO	1993	Increase in top corporate income tax rate from 5% to 6.25% and reduction in federal income tax deductibility from 100% to 50%	43
MT	1993	Increase in tax surcharge on tax liability from 2.3% to 4.7%	1
DC	1994	Introduction of additional 2.5% surcharge on tax liability	1
VT	1997	Increase in top corporate income tax rate from 8.25% to 9.75%	7
NH	1999	Increase in top corporate income tax rate from 7% to 8%	13
AL	2001	Increase in top corporate income tax rate from 5% to 6.5%	20
NH	2001	Increase in top corporate income tax rate from 8% to 8.5%	13
KS	2002	Increase in tax surcharge on taxable income from 3.35% to 4.5%	23
TN	2002	Increase in top corporate income tax rate from 6% to 6.5%	44
AR	2003	Introduction of 3% tax surcharge on tax liability	15
CT	2003	Introduction of 20% tax surcharge on tax liability	77
IN	2003	Repeal of gross income tax (based on revenue rather than profits) and of supplemental income tax; effective adjusted gross income tax rate (on profits) increased from 7.75% to 8.5%	32
CT	2004	Increase in tax surcharge on tax liability to 25%	76
NJ	2006	Introduction of 4% tax surcharge on tax liability	116
MD	2008	Increase in top corporate income tax rate from 7% to 8.25%	40
CT	2009	Introduction of 10% tax surcharge on tax liability for companies with revenues > $100m	39
NC	2009	Introduction of 3% tax surcharge on tax liability	48
OR	2009	Increase in top corporate income tax rate from 6.6% to 7.9%	22
IL	2011	Increase in top corporate income tax rate from 4.8% to 7%	100
CT	2012	Unscheduled two-year extension of tax surcharge on tax liability and increase to 20%	1
MI	2012	Increase in top corporate income tax rate from 4.95% to 6%	6

Panel B. List of Tax Cuts.

This table lists all U.S. state corporate income tax cuts in calendar years 1989–2012 affecting firms in fiscal years 1990-2011. In states with more than one tax bracket, we report the change to the top bracket. Tax changes are identified from the Tax Foundation (an abbreviated version of which is available at http://www.taxfoundation.org), the *Book of the States*, a search of the "Current Corporate Income Tax Developments" feature published periodically in the *Journal of State Taxation*, and state tax codes accessed through Lexis-Nexis.

State	Year	Description	No. of affected sample firms
CO	1989	Reduction in top corporate income tax rate from 5.5% to 5.4%	68
WV	1989	Reduction in top corporate income tax rate from 9.6% to 9.45%	4
AZ	1990	Reduction in top corporate income tax rate from 10.5% to 9.3%	23
CO	1990	Reduction in top corporate income tax rate from 5.4% to 5.3%	74
WV	1990	Reduction in top corporate income tax rate from 9.45% to 9.3%	5
CO	1991	Reduction in top corporate income tax rate from 5.3% to 5.2%	85
MN	1991	Reduction in the legislated tax increase of 0.4%	117
MT	1991	Repeal of 5% tax surcharge	2
WV	1991	Reduction in top corporate income tax rate from 9.3% to 9.15%	6
CO	1992	Reduction in top corporate income tax rate from 5.2% to 5.1%	85
CT	1992	Reduction in tax surcharge from 20% to 10%	94
MO	1992	Reduction in top corporate income tax rate from 6.5% to 5%	41
NC	1992	Reduction in tax surcharge from 4% to 3%	65
WV	1992	Reduction in top corporate income tax rate from 9.15% to 9%	4
CO	1993	Reduction in top corporate income tax rate from 5.1% to 5.0%	81
CT	1993	Repeal of 10% tax surcharge	70
ME	1993	Repeal of 10% tax surcharge	3
NC	1993	Reduction in tax surcharge from 3% to 2%	51
NE	1993	Repeal of 15% tax surcharge	9
NH	1993	Reduction in top corporate income tax rate from 8% to 7.5%	9
AZ	1994	Reduction in top corporate income tax rate from 9.3% to 9%	31
MT	1994	Repeal of 4.7% tax surcharge	1
NC	1994	Reduction in tax surcharge from 2% to 1%	54
NH	1994	Reduction in top corporate income tax rate from 7.5% to 7%	17
NJ	1994	Repeal of 0.375% tax surcharge	154
PA	1994	Reduction in top corporate income tax rate from 12.25% to 11.99%	135
RI	1994	Repeal of 11% tax surcharge	9
CT	1995	Reduction in top corporate income tax rate from 11.5% to 11.25%	87
DC	1995	Reduction in top corporate income tax rate from 10% to 9.5% (+2 tax surcharges at 2.5% each)	6
NC	1995	Repeal of 1% tax surcharge	46
PA	1995	Reduction in top corporate income tax rate from 11.99% to 9.99%	144
CT	1996	Reduction in top corporate income tax rate from 11.25% to 10.75%	91
CA	1997	Reduction in top corporate income tax rate from 9.3% to 8.84%	554
CT	1997	Reduction in top corporate income tax rate from 10.75% to 10.5%	89
NC	1997	Reduction in top corporate income tax rate from 7.75% to 7.5%	65
AZ	1998	Reduction in top corporate income tax rate from 9% to 8%	44
CT	1998	Reduction in top corporate income tax rate from 10.5% to 9.5%	84
NC	1998	Reduction in top corporate income tax rate from 7.5% to 7.25%	59
CO	1999	Reduction in top corporate income tax rate from 5% to 4.75%	91
CT	1999	Reduction in top corporate income tax rate from 9.5% to 8.5%	77
NC	1999	Reduction in top corporate income tax rate from 7.25% to 7%	46
NY	1999	Reduction in top corporate income tax rate from 9% to 8.5%	265
OH	1999	Reduction in top corporate income tax rate from 8.9% to 8.5%	132
AZ	2000	Reduction in top corporate income tax rate from 8% to 7.968%	49
CO	2000	Reduction in top corporate income tax rate from 4.75% to 4.63%	80
CT	2000	Reduction in top corporate income tax rate from 8.5% to 7.5%	72
NC	2000	Reduction in top corporate income tax rate from 7% to 6.9%	61
NY	2000	Reduction in top corporate income tax rate from 8.5% to 8%	262

AZ	2001	Reduction in top corporate income tax rate from 7.968% to 6.968%	40
ID	2001	Reduction in top corporate income tax rate from 8% to 7.6%	7
NY	2001	Reduction in top corporate income tax rate from 8% to 7.5%	244
KS	2003	Reduction in tax surcharge from 4.5% to 3.35%	22
ND	2004	Reduction in top corporate income tax rate from 10.5% to 7%	1
AR	2005	Repeal of 3% tax surcharge	14
KY	2005	Reduction in top corporate income tax rate from 8.25% to 7%	18
OH	2005	Tax reform phasing out corp. income tax while phasing in gross receipts tax over period of 5 years	90
CT	2006	Reduction in tax surcharge from 25% to 20%	64
VT	2006	Reduction in top corporate income tax rate from 9.75% to 8.9%	2
NY	2007	Reduction in top corporate income tax rate from 7.5% to 7.1%	197
VT	2007	Reduction in top corporate income tax rate from 8.9% to 8.5%	2
WV	2007	Reduction in top corporate income tax rate from 9% to 8.75%	3
CT	2008	Repeal of 20% tax surcharge	63
KS	2008	Reduction in tax surcharge from 3.35% to 3.1%	12
KY	2008	Reduction in top corporate income tax rate from 7% to 6%	16
KS	2009	Reduction in tax surcharge from 3.1% to 3.05%	13
WV	2009	Reduction in top corporate income tax rate from 8.75% to 8.5%	3
MA	2010	Reduction in top corporate income tax rate from 9.5% to 8.75%	134
NJ	2010	Repeal of 4% tax surcharge	85
KS	2011	Reduction in tax surcharge from 3.05% to 3%	11
MA	2011	Reduction in top corporate income tax rate from 8.75% to 8.25%	123
NC	2011	Repeal of 3% tax surcharge	36
ND	2011	Reduction in top corporate income tax rate from 6.4% to 5.4%	1
OR	2011	Reduction in top corporate income tax rate from 7.9% to 7.6%	18

Appendix B. List of Changes in State Tax Loss Carryback/Carryforward Rules.

Panel A. List of Loss Carryback Period Increases.

This table lists all state-level increases in the length of tax loss carryback periods affecting firms in fiscal years 1990-2011. Tax loss carryback period changes are identified from the *Book of the States*.

State	Year	Description	No. of affected sample firms
DC	1991	Increase in loss carryback period from 0 to 3 years	7
ME	1991	Increase in loss carryback period from 0 to 3 years	3
MS	1992	Increase in loss carryback period from 0 to 1 year	7
MS	1993	Increase in loss carryback period from 1 to 2 years	7
VT	1993	Increase in loss carryback period from 0 to 3 years	4
MS	1994	Increase in loss carryback period from 2 to 3 years	6
AL	1995	Increase in loss carryback period from 0 to 3 years	21
VT	1998	Increase in loss carryback period from 0 to 2 years	8
NY	1999	Increase in loss carryback period from 0 to 2 years	282
AK	2002	Increase in loss carryback period from 0 to 2 years	2
LA	2002	Increase in loss carryback period from 2 to 3 years	23
OK	2002	Increase in loss carryback period from 0 to 2 years	23
NH	2005	Increase in loss carryback period from 0 to 3 years	12
KS	2008	Increase in loss carryback period from 0 to 2 years	12
KS	2011	Increase in loss carryback period from 0 to 3 years	13

Panel B. List of Loss Carryback Period Reductions.

This table lists all state-level reductions in the length of tax loss carryback periods affecting firms in fiscal years 1990-2011. Tax loss carryback period changes are identified from the *Book of the States*.

State	Year	Description	No. of affected sample firms
ME	1990	Removal of ability to carry back losses (reduction from 3 years to 0)	4
NM	1991	Removal of ability to carry back losses (reduction from 3 years to 0)	10
RI	1992	Removal of ability to carry back losses (reduction from 3 years to 0)	10
VT	1992	Removal of ability to carry back losses (reduction from 3 years to 0)	4
VT	1996	Removal of ability to carry back losses (reduction from 3 years to 0)	7
AL	1997	Removal of ability to carry back losses (reduction from 3 years to 0)	28
NY	1997	Removal of ability to carry back losses (reduction from 3 years to 0)	293
OK	1997	Removal of ability to carry back losses (reduction from 3 years to 0)	33
AK	1998	Reduction in loss carryback period from 3 to 2 years	2
DC	1998	Reduction in loss carryback period from 3 to 2 years	4
DE	1998	Reduction in loss carryback period from 3 to 2 years	11
GA	1998	Reduction in loss carryback period from 3 to 2 years	100
HI	1998	Reduction in loss carryback period from 3 to 2 years	5
IA	1998	Reduction in loss carryback period from 3 to 2 years	18
IL	1998	Reduction in loss carryback period from 3 to 2 years	153
IN	1998	Reduction in loss carryback period from 3 to 2 years	43
KY	1998	Reduction in loss carryback period from 3 to 2 years	18
MD	1998	Reduction in loss carryback period from 3 to 2 years	51
ME	1998	Reduction in loss carryback period from 3 to 2 years	7
MO	1998	Reduction in loss carryback period from 3 to 2 years	56
MS	1998	Reduction in loss carryback period from 3 to 2 years	11
ND	1998	Reduction in loss carryback period from 3 to 2 years	1
VA	1998	Reduction in loss carryback period from 3 to 2 years	79
WV	1998	Reduction in loss carryback period from 3 to 2 years	5
ID	1999	Reduction in loss carryback period from 3 to 2 years	9
DC	2000	Removal of ability to carry back losses (reduction from 2 years to 0)	5
AK	2001	Removal of ability to carry back losses (reduction from 2 years to 0)	1
LA	2001	Reduction in loss carryback period from 3 to 2 years	24
ME	2002	Removal of ability to carry back losses (reduction from 2 years to 0)	2
ND	2003	Removal of ability to carry back losses (reduction from 2 years to 0)	1
IL	2004	Removal of ability to carry back losses (reduction from 2 years to 0)	118
KY	2006	Removal of ability to carry back losses (reduction from 2 years to 0)	17
VT	2006	Removal of ability to carry back losses (reduction from 2 years to 0)	2
NH	2008	Removal of ability to carry back losses (reduction from 3 years to 0)	7
IA	2009	Removal of ability to carry back losses (reduction from 2 years to 0)	12
KS	2009	Removal of ability to carry back losses (reduction from 2 years to 0)	13

Panel C. List of Loss Carryforward Period Increases.

This table lists all state-level increases in the length of tax loss carryforward periods affecting firms in fiscal years 1990-2011. Tax loss carryforward period changes are identified from the *Book of the States*.

State	Year	Description	No. of affected sample firms
AL	1990	Increase in loss carryforward period from 5 to 15 years	11
ID	1990	Increase in loss carryforward period from 10 to 15 years	10
OH	1990	Increase in loss carryforward period from 5 to 15 years	120
TN	1991	Increase in loss carryforward period from 7 to 15 years	29
MS	1992	Increase in loss carryforward period from 5 to 15 years	7
UT	1993	Increase in loss carryforward period from 5 to 15 years	30
CA	1994	Increase in loss carryforward period from 5 to 15 years	458
PA	1995	Increase in loss carryforward period from 0 to 2 years	143
PA	1996	Increase in loss carryforward period from 2 to 3 years	145
NM	1997	Increase in loss carryforward period from 0 to 5 years	4
TX	1997	Increase in loss carryforward period from 0 to 5 years	316
AK	1998	Increase in loss carryforward period from 15 to 20 years	2
CA	1998	Increase in loss carryforward period from 4 to 5 years	583
CO	1998	Increase in loss carryforward period from 15 to 20 years	97
DE	1998	Increase in loss carryforward period from 15 to 20 years	11
FL	1998	Increase in loss carryforward period from 15 to 20 years	163
GA	1998	Increase in loss carryforward period from 15 to 20 years	100
HI	1998	Increase in loss carryforward period from 15 to 20 years	5
IA	1998	Increase in loss carryforward period from 15 to 20 years	18
IL	1998	Increase in loss carryforward period from 15 to 20 years	153
IN	1998	Increase in loss carryforward period from 15 to 20 years	43
KY	1998	Increase in loss carryforward period from 15 to 20 years	18
MD	1998	Increase in loss carryforward period from 15 to 20 years	51
ME	1998	Increase in loss carryforward period from 15 to 20 years	7
MO	1998	Increase in loss carryforward period from 15 to 20 years	56
MS	1998	Increase in loss carryforward period from 15 to 20 years	11
ND	1998	Increase in loss carryforward period from 15 to 20 years	1
NY	1998	Increase in loss carryforward period from 15 to 20 years	283
PA	1998	Increase in loss carryforward period from 3 to 10 years	140
VA	1998	Increase in loss carryforward period from 15 to 20 years	79
VT	1998	Increase in loss carryforward period from 15 to 20 years	8
WV	1998	Increase in loss carryforward period from 15 to 20 years	5
DC	1999	Increase in loss carryforward period from 15 to 20 years	7
ID	1999	Increase in loss carryforward period from 15 to 20 years	9
NC	1999	Increase in loss carryforward period from 5 to 15 years	56
SC	1999	Increase in loss carryforward period from 15 to 20 years	21
CA	2000	Increase in loss carryforward period from 5 to 10 years	574
CT	2000	Increase in loss carryforward period from 5 to 20 years	79
CA	2001	Increase in loss carryforward period from 10 to 20 years	528
LA	2001	Increase in loss carryforward period from 15 to 20 years	24
NH	2002	Increase in loss carryforward period from 5 to 10 years	13
OK	2002	Increase in loss carryforward period from 15 to 20 years	23
PA	2002	Increase in loss carryforward period from 10 to 20 years	136
OH	2003	Increase in loss carryforward period from 15 to 20 years	103
CA	2008	Increase in loss carryforward period from 10 to 20 years	454
MA	2010	Increase in loss carryforward period from 5 to 20 years	132
NJ	2011	Increase in loss carryforward period from 7 to 20 years	83

Panel D. List of Loss Carryforward Period Reductions.

This table lists all state-level reductions in the length of tax loss carryforward periods affecting firms in fiscal years 1990-2011. Tax loss carryforward period changes are identified from the *Book of the States*.

State	Year	Description	No. of affected sample firms
NM	1991	Reduction in loss carryforward period from 15 to 5 years	10
PA	1991	Removal of ability to carry forward losses (reduction from 3 years to 0)	131
NM	1992	Removal of ability to carry forward losses (reduction from 5 years to 0)	9
RI	1992	Reduction in loss carryforward period from 15 to 5 years	10
CA	1993	Reduction in loss carryforward period from 15 to 5 years	442
CA	1997	Reduction in loss carryforward period from 15 to 4 years	554
CA	2002	Reduction in loss carryforward period from 20 to 10 years	529
LA	2002	Reduction in loss carryforward period from 20 to 15 years	23
IL	2004	Reduction in loss carryforward period from 20 to 12 years	118
VT	2006	Reduction in loss carryforward period from 20 to 10 years	2

Appendix C. Coincident State-Level Changes.

Panel A. Coincident State-Level Changes for Tax Rate Changes.

This table reports state-level changes in economic quantities that coincide with either increases or cuts in state corporate income taxes and that have a plausible basis in theory to potentially affect corporate risk-taking decisions. We focus on changes in state taxes on banks and changes in state investment incentive programs (i.e., tax credits for investment, R&D, and job creation, as well as job creation grant programs). We also report state-level changes in the length of tax loss carryback/carryforward periods that coincide with state tax rate changes. For variable definitions and details of their construction, see Appendix D.

		Tax increases	Tax cuts
Number of tax changes		40	73
… of which coincide with	increase in length of state carryback periods	1	3
	cut in length of state carryback periods	0	2
	increase in length of state carryforward periods	0	4
	cut in length of state carryforward periods	1	2
	increase in state tax on banks	28	0
	cut in state tax on banks	0	56
	increase in state investment tax credit rate	1	6
	cut in state investment tax credit rate	0	0
	increase in state R&D credit rate	2	9
	cut in state R&D credit rate	1	2
	increase in state job creation credit	0	3
	cut in state job creation credit	0	1
	increase in state job creation grants	0	1
	cut in state job creation grants	0	0

Panel B. Coincident State-Level Changes for Tax Loss Carryback Changes.

This table reports state-level changes in economic quantities that coincide with either increases or cuts in the number of periods a state allows a company to carry back losses and that have a plausible basis in theory to potentially affect corporate risk-taking decisions. We focus on changes in state taxes on banks and changes in state investment incentive programs (i.e., tax credits for investment, R&D, and job creation, as well as job creation grant programs). For variable definitions and details of their construction, see Appendix D.

		Increases in carrybacks	Cuts in carrybacks
Number of carryback changes		15	36
… of which coincide with	increase in state tax on banks	1	0
	cut in state tax on banks	0	0
	increase in state investment tax credit rate	2	1
	cut in state investment tax credit rate	0	0
	increase in state R&D credit rate	0	2
	cut in state R&D credit rate	0	0
	increase in state job creation credit	2	0
	cut in state job creation credit	0	0
	increase in state job creation grants	0	0
	cut in state job creation grants	0	0

Panel C. Coincident State-Level Changes for Tax Loss Carryforward Changes.

This table reports state-level changes in economic quantities that coincide with either increases or cuts in the number of periods a state allows a company to carry forward losses and that have a plausible basis in theory to potentially affect corporate risk-taking decisions. We focus on changes in state taxes on banks and changes in state investment incentive programs (i.e., tax credits for investment, R&D, and job creation, as well as job creation grant programs). For variable definitions and details of their construction, see Appendix D.

		Increases in carryforwards	Cuts in carryforwards
Number of carryforward changes		47	10
… of which coincide with	increase in state tax on banks	1	0
	cut in state tax on banks	3	1
	increase in state investment tax credit rate	3	1
	cut in state investment tax credit rate	0	0
	increase in state R&D credit rate	2	2
	cut in state R&D credit rate	0	0
	increase in state job creation credit	2	0
	cut in state job creation credit	1	0
	increase in state job creation grants	0	0
	cut in state job creation grants	0	0

Appendix D. Variable Definitions.

Dependent variables

ROA volatility is defined as the standard deviation of the difference between quarterly *ROA* and *ROA* for the same quarter of the previous year, computed over a three-year period *t* to *t*+2 (requiring a minimum of four quarters of data). *ROA* (return on assets) is defined as operating income after depreciation (Compustat item *oiadpq*) over the book value of assets (Compustat item *atq*). We annualize *ROA volatility* by multiplying it by $\sqrt{4}$.

ROIC volatility is defined as the standard deviation of the difference between quarterly *ROIC* and *ROIC* for the same quarter of the previous year, computed over a three-year period *t* to *t*+2 (requiring a minimum of four quarters of data). *ROIC* (return on invested capital) is defined as operating income after depreciation (Compustat item *oiadpq*) over the sum of debt (Compustat items *dlttq* + *dlcq*), minority interests (Compustat item *mibtq*), preferred stock (*pstkq*) and common stock (*ceqq*). We annualize *ROIC volatility* by multiplying it by $\sqrt{4}$.

Operating cycle is defined as the sum of the average inventory holding period and the average number of days to collect receivables minus the average number of days to pay payables. The average inventory holding period is computed as average inventory (Compustat item *invt*) over cost of goods sold (Compustat item *cogs*), multiplied by 365. The average number of days to collect receivables is computed as average accounts receivable (Compustat item *rect*) over sales (Compustat item *sale*), multiplied by 365. The average number of days to pay payables is computed as average accounts payable (Compustat item *ap*) over purchases (cost of goods sold + ending inventory – beginning inventory), multiplied by 365.

Days inventory is defined as the average inventory holding period, computed as average inventory (Compustat item *invt*) over cost of goods sold (Compustat item *cogs*), multiplied by 365.

Operating leverage is measured as the sensitivity of EBIT to sales (Mandelker and Rhee 1984). Specifically, it is estimated as the coefficient on the logarithm of quarterly sales in a firm-specific regression that regresses the logarithm of quarterly operating income after depreciation (Compustat item *oiadpq*) on the logarithm of quarterly sales (Compustat item *saleq*) over a three-year period from *t* to *t*+2 (requiring a minimum of four quarters of data).

Capex is defined as net capital expenditure (Compustat item *capx* – *sppe*) over the book value of assets (Compustat item *at*).

R&D is defined as research and development expenditure (Compustat item *xrd*) over the book value of assets (Compustat item *at*). Following standard practice, we set *xrd* equal to zero when it is missing from Compustat.

RQ (short for research quotient) is a firm-year measure of the output elasticity of R&D (Knott 2008), obtained from the WRDS RQ™ database. It represents the percentage increase in revenues (in year *t*+1) resulting from a 1% increase in R&D (in year *t*), when other inputs and their elasticities are held constant.

Independent variables: Firm characteristics

Firm age is defined as the Compustat age.

Firm size is defined as the book value of total assets (Compustat item *at*) in year 2009 real dollars (deflated using the GDP deflator available at http://www.bea.gov/national/xls/gdplev.xls).

Market/book is defined as the ratio of the market value of equity (Compustat items *prcc_f* × *csho*) to the book value of equity (Compustat item *ceq*).

Book leverage is defined as long-term debt (Compustat item *dltt*) over the book value of assets (Compustat item *at*).

Cash surplus is defined as cash from assets-in-place (Compustat items *oancf* – *dpc* + *xrd*) over the book value of assets (Compustat item *at*).

Loss carryforward is an indicator set equal to one if the firm has positive net operating loss carryforward (Compustat item *tlcf*), and zero otherwise.

Sales growth is defined as the log of current year sales over last year sales (Compustat item *sale*).

Stock return is defined as cumulated monthly returns over the 12-month period ending at the fiscal year end (measured using data from CRSP).

Independent variables: State-level characteristics

State unemployment rate is the state unemployment rate, obtained from the U.S. Bureau of Labor Statistics.

GSP growth rate is the real annual growth rate in gross state product (GSP) using data obtained from the U.S. Bureau of Economic Analysis.

Table 1. Firm-Level Summary Statistics.

The sample consists of 64,447 firm-years for all non-financial and non-utility U.S. companies that are traded on the NYSE, Amex, or Nasdaq in fiscal years 1990 through 2011, as per the merged CRSP-Compustat Fundamentals Annual database. The table reports summary statistics for our dependent variables and the controls. For variable definitions and details of their construction, see Appendix D. All variables are winsorized 1% in each tail.

			percentile		
	mean	s.d.	25th	50th	75th
Dependent variables					
ROA volatility (in %)	6.8	11.0	2.3	3.8	7.2
ROIC volatility (in %)	10.6	17.2	3.1	5.3	10.2
operating cycle	83.6	96.1	32.2	73.3	125.7
days inventory	75.7	76.8	12.9	59.7	108.7
operating leverage	2.5	3.6	0.9	1.8	3.4
capex (in %)	5.4	6.1	1.7	3.6	6.9
R&D (in %)	5.3	11.8	0.0	0.1	5.9
RQ	10.0	5.4	7.5	10.0	12.6
State characteristics					
GSP growth rate (in %)	2.7	2.6	1.1	2.7	4.2
state unemployment rate (in %)	5.9	1.9	4.6	5.5	6.9
Firm characteristics					
firm age	19.6	13.3	9.0	15.0	27.0
firm size (total assets, $m)	1,755.2	4,899.7	52.6	219.2	969.3
market/book	3.0	4.7	1.1	1.9	3.3
book leverage	0.162	0.179	0.002	0.111	0.267
cash surplus	0.035	0.199	-0.012	0.050	0.115
loss carryforward	0.363	0.481	0.000	0.000	1.000
sales growth	0.052	0.339	-0.057	0.050	0.166
stock return	0.166	0.744	-0.251	0.040	0.375

Table 2. Effect of Tax Changes on Firm Risk.

We estimate OLS regressions to test whether, and by how much, firms change their risk profile in response to changes in state corporate income taxes. The dependent variable *change in log ROA* (or *ROIC*) *volatility* is defined as the difference between log *ROA* (or *ROIC*) *volatility* at *t* (i.e., computed over *t* to *t*+2) and log *ROA* (or *ROIC*) *volatility* at *t*–3 (i.e., computed over *t*–3 to *t*–1). For variable definitions and details of their construction, see Appendix D. In columns 1 and 2, we use contemporaneous changes in the firm's home-state top marginal corporate income tax rate. In columns 3 and 4, we use lagged changes in the firm's home-state top marginal corporate income tax rate. Columns 5 and 6 use the contemporaneous nexus-weighted change in tax rates as defined in Eq. (1). The unit of analysis in each column is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The fixed effects are not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity (tax increase = -tax cut) is one-sided.

	Change in log …					
	ROA volatility (1)	ROIC volatility (2)	ROA volatility (3)	ROIC volatility (4)	ROA volatility (5)	ROIC volatility (6)
magnitude of tax increase	-0.019***	-0.020***				
	0.007	*0.007*				
magnitude of tax cut	0.016	0.018				
	0.016	*0.015*				
lagged tax increase			-0.026***	-0.019**		
			0.007	*0.009*		
lagged tax cut			0.000	0.000		
			0.015	*0.017*		
nexus-weighted tax increase					-0.024**	-0.032***
					0.009	*0.011*
nexus-weighted tax cut					0.014	0.017
					0.024	*0.028*
Change in …						
GSP growth rate	-0.003**	-0.003*	-0.003**	-0.003*	-0.003**	-0.003*
	0.001	*0.001*	*0.001*	*0.002*	*0.001*	*0.001*
state unemployment rate	0.009**	0.010*	0.009*	0.009*	0.009**	0.009*
	0.005	*0.006*	*0.005*	*0.005*	*0.005*	*0.006*
Lagged change in …						
log firm age	-0.526***	-0.556***	-0.526***	-0.553***	-0.527***	-0.556***
	0.040	*0.041*	*0.040*	*0.040*	*0.039*	*0.041*
log firm size	-0.242***	-0.325***	-0.242***	-0.325***	-0.242***	-0.325***
	0.018	*0.027*	*0.017*	*0.027*	*0.018*	*0.027*
log market/book	0.123***	0.164***	0.121***	0.163***	0.123***	0.164***
	0.007	*0.007*	*0.007*	*0.008*	*0.007*	*0.007*
book leverage	-0.300***	-0.389***	-0.301***	-0.392***	-0.300***	-0.389***
	0.032	*0.035*	*0.034*	*0.037*	*0.032*	*0.035*
cash surplus	-0.250***	-0.253***	-0.248***	-0.247***	-0.249***	-0.253***
	0.021	*0.021*	*0.020*	*0.020*	*0.021*	*0.021*
loss carryforward	0.018*	0.030***	0.017*	0.029***	0.018*	0.030***
	0.010	*0.010*	*0.010*	*0.010*	*0.010*	*0.010*
sales growth	0.042***	0.052***	0.042***	0.052***	0.042***	0.052***
	0.005	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
stock return	-0.047***	-0.055***	-0.046***	-0.054***	-0.047***	-0.055***
	0.002	*0.003*	*0.003*	*0.003*	*0.002*	*0.003*
R^2	21.3%	21.0%	21.4%	21.1%	21.3%	21.0%
Equal tax sensitivity? (*F*)	0.03	0.02	2.03*	0.74	0.17	0.25
No. of firms	8,046	7,999	8,041	7,994	8,046	7,999
No. of observations	64,447	64,221	64,435	64,200	64,447	64,221

Table 3. Effect of Tax Changes on Risk for Firms with Low or High Leverage.

To test whether firms are constrained by their lenders from increasing risk in response to a tax cut, we partition the sample based on financial leverage (measured as of the end of the fiscal year before a tax change). Columns 1 and 3 focus on firms with book leverage below the sample median. Columns 2 and 4 focus on firms with book leverage above the sample median. For variable definitions and details of their construction, see Appendix D. The unit of analysis is a firm-year. All specifications are estimated using OLS in first differences with industry-year fixed effects (not shown for brevity). Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity is one-sided.

	Change in log …			
	ROA volatility		ROIC volatility	
	Low leverage (1)	High leverage (2)	Low leverage (3)	High leverage (4)
magnitude of tax increase	-0.026***	-0.024***	-0.032**	-0.022**
	0.009	*0.008*	*0.012*	*0.009*
magnitude of tax cut	0.063***	-0.019	0.072***	-0.019
	0.018	*0.019*	*0.014*	*0.023*
Change in …				
GSP growth rate	-0.003*	-0.003	-0.002	-0.002
	0.002	*0.002*	*0.002*	*0.002*
state unemployment rate	0.018***	-0.001	0.017**	0.001
	0.007	*0.008*	*0.008*	*0.009*
Lagged change in …				
log firm age	-0.580***	-0.508***	-0.664***	-0.480***
	0.086	*0.087*	*0.085*	*0.082*
log firm size	-0.256***	-0.226***	-0.348***	-0.292***
	0.020	*0.025*	*0.028*	*0.035*
log market/book	0.130***	0.110***	0.171***	0.148***
	0.009	*0.010*	*0.010*	*0.011*
book leverage	-0.241***	-0.285***	-0.395***	-0.367***
	0.051	*0.052*	*0.065*	*0.057*
cash surplus	-0.248***	-0.246***	-0.246***	-0.248***
	0.029	*0.034*	*0.031*	*0.038*
loss carryforward	0.034**	-0.003	0.052***	0.006
	0.013	*0.016*	*0.015*	*0.015*
sales growth	0.034***	0.051***	0.047***	0.051***
	0.007	*0.014*	*0.008*	*0.014*
stock return	-0.044***	-0.050***	-0.051***	-0.057***
	0.004	*0.006*	*0.005*	*0.006*
R^2	25.6%	31.1%	25.3%	31.1%
Equal tax sensitivity? (*F*)				
Tax increases: (1) vs. (2) or (3) vs. (4)	0.03		0.41	
Tax cuts: (1) vs. (2) or (3) vs. (4)	15.44***		13.91***	
No. of firms	5,769	5,467	5,723	5,441
No. of observations	32,223	32,224	32,105	32,106

Table 4. Testing for Pre-Trends, Delays, and Post-Event Reversals.

To investigate possible pre-trends, delays, and reversals, we include lead and lag terms in the baseline regressions shown in Table 2, columns 1 and 2. Recall that the change in *ROA volatility* or *ROIC volatility* compares earnings volatility in the period *t* to *t*+2 to earnings volatility in the period *t*–3 to *t*–1. Accordingly, we use leads dated *t*+3 and lags dated *t*–3 to avoid inducing a mechanical correlation between the dependent variable and the lead or lag term. For variable definitions and details of their construction, see Appendix D. The unit of analysis is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The full set of controls (as in Table 2) and fixed effects are included but not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

	Change in log …	
	ROA volatility (1)	ROIC volatility (2)
magnitude of tax increase at t = +3	-0.001	-0.005
	0.025	*0.028*
magnitude of tax increase at t = 0	-0.019**	-0.017**
	0.009	*0.008*
magnitude of tax increase at t = –3	-0.016*	-0.014
	0.008	*0.008*
magnitude of tax cut at t = +3	-0.007	0.007
	0.011	*0.013*
magnitude of tax cut at t = 0	0.018	0.018
	0.014	*0.014*
magnitude of tax cut at t = –3	-0.001	-0.002
	0.014	*0.018*
R^2	24.4%	23.6%
No. of firms	6,183	6,171
No. of observations	47,966	47,879

Table 5. Potential Confounds: Local Business Cycle Effects and Other Tax Changes.
States may change corporate tax rates, and firms may change their risk profile, in response to unobserved changes in local business conditions. To examine this potential confound, we restrict the set of control firms to those located in a neighboring state, thus excluding far-away states (i.e., firms in states that neither experience a tax change nor border a state that does are excluded). This means that we drop observations for states that are treated in another year but are not the neighbor of a treated state in the current year. This reduces the sample compared to the baseline models shown in Table 2. To address concerns stemming from the fact that corporate tax changes occasionally coincide with changes in state taxes on bank profits or in investment incentive programs (i.e., tax credits for investment, R&D, and job creation), columns 3 and 4 control explicitly for these concurrent changes. The unit of analysis in each specification is a firm-year. All specifications are estimated using OLS in first differences with industry-year fixed effects. The full set of controls (as in Table 2) and fixed effects are included but not reported for brevity. For variable definitions and details of their construction, see Appendix D. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity (tax increase = -tax cut) is one-sided.

	Change in log …			
	ROA volatility (1)	ROIC volatility (2)	ROA volatility (3)	ROIC volatility (4)
magnitude of tax increase	-0.021***	-0.022***	-0.021**	-0.026**
	0.006	*0.007*	*0.010*	*0.011*
magnitude of tax cut	0.012	0.011	-0.008	-0.011
	0.016	*0.015*	*0.013*	*0.015*
Other coincident tax changes				
increase in state tax on banks			0.003	0.015
			0.019	*0.021*
cut in state tax on banks			0.049**	0.055***
			0.019	*0.017*
increase in state investment tax credits			-0.003	-0.004
			0.005	*0.005*
cut in state investment tax credits			0.003	-0.001
			0.005	*0.005*
increase in state R&D tax credits			0.001	0.001
			0.003	*0.003*
cut in state R&D tax credits			-0.006	-0.009***
			0.005	*0.003*
increase in state job tax credits			0.011	0.012
			0.023	*0.024*
cut in state job tax credits			0.023	0.060
			0.036	*0.037*
R^2	28.7%	28.4%	28.7%	28.4%
Equal tax sensitivity? (F)	0.29	0.41	5.38**	3.34**
No. of firms	6,587	6,548	6,587	6,548
No. of observations	29,619	29,504	29,619	29,504

Table 6. Anticipation Effects.

If state tax rate changes are anticipated, measured treatment responses to realized tax rate changes may not capture causal effects (Hennessy and Strebulaev 2015). To address this concern, we exclude firms headquartered in states whose tax rate changes are likely to be anticipated. Ljungqvist and Smolyansky (2015) test whether state tax rates follow a Martingale (which implies that changes in tax rates are unpredictable). Based on their findings, columns 1 and 2 exclude firms headquartered in Connecticut or Massachusetts while columns 3 and 4 exclude firms headquartered in New England (i.e., Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, or Vermont). Heider and Ljungqvist (2015) examine the political economy events surrounding all state tax changes affecting at least 100 firms, using a "narrative approach" to identify potentially anticipated tax changes. Based on their findings, columns 5 and 6 exclude firms headquartered in Colorado, Connecticut, Minnesota, or New York. For variable definitions and details of their construction, see Appendix D. The unit of analysis in each column is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The full set of controls (as in Table 2) and fixed effects are included but not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

	Change in log …					
	ROA volatility (1)	ROIC volatility (2)	ROA volatility (3)	ROIC volatility (4)	ROA volatility (5)	ROIC volatility (6)
magnitude of tax increase	-0.016**	-0.018**	-0.014**	-0.017**	-0.016**	-0.019**
	0.006	*0.008*	*0.006*	*0.007*	*0.007*	*0.008*
magnitude of tax cut	0.003	0.009	0.006	0.012	-0.012	-0.009
	0.021	*0.022*	*0.022*	*0.023*	*0.014*	*0.014*
Adjusted R^2	22.1%	21.9%	22.2%	22.0%	23.3%	23.0%
No. of firms	7,433	7,391	7,363	7,321	6,685	6,652
No. of observations	59,130	58,915	58,476	58,263	52,699	52,511

Table 7. Effect of Tax Changes on Operational and Investment Choices.

We estimate OLS regressions to test whether, and by how much, firms change their operational and investment policies in response to changes in state corporate income taxes. Panel A focuses on a firm's operational choices. The dependent variable *change in operating cycle* (or *days inventory*) is defined as the difference between *operating cycle* (or *days inventory*) at time *t* and *operating cycle* (or *days inventory*) at *t*–1. The dependent variable *change in operating leverage* is defined as the difference between *operating leverage* at time *t* (i.e., computed over *t* to *t*+2) and *operating leverage* at *t*–3 (i.e., computed over *t*–3 to *t*–1). Panel B focuses on a firm's investment choices. To investigate possible pre-trends, delays, and reversals, we include lead and lag terms in the regressions. The dependent variable *change in capex* (or *R&D*, *RQ*) is defined as the difference between *capex* (or *R&D*, *RQ*) at time *t* and *capex* (or *R&D*, *RQ*) at *t*–1. In both panels, columns 1 to 3 use changes in the firm's home-state corporate income tax rate while columns 4 to 6 use the nexus-weighted change in tax rates as defined in Eq. (1). For variable definitions and details of their construction, see Appendix D. The unit of analysis in each column is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. We include the same controls and fixed effects as in Table 2. These are not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

Panel A. Effect of Tax Changes on Operational Choices.

	Change in …					
	operating cycle (1)	days inventory (2)	operating leverage (3)	operating cycle (4)	days inventory (5)	operating leverage (6)
magnitude of tax increase	-1.702***	-0.724*	0.078			
	0.379	*0.375*	*0.099*			
magnitude of tax cut	-0.030	-0.246	0.173			
	0.956	*0.755*	*0.135*			
nexus-weighted tax increase				-3.052**	-1.473**	0.077
				1.163	*0.559*	*0.177*
nexus-weighted tax cut				-0.787	-0.134	0.158
				1.431	*1.014*	*0.193*
R^2	10.1%	11.5%	14.9%	10.1%	11.5%	14.9%
No. of firms	7,952	7,981	6,105	7,952	7,981	6,105
No. of observations	63,472	63,881	49,707	63,472	63,881	49,707

Panel B. Effect of Tax Changes on Investment Choices.

	Change in …					
	capex	R&D	RQ	capex	R&D	RQ
	Home-state tax changes			Nexus-weighted tax changes		
	(1)	(2)	(3)	(4)	(5)	(6)
magnitude of tax increase at t = +1	0.000	0.000	-0.121	0.000	0.001	-0.114
	0.001	*0.001*	*0.114*	*0.001*	*0.001*	*0.110*
magnitude of tax increase at t = 0	0.000	-0.001	-0.049	-0.001	-0.001	-0.098
	0.001	*0.001*	*0.089*	*0.001*	*0.001*	*0.113*
magnitude of tax increase at t = –1	0.000	0.000	-0.167*	0.000	0.000	-0.231*
	0.001	*0.000*	*0.089*	*0.001*	*0.001*	*0.123*
magnitude of tax increase at t = –2	0.000	0.001	-0.085	0.001	0.001	-0.005
	0.000	*0.001*	*0.099*	*0.001*	*0.001*	*0.109*
magnitude of tax increase at t = –3	0.001	-0.001	-0.155*	0.002	-0.001	-0.231**
	0.001	*0.001*	*0.081*	*0.001*	*0.001*	*0.113*
magnitude of tax cut at t = +1	0.000	0.001	0.126	-0.001	0.002	0.227
	0.001	*0.002*	*0.130*	*0.001*	*0.002*	*0.169*
magnitude of tax cut at t = 0	-0.001	-0.003	-0.058	0.000	-0.004	0.002
	0.001	*0.002*	*0.122*	*0.002*	*0.003*	*0.128*
magnitude of tax cut at t = –1	0.000	0.002	-0.009	-0.001	0.003	-0.140
	0.001	*0.001*	*0.117*	*0.001*	*0.002*	*0.133*
magnitude of tax cut at t = –2	0.000	-0.001	-0.016	0.000	-0.002	-0.035
	0.001	*0.001*	*0.082*	*0.001*	*0.002*	*0.135*
magnitude of tax cut at t = –3	0.001	0.001	-0.146	0.002	0.001	-0.184
	0.001	*0.002*	*0.117*	*0.001*	*0.003*	*0.144*
R^2	16.7%	8.0%	29.5%	16.7%	8.0%	29.5%
No. of firms	7,323	7,379	3,771	7,323	7,379	3,771
No. of observations	57,747	58,498	28,833	57,747	58,498	28,833

Table 8. Heterogeneous Treatment Effects.

Tax loss carryback and carryforward rules dampen the impact of corporate income tax rate changes on firm risk. To test this, we partition sample firms based on the tax loss carryback and carryforward rules of their headquarter state. Columns 1 and 3 include firms headquartered in a state that (1) does not allow losses to be carried back and (2) does not permit losses to be carried forward for more than 10 years. Columns 2 and 4 include only the remaining sample firms. For variable definitions and details of their construction, see Appendix D. The unit of analysis is a firm-year. All specifications are estimated using OLS in first differences with industry-year fixed effects (not shown for brevity). Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity is one-sided.

	Change in log …			
	ROA volatility		ROIC volatility	
	Low loss offset ability (1)	High loss offset ability (2)	Low loss offset ability (3)	High loss offset ability (4)
magnitude of tax increase	-0.026**	-0.010	-0.033***	-0.004
	0.009	*0.012*	*0.011*	*0.016*
magnitude of tax cut	0.009	0.012	0.017	0.014
	0.022	*0.017*	*0.019*	*0.019*
Change in …				
GSP growth rate	-0.003*	-0.003	-0.002	-0.003
	0.002	*0.002*	*0.002*	*0.002*
state unemployment rate	0.006	0.014**	0.012	0.012*
	0.008	*0.006*	*0.010*	*0.007*
Lagged change in …				
log firm age	-0.563***	-0.528***	-0.635***	-0.522***
	0.070	*0.061*	*0.072*	*0.066*
log firm size	-0.240***	-0.251***	-0.314***	-0.341***
	0.027	*0.024*	*0.049*	*0.026*
log market/book	0.126***	0.120***	0.165***	0.163***
	0.010	*0.008*	*0.011*	*0.009*
book leverage	-0.273***	-0.291***	-0.369***	-0.379***
	0.054	*0.049*	*0.051*	*0.051*
cash surplus	-0.268***	-0.233***	-0.270***	-0.242***
	0.037	*0.021*	*0.039*	*0.022*
loss carryforward	0.001	0.031*	0.017	0.037**
	0.016	*0.016*	*0.015*	*0.016*
sales growth	0.042***	0.040***	0.049***	0.051***
	0.007	*0.007*	*0.008*	*0.007*
stock return	-0.048***	-0.045***	-0.053***	-0.056***
	0.004	*0.003*	*0.007*	*0.004*
R^2	29.8%	26.9%	28.8%	26.8%
Equal tax sensitivity? (F)				
Tax increases: (1) vs. (2) or (3) vs. (4)	1.18		2.10*	
No. of firms	4,221	5,757	4,203	5,716
No. of observations	26,005	38,442	25,914	38,297

Table 9. Effect of Changes in Loss Carryback/Carryforward Rules on Firm Risk.
We estimate OLS regressions to test whether, and by how much, firms change their risk profile in response to changes in state tax loss carryback/carryforward rules. Panel A focuses on the change in the number of years a loss can be carried back or forward in a firm's headquarter state. Panel B focuses on the nexus-weighted change in the number of years a loss can be carried back or forward in the states a firm has nexus with. Both increases and reductions are measured in absolute terms. For variable definitions and details of their construction, see Appendix D. The unit of analysis is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The full set of controls (as in Table 2) and fixed effects are not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity is one-sided.

Panel A. Home-State Rule Changes.

	Change in log …			
	ROA volatility (1)	ROIC volatility (2)	ROA volatility (3)	ROIC volatility (4)
increase in length of carryback period	0.016	0.022	0.016	0.022
	0.014	*0.016*	*0.014*	*0.016*
reduction in length of carryback period	-0.023***	-0.019**	-0.023***	-0.019**
	0.007	*0.008*	*0.007*	*0.008*
increase in length of carryforward period	0.002**	0.003***	0.002**	0.003***
	0.001	*0.001*	*0.001*	*0.001*
reduction in length of carryforward period	0.001	0.001	0.001	0.001
	0.001	*0.001*	*0.001*	*0.001*
magnitude of length of tax increase			-0.019***	-0.020***
			0.007	*0.007*
magnitude of length of tax cut			0.014	0.015
			0.016	*0.016*
R^2	21.3%	21.0%	21.3%	21.0%
Equal tax sensitivity? (*F*)				
increase in carryback = -reduction in carryback	0.24	0.03	0.23	0.04
increase in carryforward = -reduction in carryforward	4.95**	5.49**	4.03**	4.66**
reduction in carryback = -increase in carryforward	8.02***	3.89**	8.21***	3.93**
No. of firms	8,046	7,999	8,046	7,999
No. of observations	64,447	64,211	64,447	64,211

Panel B. Nexus-Weighted Rule Changes.

	Change in log …			
	ROA volatility (1)	ROIC volatility (2)	ROA volatility (3)	ROIC volatility (4)
nexus-weighted increase in carryback period	0.025	0.038	0.025	0.038
	0.024	*0.028*	*0.024*	*0.028*
nexus-weighted reduction in carryback period	-0.035***	-0.028***	-0.035***	-0.028***
	0.010	*0.010*	*0.010*	*0.010*
nexus-weighted increase in carryforward period	0.002	0.003**	0.002	0.003*
	0.002	*0.001*	*0.002*	*0.001*
nexus-weighted reduction in carryforward period	0.000	0.000	0.000	0.000
	0.002	*0.002*	*0.002*	*0.002*
nexus-weighted tax increase			-0.024**	-0.031***
			0.009	*0.011*
nexus-weighted tax cut			0.012	0.015
			0.024	*0.028*
R^2	21.3%	21.0%	21.3%	21.0%
Equal tax sensitivity? (*F*)				
increase in carryback = -reduction in carryback	0.22	0.13	0.21	0.15
increase in carryforward = -reduction in carryforward	0.52	0.84	0.47	0.76
reduction in carryback = -increase in carryforward	10.56***	5.70**	10.65***	5.70**
No. of firms	8,046	7,999	8,046	7,999
No. of observations	64,447	64,211	64,447	64,211

INTERNET APPENDIX

(NOT INTENDED FOR PUBLICATION)

Table IA.1. Effect of Tax Changes on Firm Risk: Alternative Standard Errors.

We repeat the tests in Table 2 with standard errors corrected for heteroskedasticity and cross-sectional and time-series correlations using a two-way cluster at the firm and year levels (Gow, I.D., Ormazabal, G., Taylor, D.J., 2010. Correcting for cross-sectional and time-series dependence in accounting research. *The Accounting Review* 85, 483–512). In columns 1 and 2, we use contemporaneous changes in the firm's home-state top marginal corporate income tax rate. In columns 3 and 4, we use lagged changes in the firm's home-state top marginal corporate income tax rate. Columns 5 and 6 use the contemporaneous nexus-weighted change in tax rates as defined in Eq. (1). For variable definitions and details of their construction, see Appendix D. The unit of analysis in each column is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The fixed effects are not reported for brevity. Standard errors are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity (tax increase = -tax cut) is one-sided.

	Change in log …					
	ROA volatility (1)	ROIC volatility (2)	ROA volatility (3)	ROIC volatility (4)	ROA volatility (5)	ROIC volatility (6)
magnitude of tax increase	-0.019***	-0.020***				
	0.006	*0.006*				
magnitude of tax cut	0.016	0.018				
	0.015	*0.014*				
lagged tax increase			-0.026***	-0.019***		
			0.004	*0.004*		
lagged tax cut			0.000	0.000		
			0.014	*0.015*		
nexus-weighted tax increase					-0.024***	-0.032***
					0.009	*0.010*
nexus-weighted tax cut					0.014	0.017
					0.016	*0.018*
Change in …						
GSP growth rate	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	0.002	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
state unemployment rate	0.009	0.010	0.009	0.009	0.009	0.009
	0.007	*0.007*	*0.007*	*0.007*	*0.007*	*0.007*
Lagged change in …						
log firm age	-0.526***	-0.556***	-0.526***	-0.553***	-0.527***	-0.556***
	0.089	*0.103*	*0.088*	*0.102*	*0.089*	*0.103*
log firm size	-0.242***	-0.325***	-0.242***	-0.325***	-0.242***	-0.325***
	0.020	*0.024*	*0.020*	*0.025*	*0.020*	*0.024*
log market/book	0.123***	0.164***	0.121***	0.163***	0.123***	0.164***
	0.010	*0.012*	*0.010*	*0.012*	*0.010*	*0.012*
book leverage	-0.300***	-0.389***	-0.301***	-0.392***	-0.300***	-0.389***
	0.037	*0.037*	*0.037*	*0.038*	*0.037*	*0.037*
cash surplus	-0.250***	-0.253***	-0.248***	-0.247***	-0.249***	-0.253***
	0.034	*0.038*	*0.030*	*0.034*	*0.034*	*0.038*
loss carryforward	0.018	0.030***	0.017	0.029***	0.018	0.030***
	0.011	*0.010*	*0.011*	*0.010*	*0.011*	*0.010*
sales growth	0.042***	0.052***	0.042***	0.052***	0.042***	0.052***
	0.012	*0.012*	*0.013*	*0.013*	*0.012*	*0.012*
stock return	-0.047***	-0.055***	-0.046***	-0.054***	-0.047***	-0.055***
	0.007	*0.010*	*0.008*	*0.010*	*0.007*	*0.010*
R^2	21.3%	21.0%	21.4%	21.1%	21.3%	21.0%
Equal tax sensitivity? (*F*)	0.05	0.03	4.52**	1.80*	0.48	0.83
No. of firms	8,046	7,999	8,041	7,994	8,046	7,999
No. of observations	64,447	64,221	64,435	64,200	64,447	64,221

Table IA.2. Effect of Tax Changes on Firm Risk: Big and Small Tax Cuts.
To investigate whether the insignificant coefficients on tax cuts reported in Table 2 are driven by the fact that tax cuts in our sample are, on average, smaller than tax increases (in absolute magnitude), we allow for a differential sensitivity to large and small tax cuts. For variable definitions and details of their construction, see Appendix D. The unit of analysis in each column is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The full set of controls (as in Table 2) and fixed effects are included but not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

	Change in log …			
	ROA volatility (1)	ROIC volatility (2)	ROA volatility (3)	ROIC volatility (4)
magnitude of tax increase	-0.019***	-0.020***	-0.019***	-0.020***
	0.007	*0.007*	*0.007*	*0.007*
magnitude of large tax cut (≥50 bps)	0.012	0.013		
	0.015	*0.014*		
magnitude of small tax cut (<50 bps)	0.048	0.054		
	0.046	*0.051*		
magnitude of large tax cut (≥100 bps)			0.008	0.008
			0.017	*0.014*
magnitude of small tax cut (<100 bps)			0.041	0.048
			0.031	*0.035*
Adjusted R^2	21.3%	21.0%	21.3%	21.0%
No. of firms	8,046	7,999	8,046	7,999
No. of observations	64,447	64,221	64,447	64,221

Table IA.3. Potential Cross-State Spillovers.

One identification concern is that tax changes in one state may trigger changes in the behavior of firms in the neighboring states. To address this concern, we restrict the set of control firms to those located in states that do not neighbor the treated state. (This contrasts with Table 5, where the set of control firms is restricted to those located in neighboring states.) This reduces the sample compared to the baseline models shown in Table 2. To address concerns stemming from the fact that corporate tax changes occasionally coincide with changes in state taxes on bank profits or in investment incentive programs (i.e., tax credits for investment, R&D, and job creation), columns 3 and 4 control explicitly for these concurrent changes. The unit of analysis in each specification is a firm-year. All specifications are estimated using OLS in first differences with industry-year fixed effects. The full set of controls (as in Table 2) and fixed effects are included but not reported for brevity. For variable definitions and details of their construction, see Appendix D. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity (tax increase = -tax cut) is one-sided.

	Change in log …			
	ROA volatility (1)	ROIC volatility (2)	ROA volatility (3)	ROIC volatility (4)
magnitude of tax increase	-0.022**	-0.026***	-0.019**	-0.027**
	0.010	*0.009*	*0.009*	*0.011*
magnitude of tax cut	0.023	0.030*	0.007	0.007
	0.016	*0.017*	*0.012*	*0.013*
Other coincident tax changes				
increase in state tax on banks			-0.009	0.003
			0.018	*0.016*
cut in state tax on banks			0.044***	0.057***
			0.014	*0.021*
increase in state investment tax credits			-0.005***	-0.004*
			0.002	*0.002*
cut in state investment tax credits			-0.004	0.001
			0.004	*0.004*
increase in state R&D tax credits			-0.003	-0.001
			0.003	*0.003*
cut in state R&D tax credits			-0.006	-0.005
			0.004	*0.004*
increase in state job tax credits			-0.008	-0.012
			0.016	*0.015*
cut in state job tax credits			-0.009	-0.008
			0.034	*0.036*
R^2	25.7%	25.1%	25.7%	25.1%
Equal tax sensitivity? (F)	0.01	0.04	0.66	1.19
No. of firms	7,160	7,114	7,160	7,114
No. of observations	40,900	40,751	40,900	40,751

Table IA.4. Effect of Tax Changes on Acquisitions.

We estimate OLS regressions to test whether, and by how much, firms change their M&A activity in response to changes in state corporate income taxes. The dependent variable *change in the number of acquisitions* (or *diversifying acquisitions*) is defined as the difference between the *number of acquisitions* (or *diversifying acquisitions*) in year *t* and the *number of acquisitions* (or *diversifying acquisitions*) in year *t*–1. The *number of acquisitions* (or *diversifying acquisitions*) is defined following Gormley and Matsa (2016). Specifically, the *number of acquisitions* is calculated using SDC's Mergers and Acquisitions Database after excluding acquisitions meeting any of the following criteria: (1) the ratio of the deal size to the market value of the acquirer's assets is less than 1%; (2) the acquiring firm controlled more than 50% of the target's equity prior to the announcement date or less than 100% after the acquisition was completed; (3) the ultimate parent of the acquirer and the target are the same; (4) either the acquirer or the target is a financial firm; or (5) the deal was not completed within 1,000 days of the announcement date. The number of diversifying acquisitions is the number of acquisitions a firm undertakes for which its primary SIC industry does not coincide with any of the target firm's SIC codes. In columns 1 and 2, we use contemporaneous changes in the firm's home-state top marginal corporate income tax rate. In columns 3 and 4, we use lagged changes in the firm's home-state top marginal corporate income tax rate. Columns 5 and 6 use the contemporaneous nexus-weighted change in tax rates as defined in Eq. (1). The unit of analysis in each column is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. We include the same controls and fixed effects as in Table 2. These are not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

	Change in the number of …					
	acquisitions	diversifying acquisitions	acquisitions	diversifying acquisitions	acquisitions	diversifying acquisitions
	(1)	(2)	(3)	(4)	(5)	(6)
magnitude of tax increase	0.002	0.000				
	0.012	*0.009*				
magnitude of tax cut	0.006	0.000				
	0.010	*0.007*				
lagged tax increase			0.005	0.007		
			0.006	*0.004*		
lagged tax cut			0.019	0.010		
			0.014	*0.010*		
nexus-weighted tax increase					-0.004	-0.003
					0.013	*0.011*
nexus-weighted tax cut					0.015	0.003
					0.009	*0.007*
R^2	14.2%	13.8%	14.4%	14.1%	14.2%	13.8%
No. of firms	8,077	8,077	7,931	7,931	8,077	8,077
No. of observations	64,721	64,721	63,762	63,762	64,721	64,721

Table IA.5. Effect of Tax Changes on Equity Volatility.

We estimate OLS regressions to test whether, and by how much, firms change their equity volatility in response to changes in state corporate income taxes in their headquarter state. Column 1 models equity volatility and column 2 models deleveraged equity volatility. *Equity volatility* is defined as the standard deviation of monthly returns over the 12-month period ending at the fiscal year end (measured using data from CRSP). We annualize equity volatility by multiplying it by $\sqrt{12}$. *Deleveraged equity volatility* is defined as equity volatility times the ratio of market capitalization (Compustat items *prcc_f* × *csho*) to the sum of market capitalization and the book value of debt (Compustat items *dlttq* + *dlcq*). For variable definitions and details of their construction, see Appendix D. The unit of analysis in each column is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The fixed effects are not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity (tax increase = -tax cut) is one-sided.

	Change in log …	
	equity volatility (1)	deleveraged equity volatility (2)
magnitude of tax increase	-0.023***	-0.020***
	0.005	*0.006*
magnitude of tax cut	0.002	-0.003
	0.005	*0.006*
Change in …		
GSP growth rate	-0.003**	-0.002
	0.001	*0.001*
state unemployment rate	0.022***	0.025***
	0.005	*0.005*
Lagged change in …		
log firm age	-0.032*	-0.137***
	0.018	*0.020*
log firm size	-0.118***	-0.175***
	0.007	*0.010*
log market/book	-0.084***	-0.113***
	0.006	*0.008*
book leverage	0.167***	0.183***
	0.026	*0.028*
cash surplus	-0.114***	-0.062***
	0.016	*0.015*
loss carryforward	0.011*	0.015*
	0.006	*0.007*
sales growth	0.006	0.010**
	0.004	*0.005*
stock return	-0.024***	-0.011***
	0.004	*0.003*
R^2	25.1%	22.4%
Equal tax sensitivity? (*F*)	8.57***	6.74***
No. of firms	7,867	7,865
No. of observations	63,017	62,992

Table IA.6. Effect of Tax Changes on Earnings Management.

We estimate OLS regressions to test whether, and by how much, firms change their performance-matched discretionary accruals in response to state corporate income tax changes. The dependent variable *change in performance-matched discretionary accruals* is defined as the difference between performance-matched discretionary accruals measured at t and those measured at t–1. We estimate performance matched discretionary accruals as total accruals minus predicted accruals, where predicted accruals is calculated using the formula: $PR\_ACCR_{it} = b_0 + b_1 \times (1/AT_{it}) + b_2 \times (SALE_{it} – SALE_{it-1} – RECT_{it} + RECT_{it-1}) + b_3 \times PPE_{it} + b4 \times ROA_{it-1}$. The firm-year specific parameters b_0 to b_4 are estimated using within SIC2-industry-year regressions: $ACCR_{jt} = b_0 + b_1 \times (1/AT_{jt}) + b_2 \times (SALE_{jt} – SALE_{jt-1}) + b_3 \times PPE_{jt} + b_4 \times ROA_{jt-1} + error_{jt}$. In estimating the parameters for firm i in year t, the observation of firm i in year t is excluded from the regression. *ACCR* is total accruals, calculated as Compustat item *ibc–oancf+xidoc*; *AT* is total assets (Compustat item *at*); *SALE* is total sales (Compustat item *sale*); *RECT* is accounting receivables (Compustat item *rect*); *PPE* is property, plant, and equipment (Compustat item *ppegt*); *ROA* is return on assets (Compustat item *pi/at*). In columns 2 and 3, we restrict the set of control firms to those located in a neighboring state, thus excluding far-away states (i.e., firms in states that neither experience a tax rate change nor border a state that does are excluded). For variable definitions and details of their construction, see Appendix D. The unit of analysis is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The full set of controls (as in Table 2) and fixed effects are included but not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

	Change in performance-matched discretionary accruals		
	(1)	(2)	(3)
magnitude of tax increase	0.000	-0.001	-0.003
	0.001	*0.001*	*0.002*
magnitude of tax cut	-0.002	-0.004	-0.007
	0.004	*0.006*	*0.005*
Other coincident tax changes			
increase in state tax on banks			0.007**
			0.003
cut in state tax on banks			0.007
			0.009
increase in state investment tax credits			-0.001
			0.001
cut in state investment tax credits			-0.001**
			0.001
increase in state R&D tax credits			0.000
			0.000
cut in state R&D tax credits			-0.001
			0.001
increase in state job tax credits			-0.006
			0.005
cut in state job tax credits			0.002
			0.010
R^2	18.7%	24.4%	24.4%
No. of firms	7,090	5,765	5,765
No. of observations	56,779	26,058	26,058

Table IA.7. Alternative Cutoffs of Loss Offset Rules.

We repeat the tests reported in Table 8 with alternative cutoffs for the loss offset rules. Columns 1 and 3 of Panel A include firms headquartered in a state that (1) does not allow losses to be carried back and (2) does not permit losses to be carried forward for more than 12 years. Columns 2 and 4 of Panel A include only the remaining sample firms. Columns 1 and 3 of Panel B include firms headquartered in a state that (1) does not allow losses to be carried back and (2) does not permit losses to be carried forward for more than 15 years. Columns 2 and 4 of Panel B include only the remaining sample firms. For variable definitions and details of their construction, see Appendix D. The unit of analysis is a firm-year. All specifications are estimated using OLS in first differences to remove firm fixed effects in the levels equations and include industry-year fixed effects to remove industry shocks. The full set of controls (as in Table 2) and fixed effects are included but not reported for brevity. Heteroskedasticity-consistent standard errors clustered at the state level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively. Reflecting the signed nature of the predictions, the test for equal tax sensitivity is one-sided.

Panel A. Alternative Carryforward Cutoff of 12 Years.

	Change in log …			
	ROA volatility		ROIC volatility	
	Low loss offset ability (1)	High loss offset ability (2)	Low loss offset ability (3)	High loss offset ability (4)
magnitude of tax increase	-0.030***	-0.004	-0.036***	0.014
	0.010	*0.018*	*0.013*	*0.023*
magnitude of tax cut	0.009	0.013	0.017	0.014
	0.022	*0.018*	*0.019*	*0.020*
R^2	29.8%	27.0%	28.7%	26.9%
Equal tax sensitivity? (*F*)				
Tax increases: (1) vs. (2) or (3) vs. (4)	1.41		3.45**	
No. of firms	4,383	5,715	4,365	5,674
No. of observations	26,863	37,584	26,771	37,440

Panel B. Alternative Carryforward Cutoff of 15 Years.

	Change in log …			
	ROA volatility		ROIC volatility	
	Low loss offset ability (1)	High loss offset ability (2)	Low loss offset ability (3)	High loss offset ability (4)
magnitude of tax increase	-0.027***	0.018	-0.033***	0.049
	0.008	*0.028*	*0.010*	*0.032*
magnitude of tax cut	0.014	-0.001	0.020	0.000
	0.018	*0.021*	*0.017*	*0.023*
R^2	24.5%	33.8%	24.0%	33.6%
Equal tax sensitivity? (*F*)				
Tax increases: (1) vs. (2) or (3) vs. (4)	2.38*		6.22***	
No. of firms	6,088	4,258	6,063	4,226
No. of observations	39,775	24,672	36,640	24,571