1-2019

The economics of managerial taxes and corporate risk-taking

Chris ARMSTRONG
University of Pennsylvania

Stephen GLAESER
University of Pennsylvania

Sterling HUANG
Singapore Management University, SHUANG@smu.edu.sg

Daniel TAYLOR
University of Pennsylvania

Citation

ARMSTRONG, Chris; GLAESER, Stephen; HUANG, Sterling; and TAYLOR, Daniel. The economics of managerial taxes and corporate risk-taking. (2019). *Accounting Review*. 94, (1), 1-24.
Available at: https://ink.library.smu.edu.sg/soa_research/1793

Published in Accounting Review. 94, (1), pp. 1-24.
https://doi.org/10.2308/accr-52193

The Economics of Managerial Taxes and Corporate Risk-Taking

Christopher S. Armstrong
Stephen Glaeser
University of Pennsylvania

Sterling Huang
Singapore Management University

Daniel J. Taylor
University of Pennsylvania

ABSTRACT: We examine the relation between managers' personal income tax rates and their corporate investment decisions. Using plausibly exogenous variation in federal and state tax rates, we find a positive relation between managers' personal tax rates and their corporate risk-taking. Moreover—and consistent with our theoretical predictions—we find that this relation is stronger among firms with investment opportunities that have a relatively high rate of return per unit of risk, and stronger among CEOs who have a relatively low marginal disutility of risk. Importantly, our results are unique to senior managers' tax rates—we do not find similar relations for middle-income tax rates. Collectively, our findings provide evidence that managers' *personal* income taxes influence their *corporate* risk-taking decisions.

JEL Classifications: G30; G32; G38; H24; H32.

Data Availability: Data are available from the sources cited in the text. Data on manager tax rates used in this paper are available at: http://acct.wharton.upenn.edu/~dtayl/.

Keywords: corporate risk-taking; risky investment; risk-taking incentives; personal income taxes; federal income taxes; state income taxes; agency conflicts.

I. INTRODUCTION

Fiscal policy—and taxation in particular—is one of the most important tools that policymakers can use to influence the economy. While the effect of *corporate* taxes on managers' corporate investment decisions has been extensively studied, little is known about the effect of managers' *personal* taxes on their corporate investment decisions (see Shackelford and Shevlin [2001], Graham [2003], and Hanlon and Heitzman [2010] for reviews of the corporate tax literature). We aim to fill this gap by examining the relation between personal income taxes levied directly on senior managers (hereafter, managerial taxes) and their corporate risk-taking. In this regard, we relate taxes on corporate decision-makers to their corporate decisions. Given their unique position as primary decision-makers at the firm, understanding whether and how taxes on senior managers affect their corporate decisions has important implications for fiscal policy. As Hall and Liebman (2000, 2) note "top executives manage assets worth billions of dollars, their compensation arrangements and the incentives they face are of

We thank Mirko Heinle, Becky Lester, Edward L. Maydew (editor), Ro Verrecchia, Ben Yost, and two anonymous referees for comments. We thank Scott Dyreng, Alexander Ljungqvist, Josh Lee, Jared Jennings, and Dawn Matsumoto for sharing their data on the historical location of corporate headquarters, Daniel Feenberg of the National Bureau of Economic Research for providing data on personal income tax rates, Daniel Wilson of the Federal Reserve Bank of San Francisco for providing data on state research and development and capital expenditure tax credits, and Kevin Chen for excellent research assistance. We thank our respective schools for financial support, and Christopher S. Armstrong also thanks Ernst & Young for its research support.

Supplemental material can be accessed by clicking the link in Appendix B.

Editor's note: Accepted by Oliver Zhen Li, under the Senior Editorship of Mark L. DeFond.

substantial importance to the performance of the U.S. economy . . . their responsiveness to taxation has important revenue and efficiency implications."

The intuition for how taxes affect managers' real investment decisions is similar to how taxes affect shareholders' personal investment decisions (e.g., Domar and Musgrave 1944; Mossin 1968; Stiglitz 1969; Poterba and Samwick 2003). In particular, taxes facilitate risk-sharing with the government. By reducing the disutility that a risk-averse manager associates with risky investments, taxes increase their incentive (or, equivalently, reduce their disincentive) to take risk. We use a simple theoretical framework to formalize the intuition that risk-averse managers who face different tax *rates,* but who are otherwise identical (i.e., have the same level of risk aversion, pre-tax compensation, equity holdings, and corporate investment opportunities), will make different investment decisions, and we use the insights from this framework to inform the design of our empirical tests.

We empirically examine the relation between the tax rate on senior managers and corporate risk-taking using exogenous variation in federal and state statutory income tax rates. We measure a manager's marginal income tax rate using the combined statutory tax rate for the top federal and state income bracket, assuming that the manager works in the state of the firm's headquarters, and measure corporate risk-taking using research and development (R&D) (e.g., Coles, Daniel, and Naveen 2006; Gormley, Matsa, and Milbourn 2013). A key advantage of this measure of corporate risk-taking is that it is directly controllable by senior managers, and it is not mechanically related to trading activity in capital markets, disclosure, or taxes on shareholders (e.g., capital gains taxes). Nevertheless, to ensure that our inferences are not unique to a specific measure of risk-taking, in subsequent analyses, we confirm that our results are robust to using earnings volatility and idiosyncratic return volatility as additional measures of risk-taking.

We test for a relation between managerial taxes and corporate risk-taking using multiple distinct sets of tests that exploit different sources of exogenous variation in managerial taxes. Our first set of tests consists of a between-group analysis that relies on comparisons between time periods, states, and firms. These tests estimate the relation between managerial taxes and corporate risk-taking using all of the variation in managerial taxes, regardless of its source (i.e., federal or state, cross-sectional or time-series). Consistent with our theoretical predictions, we find a positive relation between managerial taxes and corporate risk-taking. This relation is robust to controlling for a battery of time-varying firm characteristics (e.g., size, performance, and growth opportunities), manager characteristics (e.g., tenure, age, and equity incentives), and state characteristics (e.g., local economic growth and corporate taxes).

Our second set of tests consists of a within-group analysis that relies on comparisons within a given time period, state, firm, or manager. The primary advantage of these tests is that they help alleviate concerns that our results are attributable to omitted firm characteristics (e.g., industry and governance practices), manager characteristics (e.g., "managerial style"), state characteristics (e.g., geographic location and availability of natural resources), or common macroeconomic shocks or time trends. One potential disadvantage of these tests is that by controlling for common temporal variation, they necessarily eliminate all of the variation in taxes at the federal level. These tests estimate the relation between managerial taxes and corporate risk-taking using only state-level variation in managerial taxes. Despite the resulting reduction in power, we continue to find that managerial taxes are positively related to corporate risk-taking.

In our third set of tests, we examine settings where our theoretical framework predicts the effect of managerial taxes will be particularly strong. Specifically, theory suggests that the positive relation between managerial taxes and corporate risk-taking is stronger among firms with investment opportunities that have a high rate of return per unit of risk, and among managers who have a relatively low marginal disutility of risk. Consistent with these predictions, we find that the relation is stronger in industries where the investment opportunity set provides a relatively high rate of return per unit of risk and for Chief Executive Officers (CEOs) who have a relatively low marginal disutility of risk. By linking the relation between managerial taxes and corporate risk-taking to characteristics of the firm and CEO, these findings strengthen our inference that the relation is attributable to the decisions of senior managers (as opposed to mid-level managers or investors).

Finally, we repeat our primary tests including the middle-income tax rate as an additional control. By holding the middle-income rate fixed, the residual variation in senior managers' tax rate captures the difference, or "wedge," between the rate paid by senior managers and the rate paid by middle-income earners. To the extent that an omitted variable (e.g., a state-level economic shock) equally affects both rates, this analysis also controls for these omitted variables. We continue to find that the tax rate on senior managers is related to corporate risk-taking, but no evidence of an incremental relation between middle-income rates and corporate risk-taking. These findings suggest that the relation between managerial taxes and corporate risk-taking is not attributable to personal income taxes in general, but rather is specific to the tax rate on senior managers. Although we cannot definitively rule out the possibility of a correlated omitted variable, our results are robust to an extensive battery of sensitivity analyses. To explain our collective results, an omitted variable would have to (1) be correlated with both senior managers' tax rate and corporate risk-taking, (2) vary systematically with firms' investment opportunity sets and CEOs' marginal disutility to risk, and (3) cause a difference in the tax rates between senior managers and middle-income earners.

Our research question and findings should be of interest to policymakers, boards, and academics. With respect to policymakers, our work adds to the large public finance literature on the responses to taxation. Although a complete accounting of all the benefits and costs of tax policy is beyond the scope of any single study, understanding the various margins of response to taxation is central to optimal tax policy. We contribute to this literature by documenting a previously unidentified margin of response to personal taxation—namely, corporate risk-taking. Insofar as the effects that we document are attributable to the top personal income tax rate on senior managers and not the tax rate on middle-income employees (or middle-income shareholders), they potentially represent a heretofore overlooked externality of changes in the top personal income tax rate. Changes in the top personal income tax rate cause a shift in corporate resources toward high-risk projects, which can affect lower-level employees and other corporate stakeholders who are not directly subject to the tax.

With respect to boards, our findings suggest that personal income taxes can alter the disutility that senior managers associate with corporate risk-taking and, thus, directly affect their real investment decisions. While our empirical results suggest that any tax-induced risk-taking is diversifiable or idiosyncratic, to the extent that shareholders are undiversified, boards might want to consider how managers' personal taxes affect their risk-taking incentives.

Finally, with respect to academics, our study contributes to the large literature on managerial risk-taking. Numerous prior studies have sought to link managerial compensation and corporate risk-taking, but in doing so have largely ignored the role of taxation (e.g., Lambert, Larcker, and Verrecchia 1991; Guay 1999; Rajgopal and Shevlin 2002; Coles et al. 2006; Armstrong and Vashishtha 2012). We add to this literature by showing that managers' personal income taxes have a measurable effect on corporate risk-taking.

The remainder of this paper proceeds as follows. Section II provides some simple numerical examples that illustrate the effect of income taxes on a manager's selection of risky projects. Section III reviews the personal tax treatment of common forms of managerial compensation, and discusses the contributions of our study relative to prior literature. Section IV describes our sample and measurement choices. Section V presents our results. Section VI describes several sensitivity analyses. Section VII provides concluding remarks.

II. HYPOTHESIS DEVELOPMENT

The intuition for how personal income taxes affect managers' choice of risky projects is quite general and is similar to how taxes affect shareholders' choice of personal investments (e.g., Mossin 1968; Stiglitz 1969). In this section, we illustrate the intuition with a series of simple numerical examples in which we assume a fixed marginal tax rate and an exogenous set of investment opportunities. In order to focus on the most fundamental and general intuition, we deliberately abstract away from complex issues concerning progressive tax rates, moral hazard, and adverse selection. We refer the interested reader to Fellingham and Wolfson (1985), Niemann (2008), Katuscak (2009), and Krenn (2017) for a formal treatment of these issues in the context of managerial taxes.

Benchmark Case of Project Selection

Consider a manager who faces a choice between two mutually exclusive projects that differ in their payoffs to the manager, but are otherwise identical. Both projects have two potential outcomes that occur with equal likelihood. Project A pays the manager \$4 in the bad state and \$5 in the good state. Project B pays the manager \$3.25 in the bad state and \$7.75 in the good state. The payoffs are as follows:

Project A		**Project B**	
Prob.	**Payoff**	**Prob.**	**Payoff**
1/2	\$4.00	1/2	\$3.25
1/2	\$5.00	1/2	\$7.75
μ(A)	\$4.50	μ(B)	\$5.50
σ^2(A)	\$0.25	σ^2(B)	\$5.06

where $\mu(i)$ denotes the expected payoff of project i; and $\sigma^2(i)$ denotes the variance of the payoff of project i. A manager's choice between these projects depends on whether he is risk-neutral or risk-averse.

Risk-Neutral Manager: If the manager is risk-neutral, then he is indifferent towards risk, σ^2, and simply chooses the project with the highest expected payoff, μ, which corresponds to Project B.

Risk-Averse Manager: If the manager is risk-averse, then his choice will depend on how he trades off the risk, σ^2, and the reward, μ, of the two projects. Without additional assumptions about the manager's preferences (i.e., utility function), it is not possible to determine which project he will choose.

Consider a risk-averse manager who has mean-variance utility of the form:

$$U(\mu, \sigma^2) = \alpha\mu(i) - \beta\sigma^2(i) \tag{1}$$

where $\alpha > 0$ and $\beta > 0$ are arbitrary fixed parameters. Mean-variance utility is a parsimonious way to formalize the notion that a risk-averse manager likes projects that have greater expected payoffs, $\mu(i)$, and dislikes projects with more risk, or variance, $\sigma^2(i)$. Here, β represents the manager's risk aversion: higher β implies greater disutility per unit of variance. Thus, the manager's choice between Projects A and B depends on the parameters α and β. For example, if $\alpha = 1$ and $\beta = 0.3$, the manager's utility from adopting Project A is 4.43 ($4.5 - 0.3 \times 0.25$), and his utility from adopting Project B is 3.98 ($5.5 - 0.3 \times 5.06$). In this case, the manager will choose Project A.

Effect of Taxes on Project Selection

Next, we consider how taxes affect the manager's project selection. Suppose that the manager is subject to a 40 percent tax. Taxes have two effects on a risk-averse manager. First, they alter the expected payoff by a factor of $(1 - t)$, or 0.6 in this case. Second, they alter the risk the manager associates with the project by a factor of $(1 - t)^2$, or 0.36 in this case. When the manager faces a tax rate of 40 percent, his utility from adopting Project A is 2.67 ($0.6 \times 4.5 - 0.3 \times 0.36 \times 0.25$), and his utility from adopting Project B is 2.75 ($0.6 \times 5.5 - 0.3 \times 0.36 \times 5.06$). Consequently, in the presence of taxes, the risk-averse manager will now choose Project B, which is the riskier project.

To see how these two effects manifest in the manager's utility function, note that we can rewrite the utility function as follows:

$$U(\mu, \sigma^2) = \alpha(1 - t)\mu(i) - \beta(1 - t)^2\sigma^2(i) \tag{2}$$

The first term, $\alpha(1 - t)$, represents the reduction in the manager's expected payoff, and the second term, $\beta(1 - t)^2$, represents the reduction in the disutility that the risk-averse manager associates with risky projects. The higher the tax rate, t, the larger the reduction in disutility a risk-averse manager associates with risky projects. Equation (2) illustrates how two risk-averse managers who face different income tax rates—but who are otherwise identical—will evaluate risk differently. To demonstrate that this intuition is not an artefact of the specific parameter values, we next solve for the optimal project as a function of the tax rate.

Taxes with a Continuum of Projects

It is straightforward to extend our simple example from a choice between two projects to a choice from a continuum of projects. To do so, we must first specify the set of available projects, or investment opportunities, in mean-variance space. Let the set of available projects be given by a concave efficient frontier (e.g., Sharpe 1964) that takes the form:

$$\mu(i) = \varphi + \theta log(1 + \sigma^2(i)) \tag{3}$$

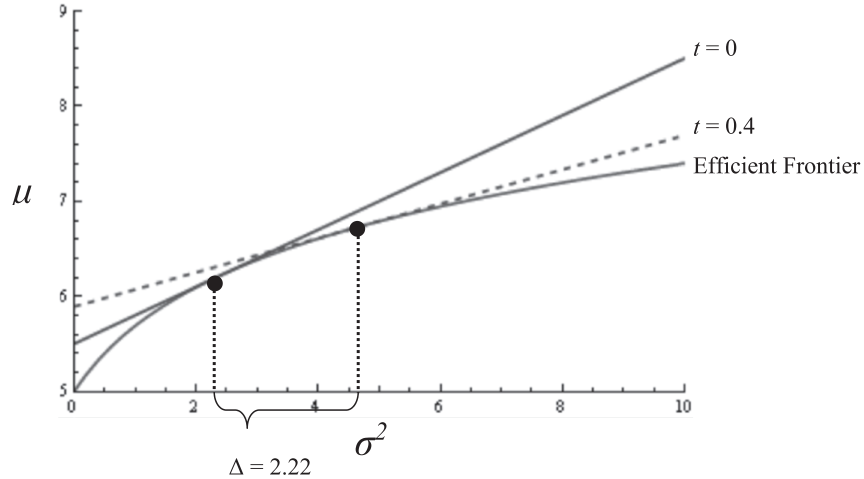
where $log(\cdot)$ is the natural log operator; φ represents the payoff to the risk-free project where $\sigma^2(i) = 0$; and θ determines the slope of the frontier. A concave efficient frontier captures the notion that to increase the expected payoff, the manager must accept increasingly more risk. Figure 1 plots the frontier for $\varphi = 5$, $\theta = 1$. The y-axis (x-axis) is the expected pre-tax payoff (variance).

Substituting Equation (3) into Equation (2) and maximizing the manager's utility over the choice of $\sigma^2(i)$ and solving for the risk of the optimal project, $\sigma^2(i^*)$, yields:

$$\sigma^2(i^*) = \left(\frac{\alpha}{\beta}\right)\left(\frac{\theta}{1 - t}\right) - 1 \tag{4}$$

provided $\alpha\theta \geq \beta(1 - t)$, and 0 otherwise. If this inequality is not satisfied, then the marginal benefit of risk is strictly less than the marginal cost (expressed in "utils") and there is no interior solution: it is never optimal to take *any* risk and the manager will always choose the risk-free project. Because this scenario is not empirically descriptive, for the remainder of the paper, we assume the existence of an interior solution (i.e., the optimal level of risk-taking is strictly positive). Equation (4) shows that, provided there is an interior solution, the risk of the optimal project is unambiguously increasing in the tax rate, i.e., $\frac{\partial\sigma^2(i^*)}{\partial t} > 0$.

FIGURE 1
Efficient Project Frontier and Manager's Indifference Curves



This figure plots the efficient frontier of projects and a risk-averse manager's indifference curves in pre-tax mean-variance space. The project's pre-tax expected payoff (variance) appears on the *y*-axis (*x*-axis). The solid line represents the manager's indifference curve at the point of tangency in the absence of taxes, $t = 0$. The dashed line represents the manager's indifference curve at the point of tangency in the presence of a 40 percent tax rate, $t = 0.40$. In our example, $\varphi = 5$, $\theta = 1$, $\alpha = 1$, and $\beta = 0.3$. The point of tangency for $t = 0$ is $\{2.33, 6.20\}$. The point of tangency for $t = 0.40$ is $\{4.55, 6.71\}$.

Figure 1 plots the manager's indifference curves for tax rates $t = 0$ and $t = 0.4$, respectively (assuming $\alpha = 1$ and $\beta = 0.3$, as in our earlier example). Figure 1 illustrates that as taxes increase, the slope of the indifference curve shifts downward—the manager associates less disutility with risk and, consequently, is willing to select riskier projects.

Cross-Sectional Predictions

In addition to illustrating how taxes affect a manager's choice of risky projects, our simple example also illustrates that the effect of taxes on risk-taking depends on specific characteristics of the firm and the manager.

Marginal Benefit of Risk

Equation (4) shows that the effect of taxes on the risk of the optimal project is increasing in the slope of the firm's investment opportunity set, $\frac{\partial^2 \sigma^2(i^*)}{\partial t \partial \theta} > 0$. The intuition for this result is that θ measures the marginal benefit to risk-taking. The higher the marginal benefit, the greater the amount of risk that is taken, and because more risk is taken, the manager derives greater benefit from sharing risk with the government.

Panel A of Figure 2 plots the investment frontier for $\theta = 1.6$ and the manager's indifference curves for tax rates $t = 0$ and $t = 0.4$, respectively (assuming $\alpha = 1$ and $\beta = 0.3$, as in Figure 1). As before, Panel A shows that taxes cause the slope of the indifference curve to shift downward. However, because the slope of the investment opportunity set is steeper than in Figure 1, the point of tangency entails a greater increase in risk-taking.

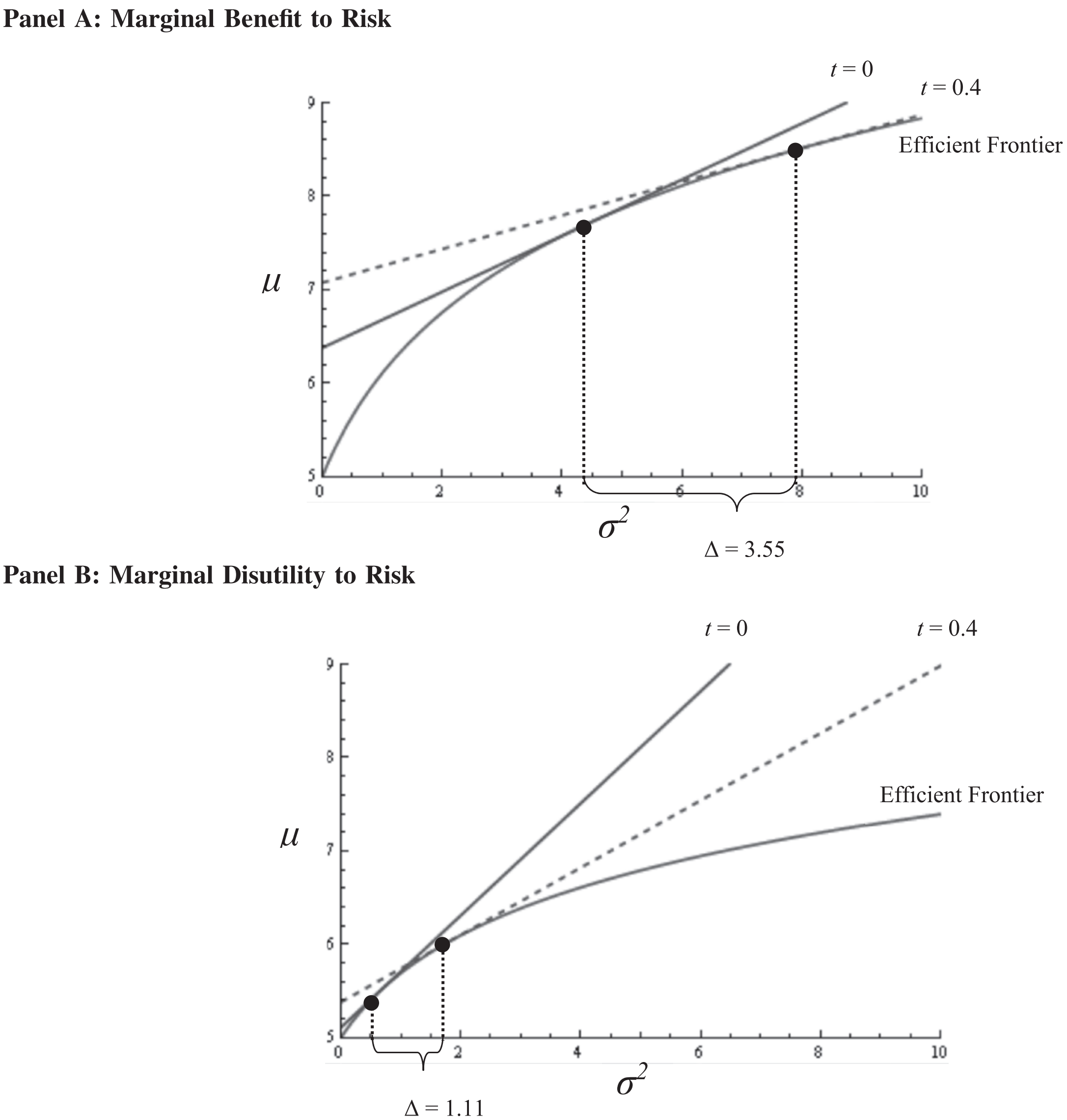
Marginal Cost of Risk

Equation (4) shows that the effect of taxes on the risk of the optimal project is decreasing in the manager's risk aversion, $\frac{\partial^2 \sigma^2(i^*)}{\partial t \partial \beta} < 0$. The intuition for this result is that β measures the marginal cost, or disutility, to risk-taking. The higher the marginal cost, the lower the amount of risk that is taken, and the less valuable it is to share risk with the government.

Panel B of Figure 2 plots the manager's indifference curves for tax rates $t = 0$ and $t = 0.4$, respectively, assuming $\alpha = 1$ and $\beta = 0.6$, and the frontier for $\theta = 1$, as in Figure 1. Because the manager is more risk-averse, the slope of the indifference curve is steeper. As before, Panel B shows that taxes still cause the slope of the indifference curve to shift downward. However, because the manager is more risk-averse (relative to Figure 1), the downward shift in the slope is less than before, and the point of tangency entails a smaller increase in risk-taking.

One important empirical consideration is that it is inherently difficult to observe managers' risk aversion. Consequently, it is necessarily difficult to test such a prediction. However, the same prediction also applies to the sensitivity of the manager's

FIGURE 2
Cross-Sectional Predictions



This figure plots the efficient frontier of projects and a risk-averse manager's indifference curves in pre-tax mean-variance space after altering the marginal benefit and marginal disutility to risk. The project's pre-tax expected payoff (variance) appears on the y-axis (x-axis). The solid line represents the manager's indifference curve at the point of tangency in the absence of taxes, $t = 0$. The dashed line represents the manager's indifference curve at the point of tangency in the presence of a 40 percent tax rate, $t = 0.40$. Panel A illustrates the effect of the marginal benefit of risk on the relation between taxes and project selection by increasing the slope of the efficient frontier from $\theta = 1$ in Figure 1 to $\theta = 1.6$ ($\varphi = 5$, $\theta = 1.6$, $\alpha = 1$, and $\beta = 0.3$). The point of tangency for $t = 0$ is $\{4.33, 7.67\}$. The point of tangency for $t = 0.40$ is $\{7.88, 8.49\}$. Panel B illustrates the effect of the marginal cost of risk on the relation between taxes and project selection by increasing the manager's risk aversion from $\beta = 0.3$ in Figure 1 to $\beta = 0.6$ ($\varphi = 5$, $\theta = 1$, $\alpha = 1$, and $\beta = 0.6$). The point of tangency for $t = 0$ is $\{0.66, 5.51\}$. The point of tangency for $t = 0.40$ is $\{1.77, 6.02\}$.

compensation to performance, where the latter is a theoretical construct that is more amenable to empirical tests (e.g., Core and Guay 2002). To see that the same predictions follow, note that the utility function of a manager who is compensated with a δ-share of the project outcome, where $\delta > 0$, is given by:

$$U(\mu, \sigma^2) = \alpha(1-t)\delta\mu(i) - \beta(1-t)^2\delta^2\sigma^2(i) \tag{5}$$

Note that we previously assumed that $\delta = 1$, which corresponds to the special case in which the manager receives the entire payoff. It is easy to verify that the risk of the optimal project is now given by:

$$\sigma^2(i^*) = \theta\left(\frac{\alpha}{\beta\delta}\right)\left(\frac{1}{1-t}\right) - 1 \tag{6}$$

Equation (6) shows that the manager's risk aversion, β, and the sensitivity of the manager's compensation to project outcome, δ, operate in exactly the same manner. The intuition for this result is that just like β, higher values of δ correspond to a greater marginal disutility of risk (see related discussions in Lambert et al. [1991] and Ross [2004]).[1] As before, when the marginal disutility of risk is high, taxes provide less of an incentive to take risk, $\frac{\partial^2\sigma^2(i^*)}{\partial t \partial \delta} < 0$. This comparative static provides a prediction that is more amenable to empirical tests than does the analogous comparative static based on the manager's risk aversion (which is unobservable).

III. INSTITUTIONAL BACKGROUND AND RELATED LITERATURE

Personal Taxation of Managerial Compensation

All forms of managerial compensation are taxed as *ordinary income* at the time the compensation is either received (salary, bonus, and long-term incentive plans), vested (restricted stock), or exercised (stock options and stock appreciation rights). In addition, any subsequent appreciation in value between the vesting/exercise date and the date the shares are sold is also taxed as ordinary income, unless the shares are sold more than 12 months after vesting/exercise. Thus, the vast majority of a manager's compensation and equity portfolio is taxed at the prevailing ordinary income rate.[2] Given this institutional feature of the taxation of managerial compensation, we focus our empirical analysis on managers' income tax rate, rather than the long-term capital gains tax rate. This is not to suggest that the long-term capital gains rate is not relevant for managers' risk-taking decisions, but rather that capital gains taxes are not *necessary* to give rise to the effects that we predict and find (i.e., we expect our results even if the manager's portfolio is not subject to capital gains taxes). See the Online Appendix for a synopsis of the income tax treatment of the different forms of managerial compensation (see Appendix B for the link to the downloadable file).

Related Literature on Managerial Taxes

We conjecture that tax rates on senior managers affect corporate risk-taking incremental to the effect of such taxes on compensation and equity incentives. We refer to this as the "direct effect" of taxes on risk-taking decisions. However, boards might also alter managers' incentive-compensation contracts, or managers might adjust their equity holdings, in response to tax changes (e.g., Jin and Kothari 2008; Yost 2018). This represents a separate "indirect effect" of taxes on risk-taking that operates through the manager's equity holdings. Figure 3 illustrates these two channels.

Prior literature focuses exclusively on the "indirect effect," and finds mixed evidence of changes in managers' incentive-compensation contracts and equity holdings in response to changes in their personal tax rates. For example, Hall and Liebman (2000) and Frydman and Molloy (2011) find little evidence that either the amount or form of managerial compensation responds to changes in federal tax rates post-World War II. Goolsbee (2000) finds that managers responded to the Omnibus Budget Reconciliation Act of 1993—which *increased* the top federal tax rate from 31 percent to 39.6 percent—by accelerating their option exercises. Hall and Liebman (2000) examine the effect of two pronounced decreases in the top federal income tax rate in the context of the Economic Recovery Tax Act of 1981 (top federal rate reduced from 70 percent to 50 percent) and the Tax Reform Act of 1986 (top federal rate reduced from 50 percent to 28 percent). They find no evidence that these large *decreases* in income tax rates affected the timing of managers' option exercises, and show that Goolsbee's (2000) results are an artefact of failing to control for stock price appreciation.

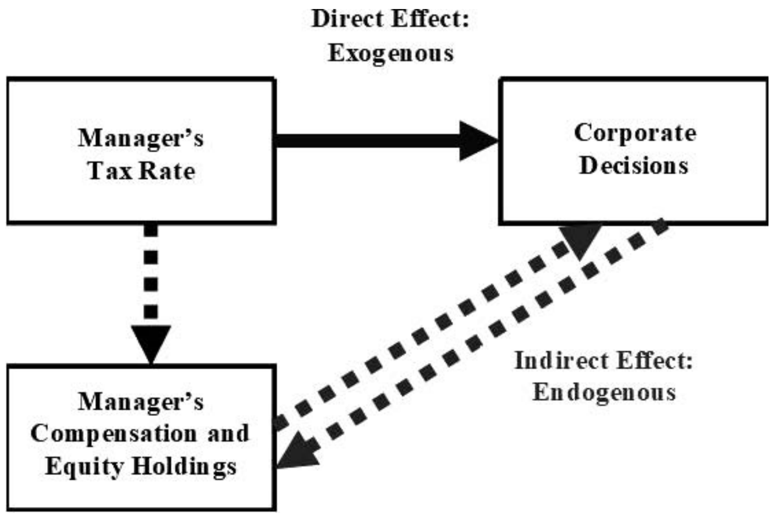
While these studies focus on *federal,* rather than *state,* tax rates, the consistent finding that relatively large changes in tax rates during the post-war period (e.g., from 50 percent to 28 percent) does not result in changes in managers' compensation or equity holdings suggests that it is unlikely that the comparatively small changes in state taxes that we study would have a measurable effect on these outcomes.[3] The results in the prior literature, combined with explicit controls for managers' pre-tax compensation and equity incentives in our tests, suggests that our findings are evidence of a "direct effect" of taxes.

[1] Consistent with this theoretical result, CEOs whose equity portfolios are more sensitive to changes in stock price have greater marginal disutility of risk and have been shown to take less risk (e.g., Coles et al. 2006).

[2] Jin and Kothari (2008) estimate that if the average CEO were to sell all of his vested equity, the capital gains tax burden would only be 2 percent of the value of his vested equity. Assuming a 20 percent long-term capital gains tax rate, their estimate implies that only 10 percent of the value of the average CEO's vested equity is subject to long-term capital gains tax.

[3] Supplemental analyses in the Online Appendix extend the results of prior literature to state taxes. Online Appendix Table IA.2 reports no evidence of a relation between state income tax rates and either total cash pay or equity portfolio incentives in our sample.

FIGURE 3
Manager's Tax Rate and Corporate Decisions



This figure illustrates the endogenous nature of the manager's compensation with corporate decisions, and two channels through which the manager's tax rate might affect corporate decisions: (1) directly, by reducing disutility associated with the adoption of risky projects, and (2) indirectly, by altering the compensation and incentives the board provides to the manager.

Rather than focus on the relation between equity holdings and tax *rates,* Jin and Kothari (2008) examine the relation between equity holdings and the *total tax liability* that managers would owe in connection with the sale of all of their vested equity holdings. They calculate the total tax liability associated with the hypothetical sale of all of a manager's vested equity holdings as the product of: (1) the respective tax rate, (2) the appreciation in value (i.e., the difference between current stock price and cost basis), and (3) the number of vested shares (or equivalents) in the manager's portfolio. Jin and Kothari (2008) find a negative relation between managers' total tax liability and their equity sales: the more a manager would owe in taxes, the less equity they sell. Importantly, since the total tax liability is a function of three variables—the number of vested shares, price appreciation, and the tax rate—it is not clear whether the negative relation between managers' tax liability and their equity sales is evidence that (1) managers sell less when they hold more equity, (2) managers sell less when stock price is relatively high, or (3) managers sell less when tax rates are high.

In related contemporaneous work, Yost (2018) examines the relation between managers' total capital gains tax liability (from hypothetically selling 100 percent of their vested equity) and corporate risk-taking. Similar to Jin and Kothari (2008), Yost (2018) posits that a larger capital gains tax liability deters managers from selling equity, and that the attendant increase in equity holdings reduces managers' incentives for risk-taking. Consistent with this prediction, Yost (2018) finds that managers' total capital gains tax liability is negatively related to firm risk and that this relation is attenuated around state tax cuts.

Our paper differs from Yost (2018) in several ways. First, from a theoretical perspective, Yost (2018) examines a different, non-mutually exclusive channel through which taxes affect risk-taking: namely, by affecting managers' equity holdings and, in turn, their equity incentives. This is the "indirect" channel referred to in Figure 3 and considered in antecedent work. This contrasts with the "direct" channel that we examine whereby taxes affect managers' risk-taking, *independent of their equity holdings,* by directly reducing the disutility that risk-averse managers associate with risky investments. Note that these channels are distinct and operate through very different economic forces. For example, the theory discussed in Section II did not entail taxes affecting the manager's equity holdings.

Second, from an empirical perspective, Yost (2018) tests for a relation between managers' *capital gains tax liability* and firm risk, and whether any such relation varies with state tax cuts. In contrast, we examine the relation between managers' *personal income tax rates* and firm risk, using panel data methods that exploit time-series and cross-sectional variation in rates. In addition, we use our theoretical framework to identify empirical settings (based on firm and CEO characteristics) where the effect will be particularly pronounced. To the best of our knowledge, this is the first paper to relate managers' personal income tax rates directly to firm risk.

Third, we explicitly control for managers' risk-taking incentives provided by their equity holdings. This rules out the effect of taxes on managers' equity holdings (i.e., the "indirect" channel) as an alternative explanation for our findings. In addition, we find that our results are most pronounced for large tax increases, a setting not considered in Yost (2018). Overall, we view our paper and Yost (2018) as theoretically and empirically distinct, and as offering complementary evidence on how managers' personal taxes might affect corporate risk-taking.

Related Literature on Corporate Taxes

Several recent studies explore the relation between corporate taxes and firm risk. For example, Heider and Ljungqvist (2015) and Ljungqvist, Zhang, and Zuo (2017) examine the relation between changes in state corporate tax rates and changes in firm leverage and earnings volatility, respectively. Kim (2017) examines the relation between changes in state corporate tax rates and location of new corporate projects. Langenmayr and Lester (2018) examine the relation between a country's statutory corporate tax rate and firms' earnings volatility. Our study differs from these papers in that we examine *managerial,* rather than *corporate,* income taxes. We highlight three important economic distinctions between these two types of taxes:

(1) *Managers versus Shareholders*. The difference between who is taxed (shareholders or managers) affects the type of risk-taking that one might expect to observe. In particular, if corporate taxes are borne by shareholders, and diversified shareholders are risk-averse with respect to systematic risk, but risk-neutral with respect to idiosyncratic risk, then corporate taxes should primarily affect the amount of *systematic risk* (i.e., risk that is non-diversifiable and is priced by shareholders). In contrast, managers are not diversified and are, therefore, averse to both systematic and idiosyncratic risk. Prior studies on corporate taxes and risk-taking generally do not make the distinction between managers or shareholders, or between idiosyncratic and systematic risk. We expect managerial taxes to primarily affect firms' idiosyncratic, rather than systematic, risk.

(2) *Absence of Asymmetry*. A manager's marginal tax rate does not directly depend on corporate performance (i.e., corporate losses). In our sample, we find that 97 percent of CEOs are in the top tax bracket based on their salaries alone. Moreover, we find no evidence that either poor accounting or stock performance alters their tax bracket.[4] Because a manager's marginal tax rate does not depend on corporate performance, managerial taxes do not have an asymmetric effect on risk-taking over gains and losses like corporate taxes (e.g., Auerbach 1986). From a theoretical perspective, managerial and corporate taxes have potentially different effects on risk-taking.

(3) *Measurement of Marginal Tax Rates*. The marginal corporate tax rate and corporate investment decisions are endogenously determined. Recent literature uses plausibly exogenous variation in statutory corporate tax rates, either across countries or across the state of firms' headquarters, to address this concern. However, *statutory* corporate tax rates are known to be a poor proxy for *marginal* corporate tax rates for at least two reasons (e.g., Shevlin 1990; Blouin, Core, and Guay 2010). First, the error with which statutory rates measure marginal rates is correlated with firm performance and risk (e.g., net operating losses). Second, U.S. corporations are subject to nexus rules that require them to pay taxes based on where their sales are made, their income is earned, and their assets and employees are located—not based on the state of the firm's headquarters. In contrast, the sheer size of managers' annual compensation implies that managers' marginal income tax rates almost always coincide with the highest statutory tax rate, regardless of firm performance or risk. In addition, nexus issues are less of a concern in our setting since senior managers' compensation is likely to be earned in—and, therefore, taxed by—the state of their firm's headquarters.

IV. SAMPLE CONSTRUCTION AND VARIABLE MEASUREMENT

Sample Construction

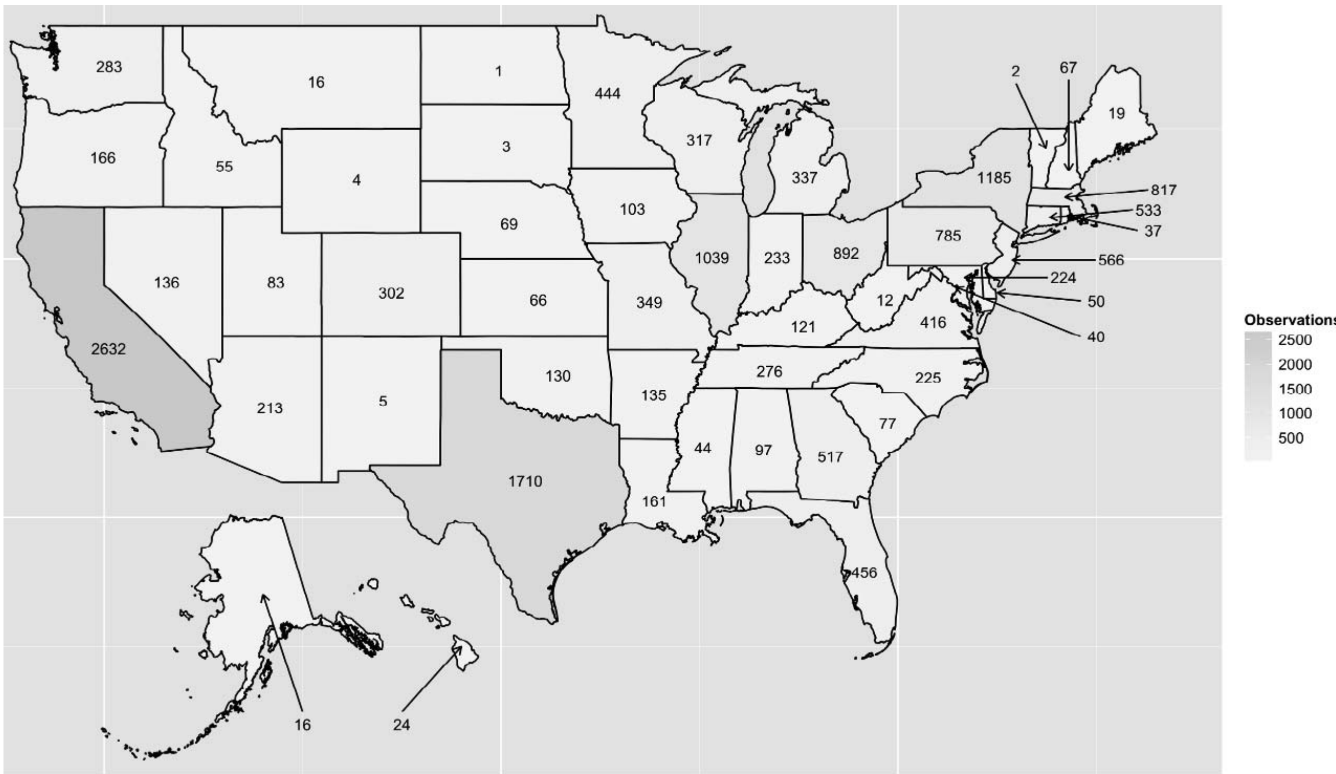
Our sample is constructed as the intersection of Compustat/CRSP, EDGAR, Execucomp, Thomson Institutional Ownership, and several government and non-profit datasets. Specifically, we require non-missing market value, total assets, total liabilities, cash holdings, plant, property, and equipment, sales, sales growth, and net income from Compustat; stock returns during the year from CRSP; historical location of the firm's corporate headquarters from the firm's EDGAR filings; and CEO cash compensation, equity ownership, age, and tenure from Execucomp.

Additionally, we require data on the political affiliation of state legislatures from the National Conference of State Legislatures; state economic activity from the Bureau of Economic Analysis; corporate tax rates from the Federation of Tax Administrators; and federal and state personal income tax rates from the National Bureau of Economic Research (NBER). We also collect data on state research and development tax credits and statutory carrybacks and carryforward periods from Wilson (2009) and state tax websites. Our sample is constructed as the intersection of these datasets, excluding financial service firms

[4] We report and discuss this analysis in more detail in the Online Appendix Table IA.1.

FIGURE 4
Number of Observations and Tax Rates by State

Panel A: Number of Observations by State



(continued on next page)

(SIC codes 6000–6999) and utilities (SIC 4900–4999), and consists of 16,490 firm-years (2,202 unique firms and 3,891 unique managers) from 1996 to 2012.

We follow Jennings, Lee, and Matsumoto (2017) and determine the location of a firm's corporate headquarters each year using the address the firm lists as its "principal executive offices" in its annual 10-K filing. Because firms update this address each time they file a 10-K, this item reflects any changes in the state of a firm's headquarters over time. Panel A of Figure 4 presents the distribution of our sample according to the state of firms' corporate headquarters.

Variable Measurement

Measurement of Managerial Taxes

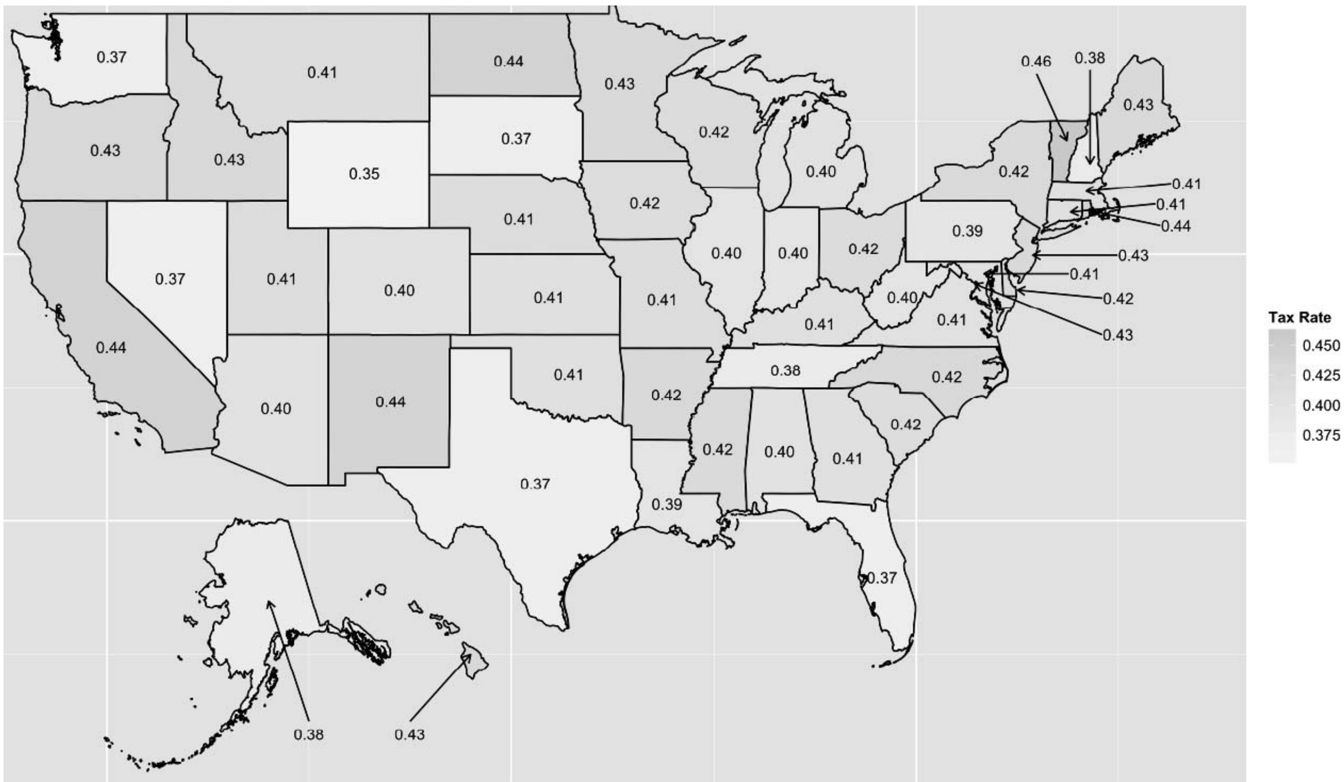
We measure managerial taxes using cross-sectional and time-series variation in federal and state personal income tax rates. Our measure of managerial taxes, *ManagerRate,* is the combined marginal tax rate on personal income for individuals in the highest federal and state tax bracket. The rate is calculated assuming that managers pay income taxes in the state of the firm's principal executive offices, are married filing jointly, with $150,000 of itemized deductions (e.g., property taxes), and allowing for the reciprocal deductibility of federal and state income taxes where applicable (e.g., Feenberg and Coutts 1993).[5]

We focus on a manager's tax rate, rather than a manager's tax liability, for two reasons. First, a manager's tax liability reflects not only the tax rate, but also share price appreciation and the amount and form of the manager's equity holdings, both of which prior work suggests are endogenous with respect to corporate risk-taking (e.g., Coles et al. 2006; Gormley et al. 2013).

[5] Data are from NBER TAXSIM and are available at: http://users.nber.org/~taxsim/state-rates/. Online Appendix Table IA.3 repeats our primary tests using the marginal tax rate calculated without assuming any itemized deductions. This alternative rate is 0.99 correlated with that used in our analysis. Inferences are unaffected.

FIGURE 4 (continued)

Panel B: Average Tax Rates by State



Panel A presents the number of observations in our sample by state. Panel B presents average values of *ManagerRate* by state. The sample is comprised of 16,490 firm-years drawn from each of the 50 states, plus Washington, DC, from 1996 to 2012.

Second, apart from any concerns about endogeneity, the tax liability is the product of both managers' equity holdings and the tax rate, and conflates two potential effects on risk-taking: the effect of holding more equity, and the effect of a higher tax rate. Given our prediction that higher tax rates lead to *increased* risk-taking, whereas greater equity holdings can lead to *decreased* risk-taking (e.g., Lambert et al. 1991; Ross 2004; Armstrong, Larcker, Ormazabal, and Taylor 2013), these effects could work in opposite directions. The opposing nature of these effects makes it difficult to use managers' tax liability to draw meaningful inferences about the effect of taxes on corporate risk-taking. Instead, we follow prior work in the tax responsiveness literature in economics and measure the tax rate on senior managers directly (see Saez, Slemrod, and Giertz [2012] for a review).

Measurement of Corporate Risk-Taking

Following prior work in the incentive-compensation literature, our primary measure of corporate risk-taking, *RiskyInvest,* is annual research and development expense scaled by ending total assets (e.g., Coles et al. 2006; Gormley et al. 2013).[6] In the context of our research question, research and development has several desirable properties as a measure of risky investment. First, it is directly controllable by senior managers and is commonly viewed as being riskier than alternative uses of funds (e.g., Bhagat and Welch 1995; Kothari, Laguerre, and Leone 2002). Second, unlike earnings-based measures of risk (e.g., earnings volatility), research and development is not mechanically affected by managers' accrual choices (e.g., depreciation, bad debt expense, etc.), and unlike market-based measures of risk (e.g., return volatility), research and development is not mechanically affected by the disclosure of public information, trading activity in the capital market, or taxes on shareholders (e.g., capital

[6] Following these studies, we replace missing values of research and development with zero. In untabulated analyses, we find that the positive relation between managerial taxes and corporate risk-taking continues to be statistically significant at the 1 percent level if we exclude such observations.

TABLE 1
Descriptive Statistics

Panel A: Firm Characteristics

Variable	Mean	Std.	25th	Median	75th
Assets	6,397.28	27,288.71	422.86	1,156.14	3,594.60
Leverage	0.22	0.19	0.04	0.20	0.33
MB	2.09	1.52	1.22	1.61	2.35
SalesGrowth	0.15	0.42	0.00	0.09	0.21
CapIntensity	0.26	0.22	0.10	0.20	0.38
Cash	0.16	0.18	0.03	0.09	0.24
ROA	0.03	0.16	0.01	0.05	0.09
Loss	0.20	0.40	0.00	0.00	0.00
LossCarry	0.42	0.49	0.00	0.00	1.00
Return	0.17	0.59	−0.17	0.09	0.37
RetailOwn	0.28	0.22	0.11	0.24	0.41
RiskyInvest	0.04	0.07	0.00	0.01	0.05

Panel B: CEO Characteristics

Variable	Mean	Std.	25th	Median	75th
ManagerRate	0.41	0.03	0.39	0.41	0.43
Age	55.39	7.31	50.00	55.00	60.00
Tenure	7.20	7.47	2.00	5.00	10.00
CashPay	1.14	1.05	0.54	0.83	1.29
TotalPay	4.68	5.65	1.25	2.69	5.70
Delta	0.70	1.58	0.08	0.22	0.60
Vega	0.12	0.28	0.01	0.04	0.12

Panel C: State Characteristics

Variable	Mean	Std.	25th	Median	75th
StateEconGrowth	0.02	0.03	0.01	0.02	0.04
RepubGovernor	0.53	0.50	0.00	1.00	1.00
RepubLegislature	0.31	0.46	0.00	0.00	1.00
CorporateRate	0.40	0.02	0.38	0.40	0.41
R&DCredit	0.06	0.05	0.00	0.06	0.10
CorpCarryBack	0.69	1.09	0.00	0.00	2.00
CorpCarryForward	13.61	6.47	7.00	15.00	20.00

This table presents descriptive statistics for the variables used in our primary analysis. Our sample is constructed from the intersection of CRSP/Compustat (accounting and stock price data), Execucomp (compensation), and SEC EDGAR 10-K filings (historical data on state of headquarters), after excluding utilities (SIC codes 4900–4999) and financial firms (SIC codes 6000–6999) over the time period 1996 to 2012. Our final sample covers a total of 16,490 firm-years (2,202 firms and 3,891 managers). Panel A reports descriptive statistics for firm characteristics used in our analysis, Panel B reports descriptive statistics for manager characteristics, and Panel C reports descriptive statistics for characteristics of the firm's state of headquarters.
All variables are as defined in Appendix A.

gains taxes). Nevertheless, to ensure that our inferences are not unique to this specific measurement choice, in subsequent analyses, we confirm that our results are robust to measuring corporate risk-taking using earnings volatility and return volatility.

Descriptive Statistics

Table 1 presents descriptive statistics for our sample at the firm, manager, and state levels in Panels A, B, and C, respectively. All variables are as defined in Appendix A and are winsorized at the 1st and 99th percentiles. Panel A shows that the average (median) firm in our sample has just over \$6.3 (\$1.1) billion in total assets (mean *Assets* = \$6,397, median *Assets* = \$1,156). Panel B shows that average *ManagerRate* is 41 percent, with a standard deviation of 3 percent. The minimum *ManagerRate* is 35 percent, which is the tax rate on individuals working in states without a personal income tax in the years

TABLE 2

Managerial Tax Rates By Year

Year	n	*ManagerRate* (Combined Top Federal + Top State) Mean	Std.	25th	Median	75th	Top Federal Rate Only
1996	836	0.44	0.02	0.43	0.44	0.45	0.396
1997	935	0.44	0.02	0.43	0.44	0.45	0.396
1998	885	0.44	0.02	0.43	0.44	0.45	0.396
1999	940	0.44	0.02	0.43	0.44	0.45	0.396
2000	981	0.44	0.02	0.43	0.44	0.46	0.396
2001	945	0.44	0.02	0.42	0.44	0.45	0.391
Bush Tax Cuts							
2002	929	0.43	0.02	0.42	0.43	0.44	0.386
2003	980	0.40	0.02	0.38	0.40	0.41	0.350
2004	927	0.40	0.02	0.38	0.40	0.41	0.350
2005	950	0.40	0.02	0.38	0.40	0.41	0.350
2006	978	0.39	0.02	0.38	0.39	0.41	0.350
2007	1,073	0.39	0.02	0.38	0.39	0.40	0.350
2008	1,125	0.39	0.02	0.37	0.39	0.40	0.350
2009	1,026	0.39	0.02	0.37	0.39	0.41	0.350
2010	1,023	0.39	0.02	0.37	0.39	0.41	0.350
2011	1,056	0.39	0.02	0.37	0.39	0.41	0.350
2012	901	0.39	0.03	0.37	0.39	0.39	0.350
Total	16,490	0.41	0.03	0.39	0.41	0.43	

This table presents descriptive statistics for *ManagerRate*, by year, for our sample of 16,490 firm-years. *ManagerRate* is the highest combined federal and state income tax rate, assuming that the individual is in top brackets at both the federal and state levels, married filing jointly, with $150,000 in deductible property taxes, and allowing for reciprocal deductibility of state and federal income taxes in states where applicable.

after the "Bush tax cuts" (beginning 2003), and the maximum *ManagerRate* is 46.7 percent, which is the rate for individuals working in California prior to the Bush tax cuts. Panel C shows that the average firm has a combined federal and state statutory tax rate of 40 percent (mean *CorporateRate* = 0.40), the statutory rate at which the firms may claim an R&D tax credit is 6 percent (mean *R&DCredit* = 0.06), and can carry net operating losses back (forward) 0.69 (13.61) years (mean *CorpCarryBack* = 0.69, mean *CorpCarryForward* = 13.61).[7]

Table 2 presents average values of *ManagerRate* by year, as well as the top federal rate for the year. In all years, the interquartile range (i.e., the difference between the 25th and 75th percentiles) is between 2 percent and 4 percent. This suggests that the amount of variation in taxes over time is similar to the amount of variation in taxes across states. Indeed, we find that time-series variation accounts for 55 percent of the total variation in *ManagerRate* (cross-sectional variation accounts for the remainder).[8] Notably, during our sample period, the total variation in the top federal rate (Std. Dev. of 0.02) is equal to the within-year variation in the top state rate (Std. Dev. of 0.02). This suggests that there are similar amounts of variation in both rates during our sample period. Panel B of Figure 4 presents average values of *ManagerRate* by state.

V. EMPIRICAL TESTS AND RESULTS

Between-Group Analysis

In our first set of tests, we conduct a between-group analysis that relies on comparisons between time periods, states, and firms. These tests estimate the relation between managerial taxes and corporate risk-taking using all of the variation in managerial taxes, regardless of its source (i.e., federal or state, cross-sectional or time-series). Specifically, we estimate the following pooled regression:

[7] Data on *R&DCredit* through 2006 were provided by Wilson (2009), and data on *CorpCarryBack* and *CorpCarryForward* were provided by Ljungqvist et al. (2017), ignoring nexus issues. Data on these variables in subsequent years come from tax forms available on state Department of Revenue websites.

[8] Fifty-five percent is calculated as the adjusted R^2 from a regression of *ManagerRate* on year fixed effects.

$$RiskyInvest_{t+1} = \gamma_0 + \gamma_1 ManagerRate_t + \boldsymbol{\omega} FirmControls_t + \boldsymbol{\pi} ManagerControls_t + \boldsymbol{\psi} StateControls_t + \varepsilon_{t+1} \quad (7)$$

where *RiskyInvest* and *ManagerRate* are as previously defined; *FirmControls* is a vector of time-varying firm-level controls; *ManagerControls* is a vector of time-varying manager-level controls; and *StateControls* is a vector of time-varying state-level controls. Throughout all of our analyses, we base our inferences on standard errors that are two-way clustered by state and year.[9]

Similar to prior research (e.g., Coles et al. 2006; Ljungqvist et al. 2017), we control for the following firm-level variables: firm size (*Log*(*Assets*)), firm leverage (*Leverage*), market-to-book ratio (*MB*), sales growth (*SalesGrowth*), capital intensity (*CapIntensity*), cash holdings (*Cash*), accounting performance (*ROA* and *Loss*), whether the firm has a tax loss carryforward (*TaxLoss*), stock returns (*Returns*), and ownership by retail investors (*RetailOwn*). Including retail ownership helps to control for the possibility that variation in risk-taking is driven by the composition of the investor base.

Following Armstrong et al. (2013), we also control for the following manager-level variables: CEO age (*Log*(*Age*)), tenure (*Log*(*Tenure*)), pre-tax cash compensation (*Log*(*CashPay*)), and pre-tax equity incentives (*Log*(*Delta*)) and *Log*(*Vega*)). The inclusion of these variables controls for risk-taking incentives provided by CEOs' *pre-tax* compensation and pre-tax equity incentives. We control for the level and structure of compensation in order to isolate the "direct effect" of managers' tax rates on risk-taking (i.e., the top arrow in Figure 3).

Following Heider and Ljungqvist (2015), we control for the growth in gross state product (*StateEconGrowth*) and, notwithstanding the aforementioned nexus issues, the highest combined federal and state statutory corporate tax rate, (*CorporateRate*), the statutory rate at which firms may claim a state R&D tax credit (*R&DCredit*), and the number of years in which a firm can carry back (forward) a net operating loss in the state (*CorpCarryBack* and *CorpCarryForward*). Following Gilligan and Matsusaka (2001) and Omer and Shelley (2004), we also control for the political affiliation of the governor (*RepubGovernor*) and the political affiliation of the legislature (*RepubLegislature*).

Table 3 presents results from estimating Equation (7). In every specification, we find robust evidence of a positive relation between managerial taxes and corporate risk-taking. Notably, the estimate of the effect of taxes *without* controls for managers' compensation and equity incentives is 0.246 (i.e., Column (2)), whereas the estimate of the effect of taxes *with* these controls is 0.237 (i.e., Column (3)). The former specification conflates both the indirect and direct effects in Figure 3, whereas the latter specification measures only the direct effect since it controls for the amount and structure of managers' incentive-compensation. In other words, because we hold compensation and equity incentives fixed, the coefficient on *ManagerRate* in the latter specification measures the effect of taxes on risk-taking for a fixed incentive-compensation package. The small difference between the two estimates suggests that the indirect effect of taxes on risk-taking—operating through the incentive-compensation channel—is modest.[10]

Table 3, Column (5) reports results after decomposing *ManagerRate* into the federal tax component, *ManagerRate_Fed,* and the state tax component, *ManagerRate_State*.[11] The key difference between these rates is that the federal rate varies over time, but not across firms, while the state rate varies both over time and across firms. Because there is no cross-sectional variation in the federal rate, we caution that this test cannot distinguish between the effect of the federal rate and the effect of any confounding macroeconomic events or time trends.

Within-Group Analysis

In our second set of tests, we conduct a within-group analysis that relies on comparisons within a given time period, state, firm, or manager. Specifically, we modify Equation (7) to include year, state, firm, and manager fixed effects:

$$\begin{aligned} RiskyInvest_{t+1} = \gamma_0 &+ \gamma_1 ManagerRate_t + \boldsymbol{\omega} FirmControls_t + \boldsymbol{\pi} ManagerControls_t + \boldsymbol{\psi} StateControls_t + \boldsymbol{\chi} Year_t + \boldsymbol{\Psi} State \\ &+ \boldsymbol{\Omega} Firm + \boldsymbol{\Gamma} Manager + \varepsilon_{t+1} \end{aligned} \quad (8)$$

We estimate four versions of Equation (8) that progressively add each of the four levels of fixed effects, beginning with year fixed effects. In each specification, we require at least two observations at the level of each fixed effect (e.g., at least two

[9] In untabulated analyses, we find that the positive relation between managerial taxes and corporate risk-taking is statistically significant at the 1 percent level if we either (1) cluster by state only, (2) cluster by firm only, or (3) two-way cluster by firm and year.

[10] Similar to Ljungqvist, Zhang, and Zuo (2017), we find no evidence of a relation between the state corporate tax rate and research and development expense.

[11] *ManagerRate_Fed* is the rate on the top federal income tax bracket, and *ManagerRate_State* is the difference between *ManagerRate* and *ManagerRate_Fed*. While federal and state taxes are not strictly additive, calculating *ManagerRate_State* in this manner ensures that the effects of cross-deductibility and compounding appear in state taxes (so that all individuals have the same federal rate).

TABLE 3

Managerial Taxes and Corporate Risk-Taking: Between-Group Analysis

	(1) No Controls		(2) Firm Characteristics		(3) Firm and Manager Characteristics		(4) Firm, Manager, and State Characteristics		(5) Federal and State Components	
Variable	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
ManagerRate	0.439***	(2.51)	0.246***	(5.34)	0.237***	(5.25)	0.135***	(2.99)		
ManagerRate_Fed									0.190***	(2.65)
ManagerRate_State									0.100*	(1.94)
Firm-Year Controls										
Log(*Assets*)			−0.001**	(−1.14)	−0.003**	(−2.49)	−0.002**	(−2.32)	−0.002**	(−2.23)
Leverage			−0.020***	(−3.64)	−0.020***	(−3.51)	−0.018***	(−3.18)	−0.017***	(−3.10)
MB			0.007***	(6.32)	0.007***	(7.07)	0.007***	(7.40)	0.007***	(7.47)
SalesGrowth			0.007*	(1.60)	0.007*	(1.83)	0.007*	(1.70)	0.007*	(1.71)
CapIntensity			−0.020***	(−4.83)	−0.018***	(−4.29)	−0.016***	(−4.21)	−0.016***	(−4.02)
Cash			0.136***	(9.69)	0.135***	(10.09)	0.125***	(9.66)	0.125***	(9.38)
ROA			−0.124***	(−6.65)	−0.122***	(−6.59)	−0.119***	(−6.35)	−0.119***	(−6.36)
Loss			0.004	(1.24)	0.004	(1.18)	0.004	(1.21)	0.004	(1.18)
LossCarry			0.009***	(2.65)	0.009***	(2.71)	0.007***	(2.59)	0.007**	(2.50)
Return			−0.007***	(−4.42)	−0.006***	(−4.31)	−0.006***	(−3.94)	−0.006***	(−4.02)
RetailOwn			0.001	(0.13)	0.003	(0.55)	0.006	(0.94)	0.006	(1.02)
Manager-Year Controls										
Log(*Age*)					−0.001	(−0.16)	−0.001	(−0.08)	−0.001	(−0.10)
Log(*Tenure*)					0.001	(0.31)	0.001	(0.38)	0.001	(0.35)
Log(*CashPay*)					−0.001	(−0.32)	−0.001	(−0.23)	−0.001	(−0.24)
Log(*Delta*)					−0.012***	(−3.30)	−0.012***	(−3.29)	−0.012***	(−3.27)
Log(*Vega*)					0.057***	(7.26)	0.052***	(6.90)	0.052***	(6.69)
State-Year Controls										
StateEconGrowth							0.043***	(2.35)	0.047***	(2.59)
RepubGovernor							−0.001	(−0.03)	0.001	(0.30)
RepubLegislature							−0.005**	(−2.47)	−0.005**	(−2.30)
CorporateRate							0.110	(1.40)	0.091	(1.06)
R&DCredit							0.087***	(4.03)	0.080***	(3.41)
CorpCarryBack							−0.002**	(−1.74)	−0.002*	(−1.81)
CorpCarryForward							−0.001	(−1.13)	0.001	(−1.24)
F	56.21		142.15		118.56		104.91		101.98	
n	16,490		16,490		16,490		16,490		16,490	

***, **, * Denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tailed), respectively.

This table presents results from estimating Equation (7). Columns (1) through (4) present results from progressively including firm-, manager-, and state-level control variables. Column (5) presents results from additively decomposing *ManagerRate* into the federal tax component, *ManagerRate_Fed,* and the state tax component, *ManagerRate_State*. *ManagerRate_Fed* is the rate on the top federal income tax bracket, and *ManagerRate_State* is the difference between *ManagerRate* and *ManagerRate_Fed*. t-statistics appear in parentheses and are based on standard errors clustered by state and year. All variables are as defined in Appendix A.

observations per firm in specifications that include firm fixed effects). This requirement results in slightly different sample sizes across the four specifications.[12]

There are two noteworthy features of this research design. First, in the presence of year fixed effects, the only remaining variation in *ManagerRate* is at the state level. Accordingly, this set of tests effectively controls for any and all variation in federal tax rates. Second, the inclusion of state, firm, and manager fixed effects controls for any cross-sectional differences between states, firms (and industries), or managers that might otherwise confound our results. For example, California generally has the highest top personal income tax rate, and firms in California are predominantly technology firms that are known to take substantial risk.[13]

Table 4 presents results from estimating Equation (8). In every specification, we find robust evidence of a positive relation between managerial taxes and corporate risk-taking (t-stats range from 2.74 to 6.51). As a robustness check, Column (5) presents results from replacing year fixed effects with industry-year fixed effects, which are constructed as a unique vector of year fixed effects for each two-digit SIC code. We continue to find a positive relation between managerial taxes and corporate risk-taking.[14]

Cross-Sectional Predictions

In our next set of tests, we examine settings where theory predicts that the relation between managerial taxes and corporate risk-taking will be particularly strong: among firms with investment opportunities that have a higher rate of return per unit of risk, and among CEOs who have a lower marginal disutility of risk. If our theoretical predictions are empirically descriptive, then these settings should provide more powerful tests of our predictions.

Our tests proceed as follows. First, we develop proxies for each of these firm- and manager- specific characteristics and partition our sample into observations with relatively high and low values of each proxy. Second, we estimate Equation (8) separately for each subsample and test for a difference in the coefficient on *ManagerRate* between the two subsamples. Viewing *ManagerRate* as the exogenous "treatment," these tests examine whether there is evidence of heterogeneous treatment effects.[15]

Table 5 presents results from examining whether the relation between managerial taxes and corporate risk-taking is stronger in firms that have an investment opportunity set that yields a higher rate of return per unit of risk. We measure the rate of return using two measures of the slope of the investment opportunity set, *Industry Q* and *Industry* θ, with larger values of each measure corresponding to greater returns for each additional unit of risk.[16] *Industry Q* is the aggregate Tobin's Q of the respective industry-year. *Industry Q* is calculated as the market value of equity plus book value of debt for all firms in the industry-year, scaled by book value of assets for all firms in the industry-year.[17] *Industry* θ is a structural estimate of the slope coefficient in Equation (3) estimated at the industry-year level. In particular, for all firms within a given industry-year, we estimate a regression of buy-and-hold returns during the year on the natural logarithm of 1 plus the variance of monthly stock returns during the year. The slope coefficient from this regression corresponds to θ in Equation (3). Larger values of Q and θ correspond to a greater marginal benefit for each additional unit of risk.

Table 5, Panel A presents results from estimating the relation between managerial taxes and corporate risk-taking after partitioning on *Industry Q*. Consistent with our predictions, we find that the effect of managerial taxes on risk-taking is stronger in industries with high Q. For firms in high Q industries, the coefficient on *ManagerRate* is 0.464 (t-stat = 3.15), and for firms in low Q industries the coefficient on *ManagerRate* is –0.056 (t-stat = −1.02). The difference between these two coefficients is

---

[12] Note that manager fixed effects can be estimated in the presence of firm fixed effects because of variation in the CEO-firm pairing during our sample period. For those CEOs and firms that are always paired together, we exclude the respective CEO effect.

[13] The inclusion of firm fixed effects controls for those firms that never invest in research and development during our sample period. In untabulated analyses, we find that the positive relation between managerial taxes and corporate risk-taking remains statistically significant at the 1 percent level if we exclude these firms from the sample. We choose to retain these firms because our alternative measures of risk-taking are not based on research and development, and because eliminating these firms introduces the potential for look-ahead bias.

[14] In untabulated analyses, we estimate Equation (8) including all time-varying controls and just year and firm fixed effects (i.e., excluding state effects and manager effects). We find similar results to those tabulated in Table 5 (i.e., coefficient on *ManagerRate* is 0.259, t-stat 4.82).

[15] We use the median to partition the sample to ensure that the two resulting subsamples are of similar size and, in turn, that our tests have similar power. Note that this design is equivalent to fully interacting an indicator for whether the observation is above or below the median with all of the control variables and fixed effects, and testing whether the interaction with *ManagerRate* is different from zero.

[16] We use the relation between risk and return at the industry level to proxy for the relation between risk and return at the project level. Although our theoretical discussion in Section II is framed in terms of a manager of a firm choosing among risky projects, an alternative interpretation is to assume that the manager instead directly selects the risk of the firm as a whole. In this regard, Equation (3) can be thought of as describing a firm's efficient frontier, and the manager simply chooses where his firm will be located on the frontier.

[17] In untabulated analyses, we find that our inferences are robust to using the average Tobin's Q for all firms in the respective industry-year.

TABLE 4

Managerial Taxes and Corporate Risk-Taking: Within-Group Analysis

	(1) Within-Year: Year Fixed Effects		(2) Within-State: Year and State Fixed Effects		(3) Within-Firm: Year, State, and Firm Fixed Effects		(4) Within-Manager: Year, State, Firm, and Manager Fixed Effects		(5) Time-Varying Industry shocks: Industry-Year, State, Firm, and Manager Fixed Effects	
Variable	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
ManagerRate	0.203***	(2.74)	0.254***	(3.00)	0.347***	(6.51)	0.237***	(3.89)	0.290***	(3.72)
Firm-Year Controls										
Log(Assets)	−0.003**	(−2.52)	−0.003**	(−2.51)	−0.008**	(−2.23)	−0.006**	(−2.51)	−0.007***	(−3.00)
Leverage	−0.017***	(−3.04)	−0.017***	(−2.98)	−0.012***	(−3.51)	−0.015***	(−1.81)	−0.013*	(−1.69)
MB	0.007***	(6.79)	0.007***	(6.95)	−0.001	(−0.25)	−0.001	(−0.43)	−0.001	(−0.52)
SalesGrowth	0.006	(1.59)	0.006	(1.46)	0.003*	(1.68)	0.003	(1.38)	0.002	(1.05)
CapIntensity	−0.015***	(−3.79)	−0.011***	(−2.72)	0.030***	(3.97)	0.025***	(3.01)	0.030***	(3.90)
Cash	0.126***	(9.29)	0.119***	(7.63)	0.006	(0.61)	0.015*	(1.64)	0.015*	(1.64)
ROA	−0.120***	(−6.21)	−0.118***	(−5.91)	−0.024***	(−3.27)	−0.019**	(−1.98)	−0.020**	(−2.28)
Loss	0.004	(1.30)	0.004	(1.11)	0.001	(0.68)	0.001	(1.02)	0.001	(0.62)
LossCarry	0.007**	(2.34)	0.007**	(2.29)	0.001	(0.08)	−0.001	(−0.35)	−0.001	(−0.41)
Return	−0.006***	(−3.06)	−0.006***	(−3.26)	−0.003**	(−2.49)	−0.002**	(−2.41)	−0.002**	(−2.47)
RetailOwn	0.006	(0.93)	0.009	(1.55)	0.002	(0.57)	0.005	(1.48)	0.004	(1.39)
Manager-Year Controls										
Log(Age)	−0.001	(−0.02)	−0.003	(−0.39)	−0.010**	(−2.06)	0.003	(0.34)	−0.001	(−0.02)
Log(Tenure)	0.001	(−1.55)	0.001	(0.26)	−0.001	(−0.87)	−0.003	(−1.33)	−0.003	(−1.55)
Log(CashPay)	0.001	(1.58)	0.002	(0.57)	0.005***	(2.71)	0.003*	(1.90)	0.003	(1.58)
Log(Delta)	−0.011***	(−3.18)	−0.012***	(−3.22)	0.001	(0.70)	−0.001	(−0.12)	−0.001	(−0.10)
Log(Vega)	0.054***	(6.63)	0.053***	(6.01)	0.002	(0.44)	0.001	(0.32)	0.006	(0.87)
State-Year Controls										
StateEconGrowth	−0.001	(−0.03)	0.031	(−1.14)	−0.027	(−1.55)	−0.015	(−0.96)	−0.018	(−1.33)
RepubGovernor	0.001	(0.25)	−0.002	(1.09)	0.001	(0.62)	−0.001	(−0.53)	−0.001	(−0.28)
RepubLegislature	−0.004*	(−1.89)	0.003**	(2.17)	0.001	(1.80)	0.001	(1.19)	0.001	(1.09)
CorporateRate	0.065	(0.66)	0.073	(0.64)	−0.008	(−0.32)	−0.054*	(−1.73)	−0.073	(−1.22)
R&DCredit	0.085***	(3.34)	0.014	(0.59)	0.028	(1.37)	0.022	(1.18)	0.022	(0.96)
CorpCarryBack	−0.002*	(−1.95)	0.001	(0.61)	0.001	(0.16)	0.001	(0.66)	0.001	(1.13)
CorpCarryForward	−0.001	(−0.94)	0.001	(0.52)	−0.001	(−0.17)	−0.001	(−1.10)	−0.001	(−1.21)
F	773.91		125.19		17.11		7.70		35.00	
n	16,490		16,489		16,231		15,461		15,324	

***, **, * Denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tailed), respectively.

This table presents results from estimating Equation (8). Column (1) presents results from a within-year analysis that includes year effects. Column (2) presents results from a within-state analysis that includes both year and state effects. Column (3) presents results from a within-firm analysis that includes year, state, and firm effects. Column (4) presents results from a within-manager analysis that includes year, state, firm, and manager effects. Column (5) presents results from replacing year effects with industry-year effects, where industry-year effects are based on two-digit SIC codes. t-statistics appear in parentheses and are based on standard errors clustered by state and year.

All variables are as defined in Appendix A.

TABLE 5

Cross-Sectional Tests: Returns to an Additional Unit of Risk

Panel A: Tobin's Q

	(1) Low Return per Unit of Risk *Industry Q* $\leq$ 1.49	(2) High Return per Unit of Risk *Industry Q* $>$ 1.49
Mean *RiskyInvest*	0.022	0.053
Variable		
ManagerRate	−0.006	0.464***
	(−0.14)	(3.15)
Time-Varying Controls		
Firm-Year	Yes	Yes
State-Year	Yes	Yes
Manager-Year	Yes	Yes
Fixed Effects		
Year	Yes	Yes
State	Yes	Yes
Firm	Yes	Yes
Manager	Yes	Yes
F	18.38	16.62
n	7,476	7,303
p-value test of diff. in *ManagerRate* Coeff: $<$ 0.01		

Panel B: Slope of the Investment Opportunity Set

	(1) Low Return per Unit of Risk *Industry* $\theta \leq$ 1.70	(2) High Return per Unit of Risk *Industry* $\theta >$ 1.70
Mean *RiskyInvest*	0.033	0.042
Variable		
ManagerRate	0.170*	0.338***
	(1.96)	(3.21)
Time-Varying Controls		
Firm-Year	Yes	Yes
State-Year	Yes	Yes
Manager-Year	Yes	Yes
Fixed Effects		
Year	Yes	Yes
State	Yes	Yes
Firm	Yes	Yes
Manager	Yes	Yes
F	43.21	25.02
n	7,178	6,990
p-value test of diff. in *ManagerRate* Coeff.: 0.15		

***, **, * Denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tailed), respectively.

This table presents results from estimating whether the relation between managerial taxes and corporate risk-taking varies with two measures of the return to an additional unit of risk: industry growth opportunities, *Industry Q*, and the slope coefficient of the investment opportunity set for the industry given in Equation (3), *Industry* θ. *Industry Q* is calculated as market value of equity plus book value of debt scaled by book value of assets, where numerator and denominator are aggregated over all firms in the respective industry-year. Larger values of *Industry Q* correspond to industries with more growth opportunities. *Industry* θ is the slope coefficient from regression of buy-and-hold return over the year on the natural log of 1 plus the variance of monthly returns, and regressions are estimated separately for each industry-year. Larger values of *Industry* θ correspond to a larger return for each additional unit of risk. We estimate Equation (8) separately for firms with above- and below-median values of these variables, and allow the coefficients on all control variables and fixed effects to vary across the two groups of firms. t-statistics appear in parentheses and are based on standard errors clustered by state and year.

All variables are as defined in Appendix A.

statistically significant at the 1 percent level. Panel B presents similar results, but with somewhat lower levels of statistical significance, when using *Industry* θ to measure the rate of return on the investment opportunity set.

Table 6 presents results from examining whether the relation between managerial taxes and corporate risk-taking is stronger for CEOs who have a relatively low marginal disutility of risk. We measure the marginal disutility of risk using two CEO-specific characteristics, *Delta* and *Age,* where *Delta* is the sensitivity of the CEO's equity portfolio to a 1 percent change in stock price (in millions), and *Age* is the CEO's age in years. Larger values of both measures correspond to a greater marginal disutility of risk. In particular, older CEOs are typically thought to be more risk-averse, where greater levels of risk aversion correspond to a greater disutility to risk-taking (e.g., Malmendier, Tate, and Yan 2011; Malmendier and Nagel 2011). In addition, although *Delta* technically increases both the marginal benefit and the marginal disutility to risk (see Armstrong et al. [2013] for a discussion), we find that the latter effect dominates theoretically and empirically.[18] Consequently, *Delta* should primarily capture the marginal disutility to risk-taking.

Table 6, Panel A presents results from estimating the relation between managerial taxes and corporate risk-taking after partitioning on *Delta*. Consistent with our predictions, we find that the effect of managerial taxes on risk-taking is stronger for CEOs whose portfolios are relatively less sensitive to changes in stock price. For CEOs with a relatively low sensitivity, the coefficient on *ManagerRate* is 0.701 (t-stat = 4.54), whereas for CEOs with a relatively high sensitivity, the coefficient on *ManagerRate* is −0.091 (t-stat = −1.32). The difference between these two coefficients is statistically significant at the 1 percent level. Panel B presents similar results, but with somewhat lower statistical significance, when using *Age* to measure the marginal disutility to risk-taking.

Collectively, the results in Tables 5 and 6 suggest that the effect of managerial taxes on corporate risk-taking is stronger among firms that have an investment opportunity set that yields a higher rate of return per unit of risk, and among CEOs who have a relatively low marginal disutility to risk-taking. Indeed, for some firms and CEOs—namely, firms in industries with low growth options and CEOs with substantial equity portfolios—we find that managerial taxes do not encourage risk-taking.

VI. SENSITIVITY ANALYSES

Whose Taxes?

Table 7 presents results from estimating Equation (8) after including the tax rate on middle-income earners (*NonManagerRate*) as an additional control. This analysis provides an important sensitivity test that helps to rule out other potential alternative explanations for our main results. For example, it is conceivable that the tax rate on senior managers is correlated with the tax rate on lower-level employees or retail investors, and that it is these individuals—rather than senior managers—who are responsible for the tax-induced risk-taking. By including *NonManagerRate* as an additional control, the coefficient on *ManagerRate* measures the relation between corporate risk-taking and the difference, or "wedge," between the tax rates on high- and middle-income earners. Accordingly, this specification controls for any omitted variables that have a similar correlation with these two rates. If an omitted variable is correlated with both the tax rates in the same way, then controlling for the latter effectively controls for the omitted variable.

We use two measures of *NonManagerRate*: (1) the average tax rate paid by residents of the firm's state of headquarters, *AverageResidentRate,* and (2) the combined federal and state marginal tax rate on \$100,000 of wage income (married filing jointly), *MargRate100K*. Table 7, Panel A reports descriptive statistics for these variables. Note that the standard deviations of these alternative tax rates are 0.02 and 0.04, compared to 0.03 for *ManagerRate*. This suggests that there are similar amounts of variation in all three rates. Not surprisingly, Panel B indicates that our measures of *NonManagerRate* are highly correlated with *ManagerRate* (correlations range from 0.76 to 0.82).

Table 7, Panel C presents regression results. Columns (1), (2), (5), and (6) present results when including *NonManagerRate,* but excluding *ManagerRate*. Columns (3), (4), (7), and (8) present results from including both *NonManagerRate* and *ManagerRate*. We find a positive, marginally significant relation between *NonManagerRate* and corporate risk-taking in one of eight specifications. When the two tax rates are included together, we find no evidence of a relation between *NonManagerRate* and corporate risk-taking, but continue to find strong evidence of a relation between *ManagerRate* and corporate risk-taking. Collectively, these results suggest that the relation between managerial taxes and corporate risk-taking is not an artefact of taxes on middle-income employees or retail investors.

[18] Theoretically, Equation (6) shows that the manager's risk aversion (β) and pay-for-performance sensitivity (δ) affect the choice of risky project in exactly the same manner and, empirically, *Delta* is negatively related to risk-taking (e.g., Coles, Daniel, and Naveen 2006).

TABLE 6

Cross-Sectional Tests: Disutility to an Additional Unit of Risk

Panel A: Sensitivity of Portfolio to Stock Price

	(1) High Disutility: *Delta* > 0.22	(2) Low Disutility: *Delta* ≤ 0.22
Mean *RiskyInvest*	0.033	0.042
Variable		
ManagerRate	−0.091	0.701***
	(−1.32)	(4.54)
Time-Varying Controls		
Firm-Year	Yes	Yes
State-Year	Yes	Yes
Manager-Year	Yes	Yes
Fixed Effects		
Year	Yes	Yes
State	Yes	Yes
Firm	Yes	Yes
Manager	No	No
F	7.80	12.15
n	7,303	7,476
p-value test of diff. in *ManagerRate* Coeff.: < 0.01		

Panel B: CEO Age

	(1) High Disutility: *Age* > 55	(2) Low Disutility: *Age* ≤ 55
Mean *RiskyInvest*	0.030	0.044
Variable		
ManagerRate	0.275***	0.420***
	(2.68)	(2.96)
Time-Varying Controls		
Firm-Year	Yes	Yes
State-Year	Yes	Yes
Manager-Year	Yes	Yes
Fixed Effects		
Year	Yes	Yes
State	Yes	Yes
Firm	Yes	Yes
Manager	No	No
F	12.59	38.08
n	7,303	7,476
p-value test of diff. in *ManagerRate* Coeff.: 0.41		

***, **, * Denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tailed), respectively.

This table presents results from estimating whether the effect of managerial taxes on corporate risk-taking varies with two measures of the disutility to an additional unit of risk: the sensitivity of the value of the CEO's equity portfolio to a 1 percent change in stock price (*Delta*) and the CEO's age in years (*Age*). Larger values of *Delta* and *Age* correspond to greater disutility for each additional unit of risk. We estimate Equation (8) separately for CEOs with above- and below-median values of these variables, and allow the coefficients on all control variables and fixed effects to vary across the two groups of firms. We exclude manager fixed effects when estimating whether the effect of taxes varies with manager characteristics. t-statistics appear in parentheses and are based on standard errors clustered by state and year.

All variables are as defined in Appendix A.

TABLE 7

Whose Taxes? Tax Rates on Non-Management Employees

Panel A: Descriptive Statistics

Variable	Mean	Std.	25th	Median	75th
AverageResidentRate	0.15	0.02	0.14	0.15	0.16
MargRate100K	0.31	0.04	0.28	0.31	0.34

Panel B: Correlation Matrix

Variable	*ManagerRate*	*AverageResidentRate*	*MargRate100K*
ManagerRate	1.00	0.80	0.82
AverageResidentRate	0.78	1.00	0.78
MargRate100K	0.82	0.76	1.00

Panel C: Regression Results

	NonManagerRate =							
	***AverageResidentRate*: Average Taxes Paid by State Residents Scaled by Average State Household Income**				***MargRate100K*: Tax Rate on Family of Four with Income of $100,000**			
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
ManagerRate			0.175**	0.224**			0.152**	0.212***
			(2.44)	(2.09)			(2.42)	(3.15)
NonManagerRate	0.166*	0.159	–0.084	0.009	0.072	0.161	–0.02	0.125
	(1.74)	(0.64)	(–0.48)	(0.03)	(1.39)	(1.45)	(–0.40)	(1.08)
Time-Varying Controls								
Firm-level	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manager-level	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-level	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects								
Year	No	Yes	No	Yes	No	Yes	No	Yes
State	No	Yes	No	Yes	No	Yes	No	Yes
Firm	No	Yes	No	Yes	No	Yes	No	Yes
Manager	No	Yes	No	Yes	No	Yes	No	Yes
F	95.60	30.98	87.05	32.75	108.8	7.73	100.88	7.25
n	15,589	14,598	15,589	14,598	16,490	15,461	16,490	15,461

***, **, * Denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tailed), respectively.
This table presents results from estimating Equation (8) replacing the tax rate on senior managers with either the average tax rate paid by state residents (*AverageResidentRate*) or the combined federal and state marginal tax rate on $100,000 in wage income (*MargRate100K*). Panel A presents descriptive statistics, Panel B presents the correlation matrix with Pearson (Spearman) correlations above (below) the diagonal, and Panel C presents regression results. t-statistics appear in parentheses and are based on standard errors clustered by state and year.
All variables are as defined in Appendix A.

Alternative Specifications

To further assess the robustness of our findings, we conduct five additional analyses described in greater detail in the Online Appendix. The findings from these additional analyses are summarized as follows: (1) Table IA.4 shows that our inferences are robust to including additional time-varying state-level controls in Equation (8). (2) Table IA.5 shows that retroactively applied state tax rate changes have less of an effect on corporate risk-taking. (3) Table IA.6 distinguishes between large and small changes and rate increases and decreases, and shows that our results are strongest for large *increases*. (4) Table IA.7 presents results from estimating a staggered adoption difference-in-differences design with leads and lags of the treatment variable (e.g., Ljungqvist et al. 2017), where "treatment" is defined as a tax increase that exceeds 75 basis points. We find that large tax increases lead to a persistent increase in risky investment, and that managers begin to increase their corporate investment in the year of the tax increase. (5) Table IA.8 presents results from estimating Equation (8) using three alternative measures of risk-taking: earnings volatility, idiosyncratic risk, and systematic risk. We find a strong positive relation between managerial taxes and earnings volatility and idiosyncratic risk, but no relation between managerial taxes and systematic risk.

VII. CONCLUSION

We examine the relation between managers' *personal* tax rates and their *corporate* investment decisions. We use a simple theoretical framework to illustrate how taxes reduce the disutility a risk-averse manager associates with risky investment and increase the incentive (or, equivalently, reduce the disincentive) to take risk, and to illustrate how the effect varies with firm and manager characteristics. Consistent with our theoretical predictions, we find evidence of a strong positive relation between managerial tax rates and corporate risk-taking, and that this relation is stronger in firms where the investment opportunity set provides a relatively high rate of return per unit of risk, and for senior managers who have a relatively low marginal disutility of risk. By linking the relation between managers' *personal* tax rates and corporate risk-taking to characteristics of the firm and CEO, these findings strengthen our inference that the relation is attributable to a reduction in the disutility that risk-averse managers associate with risky projects. These results are robust to an extensive battery of sensitivity analyses. Collectively, our results suggest that managers' *personal* tax rates affect their *corporate* investment and risk-taking decisions.

REFERENCES

Armstrong, C., and R. Vashishtha. 2012. Executive stock options, differential risk-taking incentives, and firm value. *Journal of Financial Economics* 104 (1): 70–88. https://doi.org/10.1016/j.jfineco.2011.11.005

Armstrong, C., D. Larcker, G. Ormazabal, and D. Taylor. 2013. The relation between equity incentives and misreporting: The role of risk-taking incentives. *Journal of Financial Economics* 109 (2): 327–350. https://doi.org/10.1016/j.jfineco.2013.02.019

Auerbach, A. 1986. The dynamic effects of tax law asymmetries. *Review of Economic Studies* 53 (2): 205–225. https://doi.org/10.2307/2297647

Bhagat, S., and I. Welch. 1995. Corporate research and development investments: International comparisons. *Journal of Accounting and Economics* 19 (2/3): 443–470. https://doi.org/10.1016/0165-4101(94)00391-H

Blouin, J., J. Core, and W. Guay. 2010. Have the tax benefits of debt been overestimated? *Journal of Financial Economics* 98 (2): 195–213. https://doi.org/10.1016/j.jfineco.2010.04.005

Coles, J., N. Daniel, and L. Naveen. 2006. Managerial incentives and risk taking. *Journal of Financial Economics* 79 (2): 431–468. https://doi.org/10.1016/j.jfineco.2004.09.004

Core, J., and W. Guay. 2002. Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. *Journal of Accounting Research* 40 (3): 613–630. https://doi.org/10.1111/1475-679X.00064

Domar, E., and R. Musgrave. 1944. Proportional income taxation and risk-taking. *Quarterly Journal of Economics* 58 (3): 388–422. https://doi.org/10.2307/1882847

Feenberg, D., and E. Coutts. 1993. An introduction to the TAXSIM model. *Journal of Policy Analysis and Management* 12 (1): 189–194. https://doi.org/10.2307/3325474

Fellingham, J., and M. Wolfson. 1985. Taxes and risk sharing. *The Accounting Review* 60: 10–17.

Frydman, C., and R. Molloy. 2011. Does tax policy affect executive compensation? Evidence from postwar tax reforms. *Journal of Public Economics* 95 (11/12): 1425–1437. https://doi.org/10.1016/j.jpubeco.2011.02.005

Gilligan, T., and J. Matsusaka. 2001. Fiscal policy, legislature size, and political parties: Evidence from state and local governments in the first half of the 20th century. *National Tax Journal* 54 (1): 57–82. https://doi.org/10.17310/ntj.2001.1.03

Goolsbee, A. 2000. What happens when you tax the risk? Evidence from executive compensation. *Journal of Political Economy* 108 (2): 352–378. https://doi.org/10.1086/262122

Gormley, T., D. Matsa, and T. Milbourn. 2013. CEO compensation and corporate risk: Evidence from a natural experiment. *Journal of Accounting and Economics* 56 (2/3): 79–101. https://doi.org/10.1016/j.jacceco.2013.08.001

Graham, J. 2003. Taxes and corporate finance: A review. *Review of Financial Studies* 16 (4): 1075–1129. https://doi.org/10.1093/rfs/hhg033

Guay, W. 1999. The sensitivity of CEO wealth to equity risk: An analysis of the magnitude and determinants. *Journal of Financial Economics* 53 (1): 43–71. https://doi.org/10.1016/S0304-405X(99)00016-1

Hall, B., and J. Liebman. 2000. The taxation of executive compensation. *Tax Policy and the Economy* 14: 1–44. https://doi.org/10.1086/654701

Hanlon, M., and S. Heitzman. 2010. A review of tax research. *Journal of Accounting and Economics* 50 (2/3): 127–178. https://doi.org/10.1016/j.jacceco.2010.09.002

Heider, F., and A. Ljungqvist. 2015. As certain as debt and taxes: Estimating the tax sensitivity of leverage from state tax changes. *Journal of Financial Economics* 118 (3): 684–712. https://doi.org/10.1016/j.jfineco.2015.01.004

Jennings, J., J. Lee, and D. Matsumoto. 2017. The effect of industry co-location on analysts' information acquisition costs. *The Accounting Review* 92 (6): 103–127. https://doi.org/10.2308/accr-51727

Jin, L., and S. P. Kothari. 2008. Effect of personal taxes on managers' decision to sell their stock. *Journal of Accounting and Economics* 46: 23–46. https://doi.org/10.1016/j.jacceco.2008.05.002

Katuscak, P. 2009. Impact of personal income taxation on executive compensation. In *Proceedings from the 98th Annual Conference of the National Tax Association,* 183–189. Available at: https://www.jstor.org/stable/41954837?seq=1#metadata_info_tab_contents

Kim, H. 2017. *Do State Taxes Play a Role in Corporate Investment Decisions? Evidence from Interstate Investments*. Working paper, University of Maryland.

Kothari, S. P., T. Laguerre, and A. Leone. 2002. Capitalization versus expensing: Evidence on the uncertainty of future earnings from capital expenditures versus R&D outlays. *Review of Accounting Studies* 7 (4): 355–382. https://doi.org/10.1023/A:1020764227390

Krenn, P. 2017. The impact of taxes on competition for CEOs. *European Accounting Review* 26 (3): 503–530. https://doi.org/10.1080/09638180.2016.1200477

Lambert, R., D. Larcker, and R. Verrecchia. 1991. Portfolio considerations in valuing executive compensation. *Journal of Accounting Research* 29 (1): 129–149. https://doi.org/10.2307/2491032

Langenmayr, D., and R. Lester. 2018. Taxation and corporate risk-taking. *The Accounting Review* 93 (3): 237–266. https://doi.org/10.2308/accr-51872

Ljungqvist, A., L. Zhang, and L. Zuo. 2017. Sharing risk with the government: How taxes affect corporate risk-taking. *Journal of Accounting Research* 55 (3): 669–707. https://doi.org/10.1111/1475-679X.12157

Malmendier, U., and S. Nagel. 2011. Depression babies: Do macroeconomic experiences affect risk-taking? *Quarterly Journal of Economics* 126 (1): 373–416. https://doi.org/10.1093/qje/qjq004

Malmendier, U., G. Tate, and J. Yan. 2011. Overconfidence and early-life experiences: The effect of managerial traits on corporate financial policies. *Journal of Finance* 66 (5): 1687–1733. https://doi.org/10.1111/j.1540-6261.2011.01685.x

Mossin, J. 1968. Taxation and risk-taking: An expected utility approach. *Economica* 35 (137): 74–82. https://doi.org/10.2307/2552162

Niemann, R. 2008. The effects of differential taxation on managerial effort and risk taking. *FinanzArchiv: Public Finance Analysis* 64 (3): 273–310. https://doi.org/10.1628/001522108X374142

Omer, T., and M. Shelley. 2004. Competitive, political, and economic factors influencing state tax policy changes. *Journal of the American Taxation Association* 26 (s-1): 103–126. https://doi.org/10.2308/jata.2004.26.s-1.103

Poterba, J., and A. Samwick. 2003. Taxation and household portfolio composition: US evidence from the 1980s and 1990s. *Journal of Public Economics* 87 (1): 5–38. https://doi.org/10.1016/S0047-2727(01)00168-2

Rajgopal, S., and T. Shevlin. 2002. Empirical evidence on the relation between stock option compensation and risk taking. *Journal of Accounting and Economics* 33 (2): 145–171. https://doi.org/10.1016/S0165-4101(02)00042-3

Ross, S. 2004. Compensation, incentives, and the duality of risk aversion and riskiness. *Journal of Finance* 59 (1): 207–225. https://doi.org/10.1111/j.1540-6261.2004.00631.x

Saez, E., J. Slemrod, and S. H. Giertz. 2012. The elasticity of taxable income with respect to marginal tax rates: A critical review. *Journal of Economic Literature* 50 (1): 3–50. https://doi.org/10.1257/jel.50.1.3

Shackelford, D., and T. Shevlin. 2001. Empirical tax research in accounting. *Journal of Accounting and Economics* 31 (1/3): 321–387. https://doi.org/10.1016/S0165-4101(01)00022-2

Sharpe, W. 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance* 19: 425–442.

Shevlin, T. 1990. Estimating corporate marginal tax rates with asymmetric tax treatment of gains. *Journal of the American Taxation Association* 11: 51–67.

Stiglitz, J. 1969. The effects of income, wealth, and capital gains taxation on risk-taking. *Quarterly Journal of Economics* 83 (2): 263–283. https://doi.org/10.2307/1883083

Wilson, D. 2009. Beggar thy neighbor? The in-state, out-of-state, and aggregate effects of R&D tax credits. *Review of Economics and Statistics* 91 (2): 431–436. https://doi.org/10.1162/rest.91.2.431

Yost, B. 2018. Locked-in: The effect of CEOs' capital gains taxes on corporate risk-taking. *The Accounting Review* 93 (5): 325–358. https://doi.org/10.2308/accr-51962

APPENDIX A

Variable Definitions[a]

Variable	Definition
Firm Characteristics	
Assets	Book value of total assets.
Leverage	Book value of total debt to the book value of total assets.
MB	Market value of assets to book value of assets.
SalesGrowth	Change in sales scaled by lag sales.
CapIntensity	Net plant, property, and equipment scaled by total assets.
Cash	Cash holdings scaled by total assets.
ROA	Income before extraordinary items scaled by total assets.
Loss	An indicator variable equal to 1 if income before extraordinary items is negative, and 0 otherwise.
LossCarry	An indicator variable equal to 1 if the firm has a tax loss carryover, and 0 otherwise.
Return	Buy and hold return over the year.
RetailOwn	1 minus the fraction of institutional ownership.
RiskyInvest	Research and development expense scaled by total assets.
Industry Q	Market value of equity plus book value of debt of all firms in the industry-year scaled by book value of assets of all firms in the industry-year.
Industry θ	Slope coefficient from a regression of buy-and-hold return over the year on the natural log of 1 plus the variance of monthly returns over the year. Regressions are estimated separately for each industry-year.
CEO Characteristics	
ManagerRate	Highest combined federal and state income tax rate, assuming that the individual is in top brackets at both the federal and state levels, married filing jointly, with $150,000 in deductible property taxes, and allowing for deductibility of state income taxes in states where applicable.
Age	Age of the manager (in years).
Tenure	Tenure of the manager (in years).
CashPay	Total cash compensation (in millions).
TotalPay	Total compensation (in millions).
Delta	Dollar change of the CEO's portfolio value for a 1 percent change in firm stock price (in millions).
Vega	Dollar change of the CEO's portfolio value for a 0.01 change in return volatility (in millions).
State Characteristics	
StateEconGrowth	The change in gross state product, scaled by the beginning gross state product.
RepubGovernor	Indicator variable equal to 1 if the state's governor identifies as a Republican, and 0 otherwise.
RepubLegislature	Indicator variable equal to 1 if all houses of the state's legislature have a majority of members who identify as Republican, and 0 otherwise.
CorporateRate	Highest combined federal and state corporate tax rate.
R&DCredit	Statutory rate at which firms may claim an R&D tax credit.
CorpCarryBack	The number of years which a firm can carry back a net operating loss in the state.
CorpCarryForward	The number of years which a firm can carry forward a net operating loss in the state.
AverageResidentRate	Total federal and state income tax paid by state residents scaled by total adjusted gross income of state residents (data through 2011).
MargRate100K	Combined federal and state marginal income tax rate on $100,000 in wage income, assuming that the taxpayer is married filing jointly, and allowing for deductibility of state income taxes in states where applicable.

[a] This Appendix defines the variables used in our primary analyses.

APPENDIX B

accr-52193_Online Appendix: http://dx.doi.org/10.2308/accr-52193.s01