Taxes and Risk-taking Incentives

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ABSTRACT

We predict and find that corporate taxes are positively associated with systematic (but not idiosyncratic) risk. Exploiting plausibly exogenous changes in state tax rates, we observe firms shifting away from CEO equity compensation toward greater cash compensation following state corporate tax rate increases. In contrast, we observe no changes to CEO compensation structure following personal tax rate changes, consistent with personal tax rates having no association with systematic risk. Finally, we also report that changes in new investment are associated with increases in state corporate income taxes rather than state personal income taxes. Overall, our findings provide novel insight into which taxes affect risk-taking, and how taxes can affect the design of compensation contracts and the allocation of firm resources.

**Keywords:** CEOs; executive compensation, incentives; risk-taking, systematic and idiosyncratic risk; taxes

**JEL classification:** G32; H32; J33; J41; L25

**Data Availability:** Data are obtained from public sources identified in the paper.
1. Introduction

Taxation affects many aspects of the economy, including the propensity for risk-taking. However, recently two studies show that income taxes can affect executives’ and firms’ propensity for risk-taking in different ways. Ljungqvist, Zhang, and Zuo (2017) find that firms reduce risk-taking following corporate tax increases. In contrast, Armstrong, Glaeser, Huang, and Taylor (2019) provide evidence that executives engage in greater risk-taking following personal tax rate increases. In this study, we endeavor to reconcile the apparently divergent effect of taxation on risk-taking reported in these two studies. Besides examining whether taxes shift the manager’s relative proclivities for risk-taking, we also investigate what type of risk is affected (systematic or idiosyncratic) and whether executive incentives in compensation contracts are adjusted for changes in risk-taking.

The intuition that income taxation affects risk-taking arises because taxes affect risky payoffs but also facilitate risk-sharing with the government. Accordingly, Ljungqvist et al. (2017) contend that taxes can reduce a firm’s propensity for risk-taking because higher corporate taxes reduce the after-tax profit more for risky projects than for safer ones. In contrast, Armstrong et al. (2019) argue that greater risk-sharing with the government (through higher personal taxes) can increase a manager’s propensity for risk-taking by reducing her disutility of risk. Thus, an increase in the tax rates of both managers and firms will result in divergent incentives for risk-taking.

The methodology and results from these two papers are difficult to reconcile. On the one hand, Ljungqvist et al. examine changes in risk-taking associated with changes in the state corporate tax rates. In contrast, Armstrong et al. examine whether levels of risk-taking are
associated with the level of state individual tax rates. Also, Armstrong et al. measure risk-taking activities by using annual research and development expenses (scaled by total assets) while Ljungqvist et al. use changes in earnings volatility (although Armstrong et al. report that their results are robust to using earnings and return volatility). Moreover, the conclusions in these two studies seem incongruous; can increases in the corporate tax rate reduce corporate risk-taking at the same time as high levels of manager tax rates induce greater risk-taking?

We begin by reconciling the intuition driving the results of Ljungqvist et al. and Armstrong et al. (hereinafter abbreviated LZZ and AGHT, respectively). A key difference between the two papers is whose risk preferences are relevant in corporate investment decisions. In LZZ, the authors presume that the “firm” is risk neutral and therefore the role of taxes on investment is only borne out by the asymmetric treatment of tax losses. AGHT, on the other hand, recognize that corporate investment decisions are made by risk-averse managers. Because the government shares in the returns to risky investment, the government effectively serves to reduce the manager’s disutility of risk related to investment.

Essentially, we agree and disagree with some aspects of both LZZ and AGHT. First, we believe that “firms” do not make investment decisions but rather managers. Because managers are risk averse, we contend that AGHT’s theoretical motivation is more likely to be descriptive of investment decisions. Second, it seems logical that corporate-level taxes should be the primary driver of managers’ investment decisions. Corporate-level taxes are borne by the firm every year and therefore should be considered of first-order importance in corporate project selection. To the extent that managers are compensated based on firm-level performance (whether earnings or stock price), it is the magnitude of corporate taxes that are integrated in the firm’s NPV calculations. Therefore, we anticipate that managers’ investment response should be more
strongly related to corporate taxes instead of individual taxes. If managers respond to corporate-level taxes, then the results reported in LZZ are inconsistent with the results in AGHT.

We conduct our investigation in two stages. Because LZZ suggests that tax rate increases dampen risky investment whereas AGHT suggests increases should spur risky investment, we first investigate the effect of corporate and personal income taxes on corporate risk profiles. In particular, we examine the type of risk that appears related to the changes in tax rates. Papers such as Henderson (2005) and Armstrong and Vashishtha (2012) suggest that management prefers investment that increases the firms systematic (versus idiosyncratic) risk because this risk can be hedged by trading the market portfolio. If management is behaving as a risk-averse agent and is incentivized to increase their firms’ risk, then we anticipate that higher corporate taxes will incentivize management to seek projects that increase systematic risk. Next, we then look to changes in equity compensation around tax rate changes to help us determine the association between taxes and the riskiness of investment. Assuming that managerial compensation is optimally set to link managers’ incentives with those of shareholders, we presume then if tax rate increases lead to less risky investment that equity compensation will be increased to spur incremental investment. If, on the other hand, tax rate increases lead to more risky investment, then we anticipate that equity incentives should be adjusted to reduce management’s appetite for risk.

Our analyses yield two sets of results. First, we examine the effects of both corporate and personal income taxes on total firm risk, as well as systematic and idiosyncratic risk. Both tax rates reflect combined federal and state taxes, and are adjusted for the deductibility of state taxes at the federal level if applicable. Measuring both sets of tax rates in the same manner increases the comparability of each measure and allows for a more direct comparison of the potential
differential effects on risk taking. We follow the procedures in Armstrong and Vashishtha (2012) and compute imputed measures of risk that reflect what the CEO would have anticipated given the current operating structure of the firm. This process allays concerns that risk measures based on realized returns reflect confounding effects beyond risk-taking.

We find strong evidence that corporate taxes are associated with greater firm risk, manifested primarily through systematic risk. In contrast, we observe no association between corporate taxes and idiosyncratic risk, nor any association between personal taxes and systematic or idiosyncratic risk. Having demonstrated that corporate taxes are positively associated with systematic risk in equilibrium, we then examine whether firms adjust compensation structures to offset manager-shareholder conflicts associated with greater risk taking. In this second set of tests, we use staggered changes in state corporate taxes to examine how compensation contracts change in response to changes in state taxes. This setting provides several advantages. First, exogenous changes in state tax rates represent a shift in equilibrium providing for relatively clean identification. Second, state-level changes in taxes are staggered across states and time allowing the ability to use firms in unaffected states to establish a credible counterfactual. Third, many states have both increases and decreases in tax rates, which allows us to examine how compensation contracts may differentially change in response to directional changes in state tax rates.

We find that compensation contracts adjust following state corporate tax rate increases but not decreases. In particular, firms pull back on option and equity intensity (i.e., new stock and option grants as a percentage of current-year total compensation) and increase cash intensity (i.e., salary and bonus as a percentage of current-year total compensation). The magnitudes we observe are economically meaningful. Specifically, the average decrease (increase) in option
(cash) intensity in response to a 0.2% increase in state corporate tax rates is 43 (48) percent of the mean change in these compensation components.

Besides our two primary sets of empirical tests, we also conduct a battery of supplemental tests. First, we repeat our compensation structure tests controlling for personal tax rate increases and decreases and the results are largely consistent with our primary tests. Second, we investigate the parallel trends assumption in our compensation structure tests by including lead and lagged measures of corporate tax increases. Our results confirm that the effect of tax increases on compensation design is indeed identified in the manner in which we expect. To reinforce our risk profile results, we also examine whether state corporate tax changes are associated with subsequent changes in new investment. We estimate changes in new investment following Richardson (2006) to assess whether corporate tax increases affect risky investment. The results of this test indicates that revisions to compensation design associated with corporate tax increases mitigate but do not suppress incremental new investment. Finally, we also investigate whether our results vary for the sample of firms that use relative performance evaluation. These tests suggest that benchmarking to a firm’s peers dampens the need to alter compensation related to tax-change-related changes in risk.

Our results provide several contributions to the literature. First, this study adds to the public finance literature on how corporations respond to income taxes. Specifically, beginning with Domar and Musgrave (1944), studies have attempted to discern whether income taxes affect investment. The objective of our study is to help reconcile the seemingly conflicting conclusions in the literature regarding taxes and risk taking and provide insights into how corporate income taxes affect incentive contracting. Our findings are consistent with the theoretical model
constructed by AGHT; increases in income taxes reduce the disutility that managers associate with corporate risk-taking and thereby affect their investment decisions.

While our empirical results are consistent with AGHT’s model, we find that increases in corporate, rather than individual, income taxes are associated with risk-taking. Although we agree with LZZ that corporate taxes are more likely to influence risk-taking, unlike LZZ we find that increases corporate income taxes are associated with increased risk-taking. Moreover, the tax-induced risk-taking that we observe is associated with systematic rather than idiosyncratic risk. Finally, we contribute to the compensation literature by demonstrating that incentive contracting is adjusted in a manner consistent with decreasing manager-shareholder conflicts (Armstrong and Vashishtha 2012).

2. Theory

2.1 Taxes and Risky Investment

LZZ examine whether corporate risk taking is sensitive to changes in state corporate tax rates. LZZ repeat Domar and Musgrave’s (1944) argument that tax increases reduce returns on risky projects (measured by reducing earnings volatility, shortening operating cycles, and commercializing R&D spending) asymmetrically because of loss-offset limits. Consistent with this argument, they report that firms reduce risk taking in response to a tax increase, but they find no response to tax rate reductions.

In contrast to LZZ, AGHT examine the association between the level of R&D expenditures and the combined federal and state personal tax rates at the corporate headquarters. They predict and find that higher levels of risk-taking (R&D) are associated with firms whose managers are subject to higher levels of personal taxes. Their predictions are based on a model suggesting that risk averse managers subject to higher tax rates will seek more risky investments as they trade
off reduced returns and reduced risk (from risk sharing with the government). They conclude “that the effect of taxes on risk-taking depends on the specific characteristics of the firm and the manager” (Armstrong et al., p. 9).

AGHT argue that personal tax rates are distinct from corporate rates for three reasons (page 16). First, they argue the personal tax rate of the executive does not depend on corporate performance (for example, poor firm performance does not generally reduce executive salaries). Second, they argue that the corporate tax rate and investments are endogenously determined. In other words, even when plausibly exogenous variation in state rates are used to identify tax rate effects, the state corporate tax rate is a poor proxy for marginal rates especially given nexus rules at the state level. Finally, they argue that if corporate taxes are borne by shareholders, then taxes should primarily affect systematic risk (because shareholders are diversified, they are risk neutral with respect to idiosyncratic risk). Instead, because managers are not diversified, personal taxes should primarily affect idiosyncratic risk.

Armstrong et al. acknowledge that besides affecting risk-taking behavior (a direct effect), tax rate changes may also affect rewards from incentive compensation contracts or managerial equity holdings (an indirect effect). Citing papers that report that large changes in the federal tax rate are not associated with changes in incentive arrangements or equity holdings, they argue that any indirect effect is likely insignificant because of the relatively small changes in state tax rates. Armstrong and Vashishtha (2012) examine whether risky incentives (vega) are more likely to motivate risk-averse CEOs to increase systematic rather than idiosyncratic risk. They argue that increases in systematic risk can be hedged by a CEO by trading the market portfolio. Hence, they predict and find that vega incentivizes CEOs to increase systematic risk but not idiosyncratic risk.
In Figure 1, we illustrate how taxes effect risky firm-level investment using a numerical example. Following from the example in Armstrong et al., we document how the LZZ story and the AGHT story effect the after-tax payoff to several risky investment projects. Projects A and B represent projects where both potential outcomes are profitable. Project C represents a project where one potential outcome is profitable and the other is not, but project C has the same expected payoff as Project B ($3.30 under full loss offset).

The key to the LZZ story is the notion that firms are not able to immediately use their losses (or net operating losses “NOLs”). Since the firm is risk-neutral, only the mean project payout is considered in project selection (i.e., the disutility of risk is ignored). In comparing the after-tax payout of project B and C, the inability to use the firm’s NOLs reduces the payoff from $3.30 to $3.10. If the firm were able to immediately use its NOLs, the expected payoff of Project B and Project C would be identical (in both cases $3.30). It is only when the NOLs are not able to be used (i.e., the “no offset” column) that the risky investment becomes more costly. If the firm is able to either immediately carry the NOLs back and use the deduction to generate a tax refund or carry the NOLs forward and use them quickly, then the risk-sharing story put forth in Domar and Musgrave is attenuated.

This figure also highlights the association between taxes and risky investment when the agent is risk averse. Comparing the utility from projects A and B illustrate how the disutility of risk is reduced in the presence of taxes. Before taxes, the payoff of Project A ($4.43) exceeds that of Project B ($3.98). However, after taxes, the payoff from Project B ($2.75) dominates Project A ($2.67) by $0.08. Under a higher tax rate (45%) there is an increased sharing of risk

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1 AGHT presume that managers are risk-averse with a mean-variance utility of the form \( U(\mu, \sigma^2) = \alpha \mu(i) - \beta \sigma^2(i) \) where a greater \( \beta \) implies a greater disutility of risk per a unit of variance. We follow AGHT’s example and assume that the manager’s \( \alpha = 1 \) and \( \beta = 0.3 \).
with the government the spread between the after-tax payoff of Projects A ($2.45) and B ($2.57) grows to $0.12. This means that as tax rates increase (decrease) the differential payoff from choosing riskier projects will increase (decrease) as well. AGHT compare Projects A and B to illustrate the role of the manager’s individual income taxes on investment, but it seems equally applicable to corporate-level income taxes.

It seems reasonable to believe that corporate-level taxes are of first-order importance in management’s investment decisions. While we do believe that individual-level taxes have a role, we believe that they could be of second-order importance for two reasons. First, any return to investment will immediately be subject to corporate-level taxation assuming the corporation has no option to defer taxation on its investment returns. Second, the manager is only subject to taxation indirectly on returns to corporate investment. To the extent that management is compensated using equity compensation, then the manager is only taxed when equity either vests (as with restricted stock), is exercised (as with options) or is sold. In each situation, management will be taxed on the profits from the corporate investment in the future.

Figure 1 also illustrates that the impact of the asymmetric loss offset in LZZ is dominated by the benefits of the reduction in the disutility of risk. A comparison of Project C as the tax rate increases from 40% to 45% shows that the loss of payoff due to the firm’s inability to use the NOLs is $0.03.\textsuperscript{2} However, the payoff of the project increases from -$1.26 to -$0.81 with full loss offset (-$1.94 to -$1.53 with no offset) suggesting the cost of risk aversion usurps the effects of the asymmetric treatment of losses.

\textsuperscript{2} Under the 40% tax rate the lack of loss offset results in the average payout declining from $3.30 to $3.10 (a decline of $0.20). But under the 45% tax rate the lack of loss offset results in the payout declining from $3.03 to $2.80 (a decline of $0.23).
2.2 Risk and Compensation

Compensation research generally suggests that the convexity in options contracts incentivizes managers to undertake risky investment (e.g., Smith and Stulz, 1985). However, the actual relation between stock options and risk-taking may be ambiguous (e.g., Lambert, Larcker and Verrecchia, 1991; Carpenter, 2000; Lewellen, 2006; Armstrong et al., 2013). Although an option’s vega increase the payoff per a unit of risk, an option’s delta is adversely affected by risky investment. As such, almost all recent work on managerial incentives and risk include both delta and vega in their empirical specifications. Despite the countervailing effects of incentives, in general the empirical literature documents a positive association between vega and firms’ project risk.

More recent work such as Henderson (2005) and Armstrong and Vashishtha (2012) suggest that not all risk has the same incentive effects. Because managers are under-diversified with regard to their employer’s stock, options may not lead managers to invest in projects that generate idiosyncratic risk. Although shareholders are able to diversify away idiosyncratic risk, managers may only be able to insulate themselves from incremental systematic risk by hedging. Because managers typically hold large equity positions in their firm, they are unable to mitigate firm-specific risk. Essentially, management and shareholders are at odds in terms of the “flavor” of risk that they would like to generate through investment. All else equal, this work suggests that when management’s investment risk preferences are increased, managers are more likely to select projects that have a larger increase the firm’s systematic risk.

Presuming that compensation committees are aware of the risk-related principal-agent problem, manager’s compensation should be adjusted when managers’ risk preferences change. One such situation might be tax rates changes. If tax rate changes affect the risk preferences of
management, we anticipate that the vega of manager’s compensation could be modified by the
board. Studying vega effectively allows us to distinguish between LZZ’s results and AGHT’s
results. If increases in corporate tax rates, for example, lead to manager’s seeking less risky
projects, then we anticipate that the board should increase manager’s exposure to vega. But if
corporate tax rate increases lead to more risky investment, then the board should pull back on the
intensity of options and equity in management’s compensation contract.

3. Methodology

3.1 Sample

Our sample is derived primarily from the intersection of the Compustat, CRSP, and
ExecuComp databases, spanning fiscal years 1994-2015. We begin our sample in 1994 as
ExecuComp has complete compensation coverage beginning in 1993 and, in some specifications,
we use lagged measures of compensation incentives. We hand collect historical corporate and
personal state tax rates from state statutes and the National Bureau of Economic Research. We
also hand collect various state-level data (economic growth, political affiliation with
gubernatorial and/or legislative control, corporate NOL carryover rules) from the US Census and
the Book of the States. Table 1 Panel A (Panel B) provides a time (industry) distribution of our
sample firms. Overall, our sample firms are evenly distributed across fiscal years and reflect
broad industry representation.³

3.2. Risk Profile Measures

We follow the procedures outlined in Armstrong and Vashishttha (2012) and use three
measures to examine firm risk profile. Importantly, as Armstrong and Vashishttha (2012)

³ For ease of exposition, we present one-digit Standard Industrial Classification (SIC) code in this table, however we
control for industry at a more refined level (two-digit SIC) in all regressions.
explain, realized returns reflect not only CEO risk-taking but also various aspects of the firm’s information environment. Therefore, we use segment data to construct imputed measures of firm risk that more accurately capture what the CEO would have anticipated given the current operating structure of the firm. The intuition underlying this approach is that the firm represents a portfolio of industry segments, and the CEO can choose a desired level of risk taking by altering these segments (investing in new industries, divesting in current industries, or altering the weight of current industry segments).

We use the Compustat Segments and CRSP databases to construct our measures of risk profile. This process involves three steps. First, we compute a value-weighted imputed monthly return for each firm based on the number of industry segments in which the firm operates and the book value of assets of each segment:

\[
\hat{r}_{jt} = \sum_{i=1}^{n_j} \left( \frac{A_j^i}{A_j} \right) r_{t}^i
\]  

(1)

We define \(n_j\) as the number of industry (two-digit SIC) segments firm \(j\) operates in at the end of the recent fiscal year. \(A_j^i\) is the total book value of assets for industry segment \(i\) for firm \(j\), and \(A_j\) is the total book value of assets of firm \(j\) at the end of the recent fiscal year. \(r_{t}^i\) is the value-weighted average monthly return for all Compustat firms operating exclusively in industry \(i\) at the end of the recent fiscal year. \(\hat{r}_{jt}\) is therefore the imputed monthly return for firm \(j\) during month \(t\).

Next, we compute the variance of imputed monthly returns (\(\hat{r}_{jt}\)) over the previous 60 months (requiring at least 20 months of data) using the Fama and French (1993) three factor model estimated for each firm-year:
Finally, we define total risk \((TOTALRISK)\) as the standard deviation of monthly imputed returns \((r_{j,t})\). We define systematic risk \((SYSRISK)\) as the square root of the variance of imputed returns explained by the Fama-French three factor model, and idiosyncratic \((IDIORISK)\) as the square root of the variance of imputed returns not explained by the Fama-French three factor model. We log-transform these risk profile measures to mitigate the influence of outliers.

### 3.3. Compensation Structure Measures

We follow Humphrey-Jenner et al. (2016) and use three measures of compensation structure: \(OPTION\ INTENSITY\), \(EQUITY\ INTENSITY\), and \(CASH\ INTENSITY\). \(OPTION\ INTENSITY\) equals the proportion of the CEO’s total compensation comprised of new option grants, \(EQUITY\ INTENSITY\) equals the proportion of the CEO’s total compensation for the year that is comprised of new stock and option grants, and \(CASH\ INTENSITY\) is the proportion of the CEO’s current-year compensation received in the form of cash (salary and bonus). For all of these measures, total compensation includes salary, bonus, and all other compensation, including the total value of restricted stock and option grants and long-term incentive payouts (ExecuComp data item tdc1). Option grants are valued using Black-Scholes methodology prior to FAS 123R (now codified in ASC 718) and grant date fair value after FAS 123R (i.e., ExecuComp data items option_awards_blk_value and option_awards_fv, respectively). Stock awards are measured as the grant-date fair value (ExecuComp data item stock_awards_fv).

### 3.4. Tax Rates

In our risk profile regressions, we examine (combined federal and state) tax rates of both CEOs and firms to establish which taxes (i.e., personal or corporate) are associated with different firm-risk structures. \(MGRRATE\ (CORPRATE)\) equals the top personal (corporate) rate, adjusted...
for the deductibility of state taxes at the federal level. We collect historical personal tax rates from NBER and historical corporate tax rates from state statues from 1990 through the end of our sample period.

In our compensation structure regressions, and to buttress our risk profile results, we sharpen our identification and use plausibly exogenous variation in state-level taxes to investigate whether firms adjust CEO compensation in response to a state-level rate change. Because our prediction is that firms will adjust CEO compensation structures following a corporate tax rate increase, we define $\text{TAXINCAMT (TAXDECAMT)}$ as the magnitude of the top state corporate tax rate increase (decrease) in the firm’s state of headquarters. In further tests, we consider the magnitude of top state personal tax rate changes.

3.5. Empirical Design

3.5.1 Risk Profile

We investigate our research questions in two stages. First, we examine whether (in equilibrium) firm risk profile is associated with corporate or personal tax rates. Accordingly, we estimate the following ordinary least squares regression (firm and year subscripts are omitted for brevity):

$$FIRM RISK = \alpha + \gamma_1 MGR RATE + \gamma_2 CORP RATE + X \delta + \varepsilon$$ (3)

$FIRM RISK$ denotes total risk ($TOTAL RISK$), systematic risk ($SYS RISK$), or idiosyncratic risk ($IDI ORISK$). $MGR RATE$ and $CORP RATE$ are defined in the previous section. $FIRM RISK$ is measured as of year $t+1$, and tax rates are measured as of year $t$. $X$ denotes a vector of control

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4 Importantly, because Compustat backfills headquarters locations, we use the historical headquarters locations for our sample firms.
variables, all measured as of year $t$, and informed by prior research (e.g., Armstrong and Vashsishtha 2012, Armstrong et al. 2019, Coles et al. 2006, Guay 1999).\(^5\)

We control for firm size as the natural logarithm of total assets (Compustat item $at$) to control for differential risk taking of small and large firms (e.g., Guay 1999, Coles at al. 2006, Low 2009). $LEV$ is total (long-term and short-term) debt scaled by total assets (Compustat items $(dltt+dlc)/at$). Leverage controls for differential incentives and abilities for risk taking associated with debt usage (e.g., Jensen and Meckling 1976, Leland 1998, Lewellen 2006). We control for variation in investment and growth opportunities and profitability (e.g., Bhagat and Welch 1995, Opler et al. 1999, Coles et al. 2006). Specifically, we include the market-to-book value of equity ratio (Compustat data items $(prcc_f^*csho)/ceq$), growth in total assets (Compustat item $at$), cash holdings (Compustat item $che/at$), return on assets (Compustat items $oibdp/at$), annual stock return inclusive of dividends, and annualized standard deviation of daily stock returns.

We capture various characteristics of the CEO, such as age, tenure, cash pay, and the sensitivity of the CEO’s option and stock portfolio to a 1% change in stock price and stock volatility, respectively (e.g., Guay 1999, Core and Guay 1999, Coles et al. 2006, Armstrong et al. 2019).\(^6\) We also control for several state-level factors that could influence risk-taking, such as state economic growth, whether the state legislature has a republican majority, whether the governor is a republican, and state rules related to net operating loss carrybacks and carryforwards (Armstrong et al. 2019). Finally, we include fiscal year and industry (two-digit SIC) fixed effects in all regressions, linear and quadratic trends, and standard errors are clustered by state (Armstrong et al. 2019, Ljungqvist et al. 2017).

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\(^5\) All variables are defined in the appendix.

\(^6\) We follow the procedures outlined in Core and Guay (2002) and use the one-year approximation method to compute delta and vega.
3.5.2 Compensation Structure

In our second set of tests, we examine whether CEO compensation structures respond to tax rate changes. We use plausibly exogenous variation in state-level tax rates to provide sharper identification. Accordingly, we estimate variations of the following first-differences regression (firm and year subscripts are omitted for brevity):

$$\Delta \text{COMPSTRUCTURE} = \alpha + \gamma_1 \text{TAXINCAMT} + \gamma_2 \text{TAXDECAMT} + \Delta \text{X} \delta + \varepsilon$$ (4)

COMPSTRUCTURE denotes the proportion of the CEO’s annual compensation comprised of option grants (OPTION INTENSITY), stock and option grants (EQUITY INTENSITY), or cash (CASH INTENSITY). TAXINCAMT and TAXDECAMT capture the magnitude of state corporate tax rate increases and decreases, respectively. COMPSTRUCTURE is measured as of year $t+1$, and state-level tax rate changes and all control variables are measured in year $t$. $\Delta$ denotes the first-difference operator, defined as the change in a given independent (dependent) variable from year $t-1$ to $t$ (year $t$ to $t+1$). We follow related research (e.g., Coles et al. 2006, Humphrey-Jenner et al. 2016) and control for firm size, market-to-book value of equity ratio, asset growth, research and development expenditures, operating profitability and stock return, leverage, cash holdings, and annualized stock volatility. The variable appendix contains detailed definitions.

Because we estimate these regressions as first differences, we include two indicator variables: NEWCEO and YOUNGCEO. NEWCEO equals one if the CEO has been in the current position for less than two years, zero otherwise. YOUNGCEO equals one if the CEO is younger than the sample median CEO (56 years old), zero otherwise. We include time-varying state-level controls in all regressions, linear and quadratic trends, fiscal year and industry (two-digit SIC) fixed effects, and we cluster standard errors by state (Armstrong et al. 2019, Ljungqvist et al. 2017).
4. Results

4.1 Descriptive Statistics

Table 2 reports summary statistics for the primary variables used in our main analyses. Our sample sizes vary based on the regression sample (i.e., risk profile or compensation structure) due to data availability. For example, the additional data requirements to compute our imputed firm risk profile measures (e.g., non-missing Compustat segments data, adequate historical stock return data, etc) result in a smaller regression sample than what is used for our compensation structure regressions (17,679 versus 20,744 firm-year observations).

Our summary statistics are consistent with related research. For example, the mean of TOTALRISK, SYSRISK, and IDIORISK are 0.062, 0.048, 0.036, respectively, which are comparable with Armstrong and Vashishtha (2012). The mean of OPTION INTENSITY, EQUITY INTENSITY, and CASH INTENSITY are 0.261, 0.446, and 0.388, respectively, which are consistent with Humphrey-Jenner et al. (2016). The mean personal tax rate is 41.5 percent and the mean corporate tax rate is 39.4 percent, which is consistent with Armstrong et al. (2019). Finally, the descriptive statistics for the remaining variables are consistent with related research (e.g., Armstrong et al. 2019, Armstrong and Vashishtha 2012; Coles et al. 2006; Ljungqvist et al. 2017).

4.2 Risk Profile Regressions

Table 3 reports regression results examining how corporate and personal taxes are related to firm risk profile in equilibrium. Examining the first regression (Column 1), we observe that corporate tax rates (CORPRATE) are associated with greater firm risk (Estimate = 0.296, p-value < 0.1). In contrast, the coefficient estimate of MGRRATE is positive but statistically insignificant. This finding suggests that corporate (not personal) taxes are associated with firm
risk-taking. Importantly, this regression controls for various firm-level and manager-level characteristics, as well as time-varying state-level characteristics.

Decomposing total firm risk into systematic and idiosyncratic components, we observe in Column (2) that corporate taxes are associated with greater systematic risk (Estimate = 0.312, \( p \)-value < 0.05) but not greater idiosyncratic risk, as the coefficient of \( \text{CORPRATE} \) is insignificant in Column (3). Interestingly, we observe no relation between personal taxes and firm risk for any of our measures; however, we observe a positive but statistically insignificant coefficient of \( \text{MGRRATE} \) in the total risk and idiosyncratic risk regression. Overall, these regression results indicate that corporate taxes are associated with greater firm risk-taking, primarily through greater systematic risk. This finding confirms speculation in the literature that corporate taxes are associated more with systematic risk, but not idiosyncratic risk. Next, we turn our attention to examining whether corporate taxes are associated with changes in compensation structure.

4.3 Compensation Structure Regressions

We find in our first set of tests that corporate taxes are positively associated with total (and systematic) risk, which raises questions about whether firms adjust compensation structures to offset the additional costs associated with greater risk-taking when corporate taxes increase. Because systematic risk can aggravate shareholder-manager conflicts, we conjecture that firms adjust the compensation structure of CEOs by shifting away from equity toward cash. Table 4 reports the results from estimating these regressions.

In the first three regressions (Columns 1 through 3), we examine only the magnitude of state corporate tax rate increases, whereas in the remaining regressions (Columns 4 through 6) we include the magnitude of state corporate tax rate decreases. Results indicate that state corporate tax rate increases are associated with a decrease in option grants as a percentage of total
compensation in the following year (Column 1: Estimate = -1.599, \( p \)-value < 0.05). A one-standard deviation increase in state corporate tax rates (i.e., 0.24\%) is associated with 0.38\% decrease in option intensity, which is approximately 43\% of the mean change in option intensity for our sample firms. We continue to observe this effect when controlling for the magnitude of corporate tax rate decreases (which are always insignificant).

Examining changes in equity intensity (Columns 2 and 5), we observe that state corporate tax rate increases are associated with a decrease in equity (i.e., stock and option) intensity in the following year (Column 2: Estimate = -3.185, \( p \)-value < 0.01; Column 5: Estimate = -3.206, \( p \)-value < 0.01). A one standard deviation increase in state corporate tax rates is associated with a 0.76\% decrease in equity intensity in the following year (approximately 92\% of the sample mean change in equity intensity). These results suggest that firms pull back on both stock and option awards (as a percentage of total compensation) following state tax rate increases.

We further examine how CEO compensation contracts are changing in response to state tax rate changes by examining changes in cash intensity (Columns 3 and 6). Coefficient estimates are positive which suggests that state corporate tax rate increases are associated with an increase in cash intensity in the following year. However, neither of the coefficient estimates are significant at conventional levels of confidence. Thus, our results indicate that firms shift away from equity pay following corporate tax rate increases. This pattern of results is consistent with firms aiming to reduce risk-taking incentives to mitigate the aggravated manager-shareholder conflicts associated with greater risk-taking.

To investigate the parallel trends assumption, we estimate equation (4) including a lead and lagged measure of \( TAXINCAMT \) to test for pre-trends and reversals, respectively. We use \( TAXINCAMT \) indexed at year \( t+1 \) to examine the parallel trends in compensation structure prior
to state corporate tax rate changes. We use $TAXINCAMT$ indexed at year $t-1$ to examine whether compensation structure is further adjusted in following year. For example, the change to compensation structure that we document in our main tests in year $t+1$ might represent a partial adjustment as firms might continue to scale back on equity and option awards or possibly reverse the observed adjustment in the following year.

The results indicate that our treatment and control firms (i.e., firms that experience a state corporate tax change and those that do not) have the same trend in compensation structure, as evidenced by the insignificant coefficient estimate of $TAXINCAMT$ (year $t+1$). This suggests that, in the year prior to an anticipated change in state corporate tax rate increases, there are no differences between firms headquartered in states that will be affected by a state tax change and those in other states. This test helps alleviate concerns that there are unobserved differences in firms in affected states that are driving our results, not state corporate tax changes per se. Further, the insignificant coefficient on $TAXINCAMT$ (year $t-1$) indicates that the change in compensation structure that we observe is indeed sourced to the year of the tax rate change and not subsequently reversed. This result helps dispel concerns that our findings reflect transitory adjustments to compensation structure rather than a shift in equilibrium.

5. Additional Analyses

5.1 Personal Tax Rate Changes

Our main results demonstrate that corporate taxes are associated with systematic risk-taking and that corporate tax rate increases lead to changes in compensation structure. AGHT argue that personal taxes are associated with idiosyncratic risk and, because shareholders are risk neutral with respect to idiosyncratic risk, personal taxes should have no effect on compensation structure. In this section, we use staggered increases in state personal tax rates as a falsification
test. Our variable of interest in this specification is *PERSINCAMT*, which is the magnitude of state-level increases in personal tax rates from year \( t-1 \) to \( t \). The dependent variables continue to be changes in option intensity, equity intensity, and cash intensity from year \( t \) to \( t+1 \). With the exception of *NEWCEO* and *YOUNGCEO* (which are measured at year \( t \)), the control variables are measured as changes from year \( t-1 \) to \( t \). We continue to include time-varying state-level controls, linear and quadratic trends, and fiscal year and industry fixed effects. Table 5 reports the results.

The results of estimating these regressions is presented in Table 5. In all three regressions, we do find only inconsistent evidence that personal tax rate increases are associated with changes in compensation structure. Specifically, the coefficient estimate of *PERSINCAMT* is negative in the option and equity intensity regressions, and positive in the cash intensity regressions, but statistically insignificant in all but one of three specifications. The (lack of) results from this specification support our main results demonstrating that corporate tax rates (and changes) are associated with systematic risk and compensation structure.\(^7\)

5.2 Changes in New Investment

Having demonstrated that corporate tax rate increases in year \( t \) are associated with revisions to compensation structure in year \( t+1 \), we now examine whether state corporate tax changes are associated with subsequent changes in new investment. We depart from AGHT and LZZ by using the investment measure of Richardson (2006). This measure, *NEWINVEST*, captures the incremental investment beyond that which is required to maintain assets already in place, and thus provides a better metric to assess whether taxes affect “risky” incremental investment. We

---

\(^7\) In untabulated tests, we include personal tax rate changes in our main regressions and continue to find results for corporate tax rate changes.
continue to use state corporate tax rate changes as identification and estimate our investment regressions as first-differences to more accurately establish a causal relation between corporate taxes and subsequent investment. Table 6 reports the results. We note a slight increase in sample size (26,291 firm-year observations), as we are not requiring leads and lags of tax rate changes in this analysis. As with our other changes specifications, we continue to include time-varying state-level controls, linear and quadratic trends, and fiscal year and industry fixed effects.

Results reveal that state corporate tax increases are associated with an increase in subsequent investment (Column 1: Estimate = 0.507, p-value < 0.10). In contrast, personal tax rate increases are associated with reductions in subsequent investment (Column 1: Estimate = -0.608, p-value < 0.10). This latter result suggests that prior research could be capturing a spurious relation between taxes and planned investment expenditure. Economically, a one-standard deviation increase in state corporate tax rates (0.24%) is associated with a 0.12% increase in new investment in the subsequent year (which is approximately 24% of the mean change in new investment). These results suggest that the revisions to compensation design we document in our main tests mitigate but do not suppress incremental new investment. This finding is consistent with firms balancing concerns over excessive risk-taking with shareholder preferences for value maximization, as managers continue to seek new profitable investment opportunities.

5.3 Replication using RPE Subsamples

Our main results demonstrate that corporate tax rates are positively associated with systematic risk and that state corporate tax rate increases are associated with revisions to compensation design. Park and Vrettos (2015) report evidence that relative performance evaluations (RPE) in incentive contracts encourages CEOs to prefer investments increasing idiosyncratic risk over investments increasing systematic risk. Using this insight, we replicate
our two primary tests for firms with and without RPE incentive contracts. Based on Park and Vrettos, we expect that our results will be weaker (stronger) for firms (not) employing RPE contracts.

The results of replicating our risk profile and compensation structure tests using RPE contracts to identify subsamples are presented in Tables 7 and 8, respectively. These regression results should be viewed with caution because the samples are limited to firms with RPE incentive information available on Institutional Shareholder Services on WRDS. With that caveat in mind, we observe in Table 7 that neither corporate nor manager tax rates are significantly associated with firm risk for the RPE=1 subsample. In contrast, in the RPE=0 subsample the coefficient estimates for corporate tax rates, but not manager tax rates, are positively associated with firm risk including increases in both systematic and idiosyncratic components. Table 8 presents results from replicating the compensation structure tests for the RPE=1 and RPE=0 subsamples. Consistent with our primary tests, we observe the RPE=0 subsample that state corporate tax rate increases are associated with a decrease in both stock and option intensity in the following year. In contrast, in the RPE=1 subsample we only observe a significant decrease in stock intensity associated with state corporate tax rate increases.

6. Conclusion

In this study, we endeavor to reconcile the apparently divergent effect of taxation on risk-taking reported in these two studies. Assuming that taxes shift the manager’s relative proclivities for risk-taking, we investigate whether risk is affected, and if so what type of risk (systematic or idiosyncratic) is affected. We then examine whether executive incentives in compensation contracts are adjusted for changes in risk-taking. We predict and find that corporate taxes are positively associated with systematic (but not idiosyncratic) risk. Consistent with this finding, we
also observe firms shifting away from CEO equity compensation toward greater cash compensation following state corporate tax rate increases. In contrast, we observe no changes to CEO compensation structure following personal tax rate changes, consistent with personal tax rates having no association with systematic risk. Exploiting plausibly exogenous changes in state tax rates, we also report that changes in new investment are associated with increases in state corporate income taxes rather than state personal income taxes. Overall, our findings provide novel insight into which taxes affect risk-taking, and how taxes can affect the design of compensation contracts and the allocation of firm resources.
References


Variable Appendix

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
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</thead>
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<tr>
<td><strong>A.1. Dependent Variables (measured at year t+1)</strong></td>
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</tr>
<tr>
<td><strong>A.1.1 Firm Risk measures</strong></td>
<td></td>
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<tr>
<td>TOTALRISK</td>
<td>Standard deviation of firm returns, following Armstrong and Vashishtha (2012)</td>
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<td>SYSRISK</td>
<td>Square root of the variance of firm returns explained by the Fama-French three factor model, following Armstrong and Vashishtha (2012)</td>
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<td>IDIORISK</td>
<td>Square root of the residual variance of firm returns explained by the Fama-French three factor model, following Armstrong and Vashishtha (2012)</td>
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<td><strong>A.1.2 Compensation measures</strong></td>
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<tr>
<td>OPTION INTENSITY</td>
<td>Proportion of CEO compensation that comes from option grants</td>
</tr>
<tr>
<td>EQUITY INTENSITY</td>
<td>Proportion of CEO compensation that comes from stock and option grants</td>
</tr>
<tr>
<td>CASH INTENSITY</td>
<td>Proportion of CEO compensation that comes from cash-based awards</td>
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<td><strong>A.1.3 Investment measure</strong></td>
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<td>New Invest</td>
<td>New incremental investment following Richardson (2006)</td>
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<td><strong>A.2. Independent Variables (measured at year t)</strong></td>
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<td>MGRRATE</td>
<td>Top personal combined federal and state tax rate, adjusted for the deductibility of state taxes</td>
</tr>
<tr>
<td>CORPRATE</td>
<td>Top corporate combined federal and state tax rate, adjusted for the deductibility of state taxes</td>
</tr>
<tr>
<td>TAXINCAMT</td>
<td>Magnitude of corporate tax rate increase in the firm's HQ state</td>
</tr>
<tr>
<td>TAXDECAMT</td>
<td>Magnitude of corporate tax rate decrease in the firm's HQ state</td>
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<td><strong>A.2.1 Firm risk and investment controls</strong></td>
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<td>LOGASSET</td>
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<td>Market-to-book value of equity</td>
</tr>
<tr>
<td>ASSETGR</td>
<td>Growth in total assets</td>
</tr>
<tr>
<td>CASH</td>
<td>Total cash scaled by lagged assets</td>
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<td>ROA</td>
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</tr>
<tr>
<td>RET</td>
<td>Annual stock return inclusive of dividends</td>
</tr>
<tr>
<td>STOCKVOL</td>
<td>Annualized daily stock return volatility over the fiscal year</td>
</tr>
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<td>LOGAGE</td>
<td>Natural log of CEO age</td>
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<tr>
<td>LOGTENURE</td>
<td>Natural log of CEO tenure</td>
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<td>LOGCASHPAY</td>
<td>Natural log of cash (salary and bonus) compensation</td>
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<td>Natural log of the CEO's option portfolio to a 1% change in stock volatility</td>
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<td><strong>A.2.2 Compensation controls</strong></td>
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<td>Annual stock return inclusive of dividends</td>
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<td>Total cash scaled by lagged assets</td>
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<tr>
<td>STOCKVOL</td>
<td>Annualized daily stock return volatility over the fiscal year</td>
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<td>Variable</td>
<td>Description</td>
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<td>-----------</td>
<td>--------------------------------------------------</td>
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<td>NEWCEO</td>
<td>Equals one if the CEO has been in the current position for less than two years</td>
</tr>
<tr>
<td>YOUNGCEO</td>
<td>Equals one if the CEO is younger than 56 years old</td>
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Table 1
Sample Composition
Panel A: Fiscal year distribution

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<th>Total %</th>
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Panel B: Industry distribution

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<td>3 (Manufacturing, machinery, electronics)</td>
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<td>4 (Transportation, communications, utilities)</td>
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### Table 3
Tax Rates and Risk Profile

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<th>Idiosyncratic risk</th>
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<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
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<td>(0.152)</td>
<td>(0.152)</td>
<td>(0.168)</td>
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<td>(0.146)</td>
<td>(0.146)</td>
<td>(0.160)</td>
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<td>-0.033***</td>
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<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.007)</td>
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<td>Leverage</td>
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<td>0.113***</td>
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<td></td>
<td>(0.034)</td>
<td>(0.036)</td>
<td>(0.037)</td>
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<td>MB</td>
<td>0.002**</td>
<td>0.002*</td>
<td>0.002**</td>
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<td>(0.001)</td>
<td>(0.001)</td>
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<td>0.005</td>
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<td>(0.013)</td>
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<td>(0.028)</td>
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Controlling for Personal Tax Rate Changes

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Table 6
Tax Rates and New Investment

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<td>-0.186***</td>
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State-level 
controls? Yes Yes Yes Yes
Year FE? Yes Yes Yes Yes
Industry FE? Yes Yes Yes Yes
N 26,291 26,291 26,291 26,291
R-squared 0.239 0.239 0.239 0.239
## Table 7
### Tax Rates and Risk Profile, split by RPE usage

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<td>Idiosyncratic risk</td>
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<td>(0.041)</td>
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<td>0.002**</td>
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<td>(0.003)</td>
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<td>(0.001)</td>
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<td><strong>AssetGrowth</strong></td>
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<td>(0.019)</td>
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<td>0.036</td>
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<td>(0.048)</td>
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<td>(0.004)</td>
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<td><strong>Log(Age)</strong></td>
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<td>-0.002</td>
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<td>(0.036)</td>
<td>(0.011)</td>
<td>(0.010)</td>
<td>(0.015)</td>
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<tr>
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<td>(0.004)</td>
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<td>(0.005)</td>
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<td><strong>Log(Vega)</strong></td>
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<td>0.000</td>
<td>-0.011</td>
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<td>0.004</td>
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<td>(0.011)</td>
<td>(0.010)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.005)</td>
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State-level controls? Yes Yes Yes Yes Yes Yes
Year FE? Yes Yes Yes Yes Yes Yes
Industry FE? Yes Yes Yes Yes Yes Yes
N 660 660 660 7,570 7,570 7,570
R-squared 0.847 0.819 0.838 0.536 0.560 0.537
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<th>ΔEQUITY INTENSITY</th>
<th>ΔCASH INTENSITY</th>
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<td>(0.704)</td>
<td>(0.682)</td>
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<td>(1.012)</td>
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<td>(1.595)</td>
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<td>(0.011)</td>
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<td>(0.015)</td>
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<td>(0.025)</td>
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<td>0.005</td>
<td>0.014***</td>
<td>0.032***</td>
<td>-0.001</td>
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<td>(0.017)</td>
<td>(0.010)</td>
<td>(0.005)</td>
<td>(0.007)</td>
<td>(0.006)</td>
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<tr>
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<td>-0.001</td>
<td>-0.004</td>
<td>0.003</td>
<td>0.015***</td>
<td>-0.010***</td>
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<tr>
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<td>(0.010)</td>
<td>(0.011)</td>
<td>(0.008)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
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State-level controls? | Yes | Yes | Yes | Yes | Yes | Yes |
Year FE? | Yes | Yes | Yes | Yes | Yes | Yes |
Industry FE? | Yes | Yes | Yes | Yes | Yes | Yes |
N | 897 | 897 | 897 | 9,275 | 9,275 | 9,275 |
R-squared | 0.057 | 0.071 | 0.094 | 0.010 | 0.023 | 0.019 |
Figure 1: The Effects of Taxes and Tax Rate Changes on the Payoff and Utility from Risky Investment

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<th>Tax</th>
<th>Payoff</th>
<th>No Tax</th>
<th>Tax</th>
<th>Payoff</th>
<th>Tax with Loss Offset*</th>
<th>Payoff</th>
<th>Tax with No Loss Offset**</th>
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<td>$4.00</td>
<td>$2.40</td>
<td>$3.25</td>
<td>$1.95</td>
<td>$-1.00</td>
<td>$-0.60</td>
<td>$-1.00</td>
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<td></td>
</tr>
<tr>
<td>50%</td>
<td>B</td>
<td>$5.00</td>
<td>$3.00</td>
<td>$7.75</td>
<td>$4.65</td>
<td>$12.00</td>
<td>$7.20</td>
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<td>$3.30</td>
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<td>$4.43</td>
<td>$2.67</td>
<td>$3.98</td>
<td>$2.75</td>
<td>$-7.18</td>
<td>$-1.26</td>
<td>$-1.94</td>
<td>$-1.94</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This figure presents the utility of from Projects A, B and C assuming that the manager has a mean-variance of the form $U(\mu, \sigma^2) = \alpha \mu(i) - \beta \sigma^2(i)$ and a disutility of risk ($\beta$) of 0.3.

*Under Loss Offset, it is assumed that any losses generated can immediately be used to shield current income (e.g., when the losses can be immediately carried back or used the next period). **With No Loss Offset, any losses generated cannot be utilized.