Payout Taxation and Corporate Investment: The Agency Channel*

Song Ma

ABSTRACT

This paper demonstrates the agency channel through which payout taxation affects corporate investment. Lower payout taxes increase managers' cash flow rights to the firm via managerial ownership, which further aligns shareholder-manager incentives but exacerbates managerial risk exposures to the firm. I develop a framework to test this channel and provide supporting evidence using the setting of innovation investments around the 2003 Dividend Tax Cut. Aligning incentives increases innovation inputs and outputs, but aggravated managerial risk aversion impedes innovation quantity and shifts innovation to safer and more incremental directions. I also explore underlying operational channels and interactive mechanisms.

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1. Introduction

Payout taxation, in the form of dividend or capital gains taxes, is at the center of the discussion on tax policies to support investment and growth (Poterba and Summers, 1985). In the Jobs and Growth Tax Relief Reconciliation Act of 2003 (JRTRRA), President Bush projected that the tax cut would provide "capital to build factories, to buy equipment, hire more people." Relatedly, one key tax policy to stimulate entrepreneurial investments, Section 1202 of the Internal Revenue Code, functions through exempting dividend and capital gains taxes associated with small businesses.

In classical theory, payout taxation impacts investment through the cost of capital channel. Lower payout taxes decrease firms' cost of capital (Harberger, 1962; Feldstein, 1970; Becker, Jacob, and Jacob, 2013; Lin and Flannery, 2013), which can in turn positively affect investment. However, recent studies document a near-zero effect of payout tax reform on average investments (Yagan, 2015) and provide other evidence that is difficult to explain using the above reasoning (Chetty and Saez, 2005; Li, Sun, and Yannelis, 2016). This suggests that the relationship between payout taxation and investment may go beyond the cost of capital mechanism, and calls for a better understanding of the question.

This paper enters the picture by testing a new channel through which payout taxation affects the level and composition of corporate investment: its impact on the intensity of agency conflicts between shareholders and self-interested risk-averse managers. Managers typically own stocks of their employer firm, through which they have cash flow rights to the firm from dividends and capital gains.[1] Lowering payout taxes increases the cash flow rights associated with managerial ownership. This shock, on the one hand, further aligns incentives and stimulates productive investments. On the other hand, the shock increases the manager's exposure to firm risks modeled as cash flow volatilities and thus exacerbates managerial risk aversion, which in turn discourages risky investments. I use the term "*agency channel*" to describe this mechanism.

In a frictionless world in which both the level and the annual flow of managerial ownership can be flexibly adjusted, the agency channel may not be empirically relevant. This null

[1] In fact, this paper shows that such income is an important component of executive compensation, consisting of about 20% of total compensation.

hypothesis may no longer hold, however, if frictions are present (see Edmans, Gabaix, and Jenter (2017), for a recent review). For example, compensation contracts are typically set periodically with highly rigid terms (Shue and Townsend, 2017). In addition, even if shareholders found it optimal to adjust down the stock of managerial ownership after the tax cut, it would be practically difficult to force managers to sell shares (Groen-Xu, Huang, and Lu, 2016). In the end, the existence of the agency channel would signify those frictions in managerial compensation design.

To identify this agency channel, the paper proceeds in two steps. I first develop a framework to test this channel; I then conduct empirical explorations in a setting where detailed corporate innovation investment activities can be observed and measured. To start, I develop a simple framework of payout and corporate investment. The model builds upon Chetty and Saez (2010) and Cheng, Hong, and Shue (2016), who originally proposes the mechanism, but with some major extensions. The critical feature of the framework is the conflict of interest between shareholders and the manager. I model this agency friction as arising from perk projects (private benefits) and different risk preferences (CARA risk-averse managers and risk-neutral shareholders) in the same fashion as Prendergast (1999) and Bolton and Dewatripont (2005). The manager allocates resources between productive yet risky investments and self-benefiting perks. The equity ownership of the manager provides incentive alignments and deters perk spending, but it also exposes the manager to firm-level risks that discourage productive investment (Holmström, 2017).

A dividend tax cut increases effective managerial ownership in the cash flow sense (but not in the control rights sense). To illustrate, consider a manager who owns 10% of the firm he or she manages and receives compensation only through equity ownership. When the payout tax rate decreases from 35% to 15%, the effective ownership stakes (cash-flow rights, or "keep-rate") increase from 6.5% ($= 10\% \times (1 - 35\%)$) to 8.5% ($= 10\% \times (1 - 15\%)$). This post-cut increase of effective ownership provides extra incentives to forgo private benefit (*incentive alignment*). Meanwhile, however, the manager becomes more exposed to the cash flow volatility from productive investment opportunities (*managerial risk aversion exacerbation*).

Testing the agency channel can be challenging. One cannot draw inferences by tracking investments around tax cut events due to the difficulty in distinguishing tax effects from time trends (Yagan, 2015) and because several confounding channels can be at play. The key insight that helps us cleanly document the agency channel is that the incentive alignment effect and the managerial risk aversion exacerbation effect have heterogeneous intensities across firms with different pre-event managerial ownership levels.

For the *incentive alignment* effect, when managerial ownership is low (consider 0% for the purposes of illustration), the tax cut has little influence on the manager's incentives; when the manager's ownership level is at a very high level (imagine that he or she owns 100% of the firm), the private benefit motives are mild before the shock, leaving little scope for further incentive alignment. Hence, managers with medium ownership stakes in the employer firm are most affected by the incentive provision from the tax cut.[2]

For the *managerial risk aversion exacerbation* effect, the exacerbation increases with managerial ownership. This increase is nonlinear, with particularly strong effects in the high-ownership region. Intuitively, in the stylized setting of a CARA manager and normally distributed investment risks, ownership enters the risk adjustment of the utility ("risk premium" in the compensation literature) as a quadratic term; thus managerial risk aversion is more pronounced in the very high ownership region and is dominated by the incentive alignment effect in low and medium ownership regions.[3]

Combining these two effects establishes the framework for testing whether payout taxation impacts corporate investment through the agency channel. The framework involves testing the incentive alignment effect and the managerial risk aversion exacerbation effect in separate regions. At the *low-managerial-ownership region*, managers are insensitive to the tax cut. At the *medium-managerial-ownership region*, incentive alignments motivate managers to dedicate more resources to productive investments. At the *high-managerial-ownership region*, managerial risk aversion intensifies and managers will lower risky investments, or in other words, play it safe.

[2]This is the major point of Chetty and Saez (2010), Cheng, Hong, and Shue (2016), and Li, Sun, and Yannelis (2016), all of which provide empirical evidence consistent with this proposition using payout policy changes, corporate social responsibility involvements, and firm valuation.

[3]Consistent with this nonlinearity argument, Denis, Denis, and Sarin (1997) and Kim and Lu (2011) show that managerial risk aversion only affects corporate behaviors in the high managerial ownership region, but not in others. See also Amihud and Lev (1981) and Smith and Stulz (1985).

Empirically implementing the test, however, requires overcoming two major challenges. First, we need a major payout tax change. I use the 2003 Dividend Tax Cut. This tax cut reduced the federal dividend income tax rate from 38.6% to 15%, and was one of the largest reforms ever in the US (Yagan, 2015). Besides the size of the cut, the tax cut came largely as a surprise to the market, allowing researchers to treat it more confidently as an exogenous event (Poterba, 2004; Auerbach and Hassett, 2007; Lin and Flannery, 2013). It was also narrow in scope and had negligible effects other than lowering payout taxes (Blouin, Raedy, and Shackelford, 2011).

The second empirical hurdle is to construct a dataset that captures detailed investment quantity, riskiness, and underlying real activities. Natural candidates such as capital expenditures (CAPEX) are imperfectly measured (Becker, Jacob, and Jacob, 2013), and lack granular information to help us distinguish productive versus perk, and safe versus risky investments (Cheng et al., 2016). I overcome this challenge by focusing on the setting of corporate innovation, which presents three main advantages. First, innovation is an important type of investment for corporate and economic growth (Schumpeter, 1942; Peters and Taylor, 2017). Second, both the private benefit motive and managerial risk aversion matter in the innovation setting, fitting the theoretical foundation (Holmstrom, 1989). Third, innovation data are systematically maintained and used in economic research (Hall, Jaffe, and Trajtenberg, 2001). I compile a comprehensive innovation database and construct a wide set of innovation proxies. These variables range from aggregate measures, such as input and output quantity and level of risk-taking in innovation, to micro-level details such as inventor mobility, transactions of patents, and the organizational form of innovation efforts.

Armed with the shock and the innovation setting, the test of the agency channel boils down to a difference-in-differences (DiD) specification. For the purpose of interpretation (Cheng et al., 2016), firms are categorized into with low, medium, and high managerial ownership. The estimation quantifies differences of innovation activities from pre- to post-2003 Dividend Tax Cut, across those firms. Note, the identification assumption is *not* that managerial ownership is randomly assigned across firms; it is that those firms' innovation activities would have trended similarly in the absence of the tax cut. In other words, the agency channel is identified through differences in within-firm changes in response to the tax cut due to pre-existing variations in managerial ownership.

Following this framework, I find that after the 2003 tax cut, firms with medium managerial ownership expand both innovation input, as measured by R&D scaled by total assets (around 50 basis points); and output, as measured by the quantity of new patents (around 7%). These innovations, however, appear to be neither of higher quality nor more radical than those previously produced in the firm. Firms with high managerial ownership significantly reduce innovation quantity and shift innovation to a safer and much more incremental strategy. Specifically, these firms decrease their R&D intensity by nearly 40 basis points on average, and patenting quantity decreases by 8%. Meanwhile, their newly produced patents are highly incremental and exploitative, and they attract fewer outside citations. Decreases of innovation in high-ownership firms guard against the concern that only the incentive alignment channel works here, which by itself would generate unchanged, but not lower innovation activities. Overall, those results lend strong support to the agency channel.

Next, I explore the operational activities driving those findings. Incentive alignments in medium ownership firms lead managers to break their "quiet life" (Bertrand and Mullainathan, 2003) and increase inventor mobility in the firm. Newly hired inventors appear to be more productive in terms of patent quantity. Increases in risk exposure in high ownership firms lead managers to downsize their inventor base by reducing hires. The limited number of new hires pursue safer and more incremental innovation. This exacerbated managerial risk aversion also motivates active participation in patent purchases and diversifying acquisitions, consistent with an explanation that managers shift innovation risks to outside firm boundaries (Gormley and Matsa, 2016).

Lastly, I explore the strength of the agency channel in different firms. I find that the agency channel is weakened in firms with stronger corporate governance mechanisms and with more intense industry competition. The effect of exacerbated managerial risk aversion, but not of incentive alignments, is mitigated in firms whose compensation structure is more convex, therefore rewarding risk-seeking (Coles, Daniel, and Naveen, 2006; Manso, 2011).

I provide several additional analyses and discussions to sharpen the interpretation of the agency channel. The results are robust to redefining managerial ownership using only innovation-related officers and to using non-patent-based innovation measures constructed from product descriptions. I perform analyses using measures of ownership incentives that partially control for the tax cut's effect on managerial wealth, and the findings are largely unchanged. Furthermore, the results are driven neither by the changing cost of capital nor by shareholder incentives after the tax cut. Confounding events, such as the 2004 tax holiday, do not seem to explain the findings.

This paper adds to the literature at the intersection of public finance and corporate finance. Researchers have investigated the real effects of the 2003 Dividend Tax Cut on payout policy (Chetty and Saez, 2005; Brown, Liang, and Weisbenner, 2007; Blouin, Raedy, and Shackelford, 2011), private firm investment (Yagan, 2015), financing (Lin and Flannery, 2013), and equity value (Auerbach and Hassett, 2007). Some recent studies use international settings to explore the effect of a dividend tax cut (Becker et al., 2013; Jacob and Michaely, 2017; Alstadsæter et al., 2015). This paper complements the literature in two ways. First, I study the unexpected agency implications of the payout taxation, first proposed in Chetty and Saez (2010). I enrich this agency framework by theoretically introducing managerial risk aversion and risky investment to the model. This extension leads to a more complete and realistic characterization of the agency channel between payout taxation and corporate investment. Second, this paper uses innovation as an empirically advantageous setting to provide the first comprehensive test of the channel. In doing so, it establishes a new link between taxation policy and innovation-driven economic growth.

This paper is also related to the literature on governance and innovation. Aghion, Van Reenen, and Zingales (2013) show that greater institutional ownership is correlated with higher innovation quantity and quality. Atanassov (2013) argues that weakened governance after strengthening anti-takeover provisions leads to poorer innovation performance. Balsmeier, Fleming, and Manso (2017) find that independent boards are associated not only with patent quality but also the composition of innovation. The key contributions of this paper are in making clear empirical distinctions between private benefit motives and managerial risk aversion, and are in directly showing how they affect different dimensions and real activities of innovation. These results complement the effort to understand the real effects of agency conflicts (Denis, Denis, and Sarin, 1997, 1999; Bertrand and Mullainathan, 2003; Nikolov and Whited, 2014; Gormley and Matsa, 2016).

2. Conceptual Framework and Empirical Strategy

I begin by introducing the economic framework of understanding and testing the agency channel of how payout taxation can affect corporate investment. A more formal illustrative model is presented in the Appendix.

2.1. The Agency Channel: Conceptual Framework

Managerial compensation contracts are scaled by one minus personal tax rate $(1-\tau) \times Income$, where $Income$ is a typically a weakly increasing function of firm value (Prendergast, 2015). Therefore, a shock to tax rates will change the manager's cash-flow rights to firm value through contractual arrangements. The part of $Income$ that is exogenously shocked by payout taxation reforms, say the 2003 Dividend Tax Cut, is dividend and capital gains income, i.e., $(1-\tau_{div}) \times Dividend + (1-\tau_{cap}) \times CapitalGains$.

Dividend and capital gains income are in fact a large proportion of managerial compensation, a fact that is largely ignored since they are not reported to the SEC. As shown in Figure 1, around 20% of S&P 500 CEOs' annual income is dividend income from their employers, and on average the equity owned by managers is worth five times of their total annual compensation. Meanwhile, this income directly reflects firm value in compensation. As a result, taxation shocks to this part of income have important consequences on how compensation packages govern managerial preferences.

The Jobs and Growth Tax Relief Reconciliation Act of 2003 (2003 Dividend Tax Cut, "JGTRRA") significantly reduced the tax rate applied to managerial dividend income, τ_{div}, from 38.6% to 15%, and the tax rate on long-term capital gains, τ_{cap}, from 20% to 15%. The simultaneous decreases of both dividend and capital gains taxes allow the effects to be identifiable from all firms regardless of whether they pay out via dividends.

How does this tax cut shock agency conflicts and managerial incentives? For illustration,[4] consider a manager who owns 10% of the firm he or she manages and receives compensation only through dividends that follow a policy of paying out all earnings. When the personal

[4] Since the economic reasoning applies equivalently to dividends and capital gains and since the shock leans more heavily on the dividend side, I use dividends in the following discussions, following Chetty and Saez (2010) and Cheng et al. (2016).

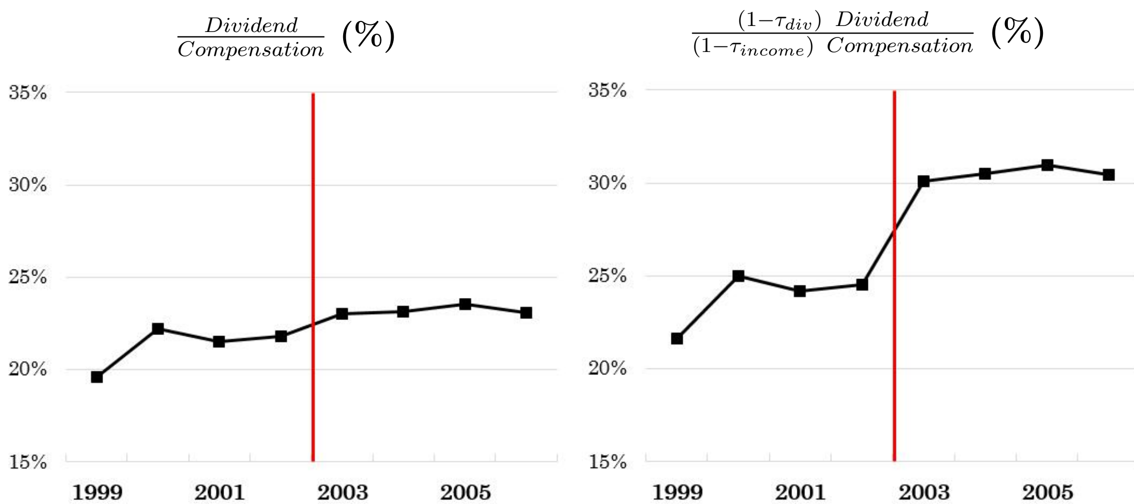


Figure 1. Dividend Income as a Fraction of Managerial Compensation

This figure shows the percentage of managerial dividend income as part of total compensation. The sample includes all S&P 500 CEOs from 1999 to 2006. Dividend income is calculated as the number of shares owned by the manager at the end of the last fiscal year multiplied by total dividend distribution per share. Total compensation is as reported from the ExecuComp database plus the dividend income. The left panel plots the raw ratio, and the right panel plots the after-tax ratio; and tax rates are proxied using the top tax bracket of the year.

income tax rate decreases from 38.6% to 15%, the marginal benefit of expanding firm value increases from 6.14% ($= 10\% \times (1-38.6\%)$) to 8.5% ($= 10\% \times (1-15\%)$). This increase of cash-flow rights leads to an increase of *incentive alignments*. Meanwhile, the risk exposure to firm value—that is, the portion of the firm cash flow volatility borne by the manager—increases. Thus, there is *managerial risk aversion exacerbation*.[5]

In a frictionless world, the agency channel may not be empirically relevant. If both the stock and the flow of managerial ownership can be flexibly adjusted and shareholders are adequately sophisticated in doing so, the agency channel can be undone to a large extent. This null hypothesis may no longer hold, however, since frictions are present. For example, compensation contracts are typically set periodically with highly rigid terms (Shue and Townsend, 2017). In addition, even if shareholders found it optimal to adjust down the stock of managerial ownership after the tax cut, it would be practically difficult to force managers to sell shares (Groen-Xu, Huang, and Lu, 2016). In the end, the existence of the agency

[5]It is worth noting that the tax cut increases only the cash flow right of managers but not the control power or voting rights. As a result, any potential channel concerning control power of the managers, such as managerial entrenchment (Stulz, 1988), is unlikely to matter much in this empirical framework.

channel would signify those frictions in managerial compensation design.

2.2. Testing Using Heterogeneities Across Managerial Ownerships

Testing the agency channel can be challenging—one cannot draw any economically meaningful inferences by tracking corporate investments around the tax cut events, for the simple reasons that corporate investments are too cyclical to distinguish tax effects from business cycle effects (Yagan, 2015), and that several confounding channels can be in play.

The key insight that can help us test the agency channel is that: the intensity of the incentive alignments and managerial risk aversion exacerbation effects are heterogeneous across firms with different levels of pre-shock managerial ownership. Note that below the description is based on categorizing firms into terciles of managerial ownership. This brings interpretation convenience, but may introduce noises in the estimation and appear to be disentangled from the theoretical framework. Later in the paper I provide separate discussions and additional analyses to evaluate the effect of this specific framing decision.

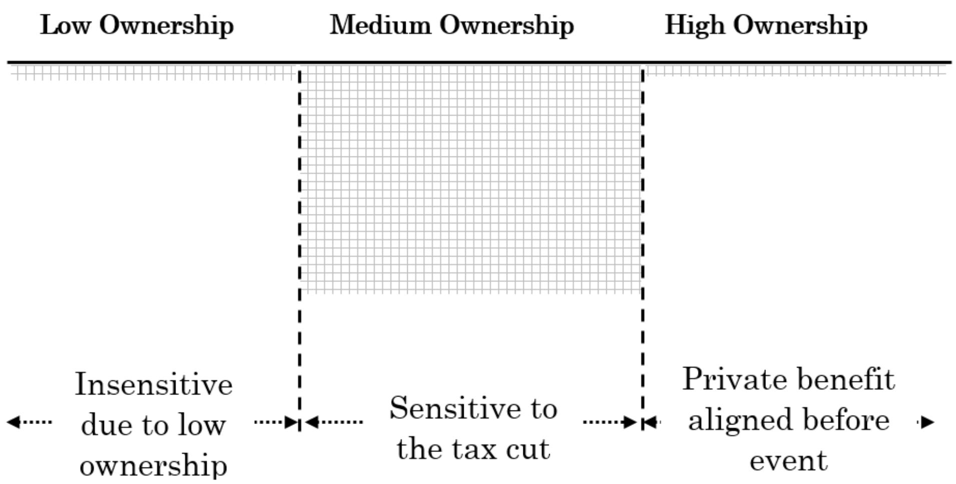


Figure 2. Incentive Alignments After Dividend Tax Cut

For incentive alignments, when managerial ownership is low (consider 0% for purposes of illustration), the manager is insensitive to equity ownership or dividend income, and a tax cut has little influence on these managers. As the ownership level increases, the incentive alignment effect of the tax cut becomes important. As the ownership level keeps increasing (imagine that the manager owns 100% of the firm), incentives are aligned ex ante, leaving little room for the tax cut to further improve—these firms are thus less sensitive to the incentive alignment effect. This non-monotonicity is illustrated in Figure 2. Cheng, Hong, and Shue (2016) employ this empirical framework to test the agency explanation of corporate social responsibility and find that firms with a medium level of managerial ownership decrease their corporate social responsibility more significantly than firms in the tails, lending support to the validity of this agency shock.

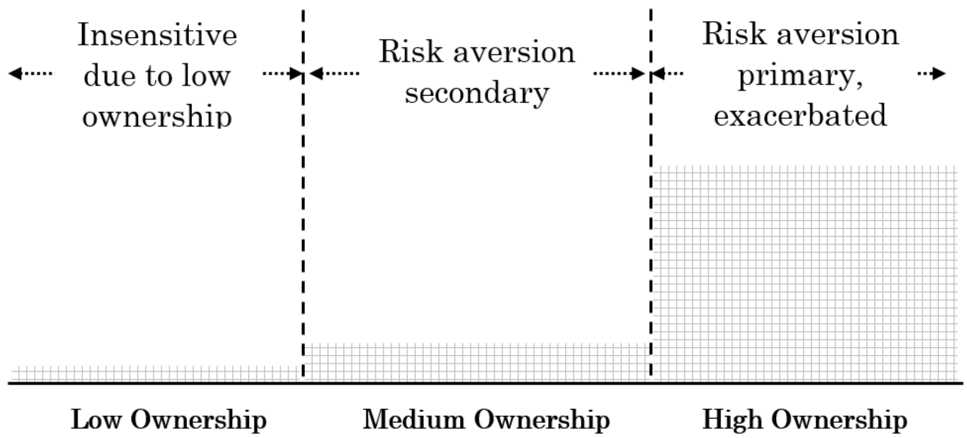


Figure 3. Managerial Risk Aversion Exacerbation after Dividend Tax Cut

For managerial risk aversion exacerbation, in the low-managerial-ownership region managers are again insensitive to the event. The exacerbation of managerial risk aversion increases with the managerial ownership, and this increase is likely to be nonlinear with particularly strong effects in the high-ownership region. This nonlinearity is shown in the stylized model discussed in the Appendix. In a setting with a risk-averse manager with CARA utility function and a risky R&D project with normally distributed return (Prendergast, 1999; Bolton and Dewatripont, 2005), the ownership enters the risk adjustment in a quadratic term; thus the effect is pronounced in the very high ownership region. Empirically, this nonlinearity is supported by evidence from Denis et al. (1997) and Kim and Lu (2011), who show that managerial risk aversion only affects corporate behaviors in the high managerial ownership region, but not in others.

The framework to test the agency channel exploits these heterogeneities across firms with different managerial ownerships. At the low-managerial-ownership region, managers are insensitive to the tax cut. At the medium-managerial-ownership region, managers' incentives are better aligned to forgo private benefits. At the high-managerial-ownership region, aggravated managerial risk aversion dominates the response. This pattern fits into a difference-in-differences (DiD) setting that compares innovation activities from pre- to post-2003 Dividend Tax Cut (the first difference), across firms whose managerial ownership is low, medium, and high (the second difference).

2.3. Empirical Specification

To implement the test, I form a panel of firms from four years prior to the tax cut (1999) to four years subsequent to the tax cut (2006). The sample is limited to "innovative firms," requiring that the firm has both filed and been successfully granted at least one patent before 1999, and has at least one positive R&D expenditure within the five-year window prior to 1999. The main DiD specification follows the model:

$$\begin{aligned} Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t\geq 2003} + \beta_{high} \times I_{high} \times I_{t\geq 2003} \\ + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}. \end{aligned} \tag{1}$$

I_{medium} and I_{high} are dummy variables indicating whether firm i belongs to the medium or high managerial ownership terciles, where managerial ownership is calculated as the average ownership of 2001 and 2002 (Chetty and Saez, 2005; Cheng, Hong, and Shue, 2016).[6] $I_{t\geq 2003}$ indicates whether the observation is post-tax cut. α_t stands for year fixed effects, and they absorb time trends in innovation. α_i picks up firm fixed effects, and they naturally subsume time-invariant, industry-level influences—the cross-industry heterogeneities of managerial ownership (i.e., IT firms are higher) are controlled for through this.. This set of fixed effects also controls for time-invariant features of the firm-level contracting environment that could affect innovation ex ante. Standard errors are clustered at the firm level to account for the serial correlation in the data.

The group of firms with low managerial ownership is theoretically insensitive to the tax cut and is effectively used as the "benchmark" in this specification. As a result, the coefficients β_{medium} and β_{high} should be interpreted as the post-pre difference benchmarked by this post-pre change for low-managerial-ownership firms. β_{medium} represents the effect of

[6]The choice of using tercile categorizations is for clear interpretation purposes. In the Appendix, I provide analysis using alternative categorizations.

incentive alignments after the dividend tax cut; β_{high} represents the influence of exacerbated managerial risk aversion.

Importantly, following Cheng, Hong, and Shue (2016), detailed size controls are also included in the specification. That is, I create ex ante size categories (small, medium, large) by ranking firms based on their average book assets in 2001 and 2002, and then include interactions of those size category dummies and $I_{t\geq 2003}$. Given that fractional managerial ownership is significantly negatively related to size, including this set of size controls better absorbs potential confounding channels through which size affects corporate responses to the tax cut. Besides those detailed size controls, $X_{i,t}$ also includes standard control variables, Tobin's Q, capital structure, and firm age.

2.4. Discussions on the Empirical Strategy

2.4.1. Anatomy of the Identification Assumptions. The key identification assumptions are that firms in different ownership groups share similar innovation trends in the absence of the tax cut, and that they have similar exposures to the tax cut except through managerial ownership. To be clear, the identification and interpretation assumption is not that the managerial ownership is randomly assigned across firms at the outset. In model (1), firm fixed effects intend to control for those time-invariant firm characteristics that determine the contracting of ex ante ownership level. Year fixed effects absorbs time trends in innovation and the effects of any other events that could affect all firms homogeneously. In other words, the difference-in-differences strategy is designed only to pick up differences in response to agency shocks due to a predetermined level of managerial ownership.

The non-monotonicity of incentive alignments and the nonlinear exacerbation of managerial risk aversion across different managerial ownership levels are particularly helpful for identifying the agency channel. An alternative explanation would need to be able to consistently explain the effects across various regions and on different innovation dimensions. There were several important events around the dividend tax cut, for example: the Sarbanes-Oxley Act (SOX), which significantly changed the governance practice of US firms; the Iraq War; and the 2004 Repatriation Tax Holiday. However, as long as those events could not affect corporate investment differently along the managerial ownership dimension, specification (1) is a proper test for the agency channel. In Section 5, I consider several potential competing stories rooted in finance literature, and reject them using a battery of empirical analyses.

2.4.2. Wealth Change after Dividend Tax Cut and Managerial Risk Attitudes. The tax cut also increased the wealth level of managers. This variation could change managerial risk attitudes through the wealth channel and be part of the agency channel.[7] This wealth channel is particularly pronounced in the high-ownership region, where the managerial wealth is likely to increase the most after the tax cut. As a result, the agency channel identified in the high-ownership region can be interpreted as due not only to increased cash flow volatility exposures but also wealth-driven changes in managerial risk aversion. Assuming the results in Becker (2006), showing that wealth can decrease absolute risk aversion of managers, hold in this paper's setting, the identified effects of managerial risk aversion thus are likely to have been slightly offset, rather than reinforced, by the risk aversion decline due to wealth increase.

2.5. 2003 Dividend Tax Cut: Background and Important Features

This section provides details on the 2003 Dividend Tax Cut for interested readers and discusses several of its features that make it a clean quasi-experiment. The Jobs and Growth Tax Relief Reconciliation Act of 2003 was signed into law on May 28, 2003,[8] and it was the most sizable dividend tax cut in decades.[9]

In addition to the size of this reform, two features of the 2003 Dividend Tax Cut are important for the identification and interpretation. First, the dividend tax proposal appears to have been largely unanticipated (Auerbach and Hassett, 2007; Poterba, 2004; Chetty and

[7] In the stylized model of the paper, I use a CARA utility, which shuts down the relation.

[8] President George W. Bush proposed the reform on January 7, 2003; it applied retroactively to January 1, 2003. The act can be accessed through http://www.gpo.gov/fdsys/pkg/PLAW-108publ27/html/PLAW-108publ27.htm and http://www.gpo.gov/fdsys/pkg/STATUTE-117/pdf/STATUTE-117-Pg752.pdf. For more background reading on the legislation history and its impact, see Auerbach and Hassett (2007) and Yagan (2015).

[9] To be more precise, the 2003 Dividend Tax Cut reduced the marginal tax rate on qualified (i.e., from US or tax-treaty-qualifying foreign corporation stock held for at least 60 days) and taxable (i.e., not from S-corporations or accrued to tax-preferred accounts) dividends for individual taxpayers in the top four ordinary income tax brackets of 27%, 30%, 35%, and 38.6% to 15%, and for individual taxpayers in the bottom two ordinary income tax brackets of 10% and 15% to 5%. The OECD reports that when considering federal and average state tax rates, the 2003 tax reform reduced the top statutory dividend tax rate from 44.7% to 20.8%.

Saez, 2005, 2006). It was not part of George W. Bush's 2001 campaign platform, and it lost momentum multiple times between proposal in January 2003 and being signed into law. The evidence that equity prices surged after its passage suggests that the market did not anticipate the event. This "unexpectedness" feature ensures that firms lacked sufficient time to adjust managerial ownership level or corporate innovation strategy taking the tax cut into account.

Second, the tax cut was narrow in scope (Blouin, Raedy, and Shackelford, 2011). Besides the large decrease in dividend tax rate, the act changed three other relevant provisions. It reduced the top capital gains tax rate (which applied to share repurchases) from 20% to 15%. It expanded temporary accelerated depreciation for equipment and light structures investment through 2004, and it accelerated the previously legislated phase-in of reductions in individual ordinary income tax rates. The narrow focus is important when interpreting the results from the perspective of dividend tax and agency conflicts. Indeed, the empirical strategy would be less credible if the tax reform involved a widespread overhaul of the tax system that influence factors far beyond shareholder taxes (e.g., Tax Reform Act of 1986).

3. Data and Measurements

3.1. Managerial Ownership

Managerial ownership data are originally extracted from the Securities and Exchange Commission (SEC) Form 4 filings. Form 4 is mandatory for all members of a firm's board of directors, its officers, or owners of more than 10% of a class of equity securities registered under Section 12 of the Securities Exchange Act of 1934 (SEA). A Form 4 must be filed for almost all activities related to ownership changes, including any equity-related grant, option exercise, vesting of restricted stock/restricted stock units (in certain situations), sales of stock (including sales under Rule 10b5-1 trading plans), receipt of a bequest under a will, transfer to a trust, and transaction in company stock by a partnership of which the reporting person is a member.[10] Form 4 data cover all public firms, allowing me to study smaller firms that

[10] Since 2002, Form 4 is required to be completed before the end of the second business day after the transaction day (before 2002, the required reporting gap was 10 days after the end of the month the transaction was conducted).

are not covered in ExecuComp but that are potentially important in an innovation setting.

I use Form 4 data to construct a firm-year managerial ownership measure.[11] The relevant Form 4 item is the remaining holding after a person transacts his or her insider shares. I first measure an insider's ownership in the firm in a specific year using the reported ownership after the last transaction conducted that year. Two cases of missing data need to be imputed in this person-year panel: when the missing person-year lies between two valid observations, I impute the observation using the last valid ownership data;[12] when a person-firm no longer appears in the dataset, I confirm whether the person is still an insider of the firm using sources such as Compact Disclosure (when possible), and impute the valid years using the last valid ownership report.[13]

The person-year level data are aggregated to the firm-year level by adding up all the insider ownership (officers and directors of boards). Following Chetty and Saez (2005) and Cheng, Hong, and Shue (2016), I focus on share holdings rather than option holdings. Because many options are not dividend protected (Zhang, 2018), it is difficult to determine an unambiguous effect from the dividend tax cut. Chetty and Saez (2005) find that the dividend policy responds to shares held by top executives but not to options held. Recent works such as Kim and Lu (2011) include options in managerial ownership and find little explanatory power for options.

3.2. Innovation Setting

3.2.1. Innovation Quantity. The first measure for innovation quantity is R&D expenditures scaled by total assets, a widely accepted measure for innovation input (Lerner, Sorensen, and Strömberg, 2011; Brav, Jiang, Ma, and Tian, 2019). Both R&D expenditures and total assets of a firm are extracted from Compustat. The second measure, capturing the output quantity of innovation, is the annual number of patent applications filed by a firm that are eventually granted by the USPTO.[14] The year of application instead of the grant year is used

[11]To my knowledge, this paper is the first to use Form 4 data to construct managerial ownership.

[12]For example, if I observe equity-related activities of John Robinson in 1999 and 2001 but not in 2000, then I impute John's remaining share in 2000 to be the same as after his last share change in 1999.

[13]I compare the individual ownership level with the ExecuComp database for people (named executives in proxy statements) who are covered in both datasets.

[14]The central patent data are obtained from the NBER Patent Data Project and Bhaven Sampat's patent and citation data. For more information on the NBER Patent Data Project, please refer to Hall,

since the former is likely to better capture the actual timing of innovation. Following the literature, I employ the logarithm of one plus this variable to fix the skewness problem for better empirical properties. As a complementary approach, I use the inverse hyperbolic sine (asinh) of the patent count. The asinh transformation closely parallels the logarithm function when there are 2+ patents, but is well defined at 0. I keep the logarithm as the primary patent count measure to be consistent with the literature.

3.2.2. Innovation Riskiness. Another important dimension in motivating innovation is the riskiness of innovative projects (Holmstrom, 1989; Ederer and Manso, 2011). Following Brav et al. (2019) and Bernstein, McQuade, and Townsend (2017), innovation projects are scored on a scale of explorative vs. exploitative. Specifically, I calculate the explorative citation ratio as the extent to which a patent uses existing versus new knowledge of the innovating firm, where a firm's existing knowledge includes all the patents owned by the firm and all the patents cited by these patents.

A lower explorative citation ratio of a patent suggests an innovative strategy that relies heavily on existing knowledge, while a higher ratio suggests an innovative strategy that focuses on exploring new technologies. Explorative patents therefore need to take risk to explore and experiment (Schumpeter, 1934; March, 1991). As discussed in Manso (2011), explorative innovations can be riskier as they demand "exploration of new untested actions... but is also likely to waste time with inferior actions."

As a secondary measure to innovation riskiness, I compute scaled lifetime citations for each patent by dividing its citation counts using the average number of citations of all patents in the same technology class and application year (i.e., the same vintage). Patent citations occur over many years (Hall, Jaffe, and Trajtenberg, 2001), so the number of total citations received by more recent patents is significantly downward biased. This truncation problem from unrealized future citations is corrected in this scaled measure (Bernstein, 2015).

Jaffe, and Trajtenberg (2001). The NBER data used in this paper were extracted in May 2016, from https://sites.google.com/site/patentdataproject/. Sampat's data can be accessed using http://thedata.harvard.edu/dvn/dv/boffindata.

3.2.3. Inventor Mobility. Inventor mobility is tracked using the Harvard Business School (HBS) patent and inventor database.[15] This database provides the names of the inventors (i.e., the individuals who receive credit for producing a patent) and their affiliations with the assignees (see Lai, DAmour, and Fleming (2009) for details). Following Bernstein (2015), I classify three groups of inventors: a "leaver" is an inventor who leaves the firm during a given year; a "new hire" is an inventor who is newly hired by a given firm in a given year; and a "stayer" is an inventor who stays with the firm during a given year. For all three groups, it is necessarily required that an inventor generate at least one patent before the event and at least one patent after the event. Therefore, the results are effectively identified through a set of frequent patenters.

3.2.4. Patent Transactions. Patent transactions are identified from the USPTO Patent Assignment and Reassignment database.[16] This database provides necessary information for analyzing patent mobility: the names of the patent buyers (assignees), the names of the patent sellers (assignors), the unique patent identifiers (patent numbers), and the patents' transaction dates (the dates on which reassignments were recorded at the patent office). I follow an algorithm developed by Ma (2019) and Brav et al. (2019) to identify patent transactions.

3.3. Other Data Sources

The sample is augmented using Compustat for financial statement data. Important variables are constructed as follows: Size (logarithm of total assets in 2007 USD), Leverage (book debt over total assets), Return-on-Assets (EBITDA over total assets), and Tobin's Q (market value over book value). All data items are pre-winsorized at the 1% and 99% level. For corporate governance data, institutional shareholding information is extracted from the WRDS Thomson Reuters 13(f) data, and G-index data are obtained from Andrew Metrick's data library.[17] Mergers and acquisitions data are extracted from the SDC Platinum.

[15] Available at: http://dvn.iq.harvard.edu/dvn/dv/patent.

[16] The data are accessible via bulk downloading of text files. See http://www.google.com/googlebooks/uspto-patents.html.

[17] Accessed using http://faculty.som.yale.edu/andrewmetrick/data.html.

4. Main Results

4.1. Summary Statistics

Table 1 overviews the panel sample and reports summary statistics. Panel A reports the number of firms covered by each industry, where industries are categorized using the Fama-French 12 Industry Classification. The sample covers almost all industries, with the majority coming from the most innovation-intensive industries, such as business equipment (42% of the sample, 42% = 943/2243), healthcare (21% of the sample), and manufacturing (16% of the sample).

[Insert Table 1 Here.]

Panel B reports summary statistics for the sample, including the mean, standard deviation, and 25th, 50th, and 75th percentile for each of the firm characteristics. An average firm in the sample has 15% outstanding shares owned by its managers, officers, and board of directors. It invests around 10% in research and development. Firms on average filed 58 patents during 1999 to 2006 (7.22 per year). For firm-year observations with patent applications, the average ratio of explorative citations in innovation scores 62%, meaning that six out of ten citations made by a new patent are knowledge never cited by the firm before. This number moves from 41% to 88% from the 25th percentile to the 75th percentile. Dividend payments are distributed to shareholders in 22% of firm-year observations—as discussed above, the simultaneous decrease of both dividend and capital gains taxes allows the effects to be identifiable from all firms regardless of whether they pay out dividends using the empirical strategy.

Panel C shows that the firm characteristics summarized above vary across firms with low, medium, and high levels of managerial ownership. Not surprisingly, managerial ownership and firm size measured by total assets are negatively correlated. This correlation is further reflected in other variables, such as the number of new patent applications. Low-managerial-ownership firms, typically more mature, spend less on R&D in general, but their patents are on average of higher quality. There are no distinguishing differences in the ratio of explorative citations across firms with different levels of managerial ownership. The important correlation between managerial ownership and size justifies the importance of controlling for size carefully in model (1) to absorb size-related heterogeneous responses to the event.

4.2. The Quantity of Innovation Investment

Table 2 investigates innovation input and output quantity. The coefficients of interest are those associated with $MedOwn \times Post2003$, which quantifies the effect of incentive alignment, and $HighOwn \times Post2003$, which quantifies the effect of exacerbated managerial risk aversion. Columns (1) to (3) estimate the basic impact on R&D intensities. R&D intensity in firms with medium managerial ownerships increases by about 0.48%, suggesting that when private benefit motives are better alleviated, more resources are allocated to innovative projects. This 0.48% increase is about a 4.8% increase from the mean R&D/Assets ratio of 9.97%. The increase in innovation effort is also reflected in the quantity of innovation output, measured using the logarithm of one plus the number of new patents applied by a firm in a year. In column (4), innovation output increases by about 4.5% in firms with aligned incentives after the dividend tax cut. As for the coefficients associated with $HighOwn \times Post2003$, firms that experience an exacerbated managerial risk aversion problem lower their investment in R&D, and decrease the number of patent filings. R&D intensity decreases by 0.82% after the tax cut, and the number of new patent applications decreases by about 4.3%.

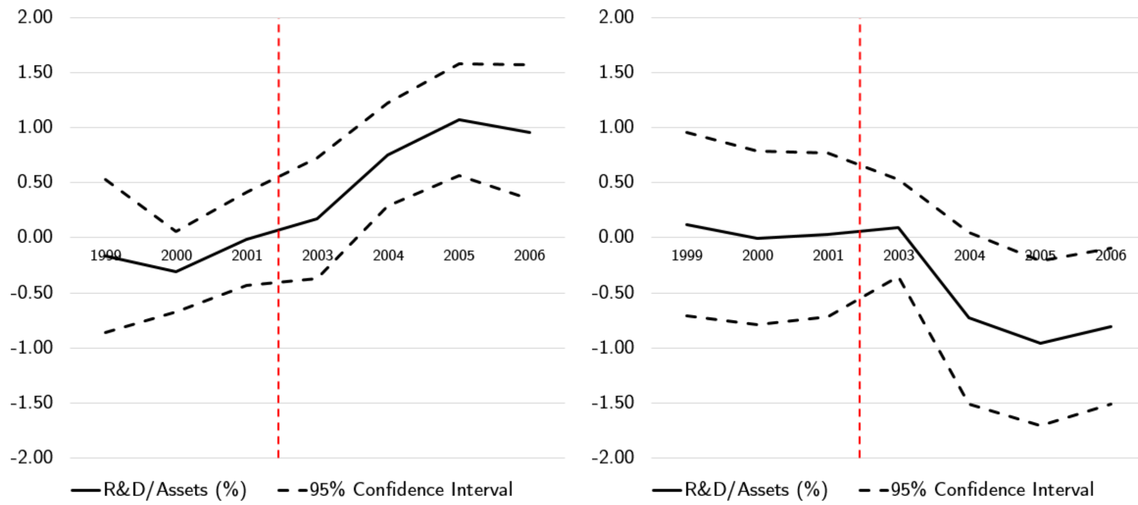
[Insert Table 2 Here.]

In columns (2) and (5), detailed size controls are included in the control variable set to mitigate the concern that different-sized firms could have responded to the 2003 tax cut differently, and the effects are both qualitatively and quantitatively similar. In columns (3) and (6), more innovation-related control variables are included in the regressions. They explicitly represent the influence of firm-level characteristics on corporate innovation activities but do not seem to change any of the results. The result is qualitatively similar when I use the inverse hyperbolic sine-transformed patent counts as the output measure, as shown in column (7).

To confirm that reverse causality or other hidden economic factors are not driving the results, I examine the dynamic effects of the event. In practice, I allow for effects of the event to vary each year and estimate how changes in medium- and high-ownership firms differ dynamically from the low-ownership firms. Mathematically, model (1) is expanded to

$$
\begin{aligned}
Innovation_{i,t} = & \sum_{t \neq 2002} \beta_{t,medium} \times I_{medium} \times I_t + \sum_{t \neq 2002} \beta_{t,high} \times I_{high} \times I_t \\
& + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t},
\end{aligned} \tag{2}
$$

where year 2002 is taken as the omitted reference year and works as the empirical benchmark of the estimation. Control variables are similarly constructed as in model (1).

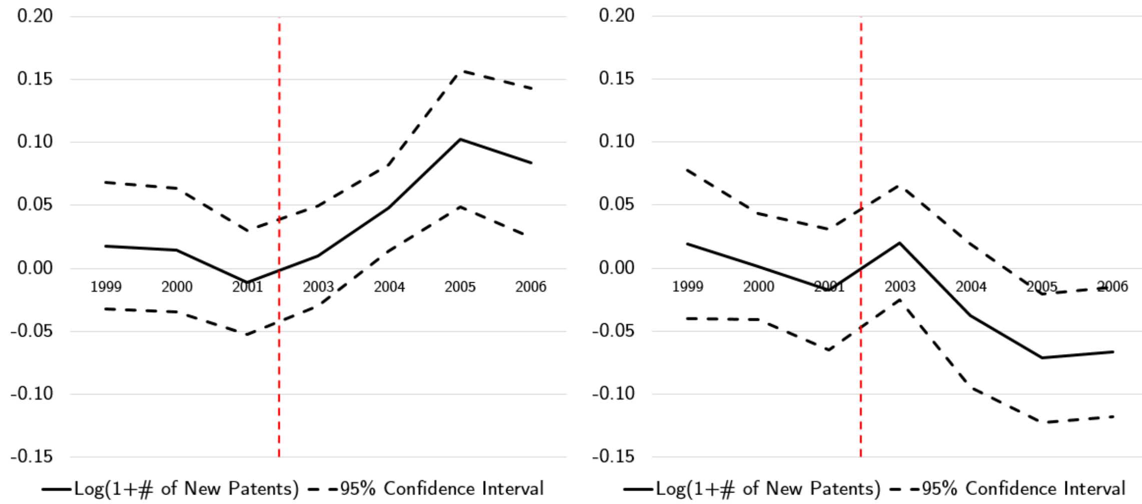


(a) Medium Ownership **(b) High Ownership**

Figure 4. Dynamic Effect of Dividend Tax Cut on Corporate R&D

This figure presents the dynamics in corporate R&D/Assets around the 2003 Dividend Tax Cut, for firms with a medium level of managerial ownership (Panel (a)) and a high level of managerial ownership (Panel (b)), respectively. The sample retains only those firms that file for a patent at least once prior to 1999. The unit of observation is at the firm-year level. Coefficients and 95% confidence intervals are estimated following model (2). Year 2002 is taken as the omitted reference year and works as the empirical benchmark of the estimation. Control variables include Tobin's Q, leverage, firm age, and detailed size controls. All specifications include firm and year fixed effects. Standard errors are clustered at the firm level.

OLS-estimated β's from model (2) are plotted in Figure 4 (R&D Expenditure/Assets) and Figure 5 (ln(1+# of New Patents)), with 95% confidence intervals. For firms with both medium- and high-managerial-ownership levels, they do not show abnormal pre-event trends in innovation quantity. This reassures that reverse causality and heterogeneous pre-event trends are unlikely to be important concerns here.



(a) Medium Ownership **(b) High Ownership**

Figure 5. Dynamic Effect of Dividend Tax Cut on Quantity of New Patents

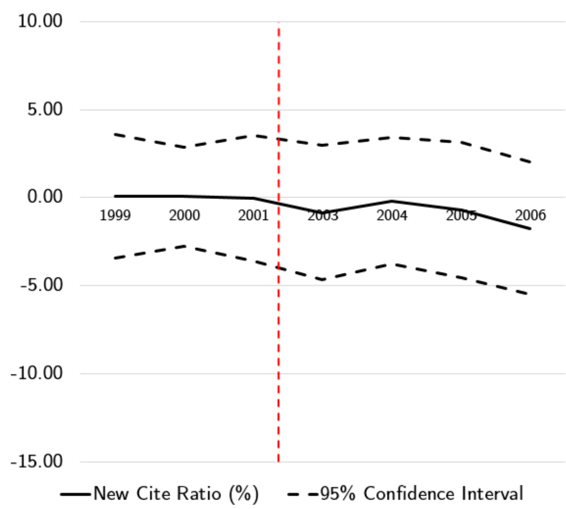
This figure presents the dynamics in the number of new patents (measured using ln(1+Number of New Patents)) around the 2003 Dividend Tax Cut for firms with a medium level of managerial ownership (Panel (a)) and a high level of managerial ownership (Panel (b)), respectively. The sample retains only those firms that file for a patent at least once prior to 1999. The unit of observation is at the firm-year level. Coefficients and 95% confidence intervals are estimated following model (2). Year 2002 is taken as the omitted reference year and works as the empirical benchmark of the estimation. Control variables include Tobin's Q, leverage, firm age, and detailed size controls. All specifications include firm and year fixed effects. Standard errors are clustered at the firm level.

4.3. The Riskiness of Innovation

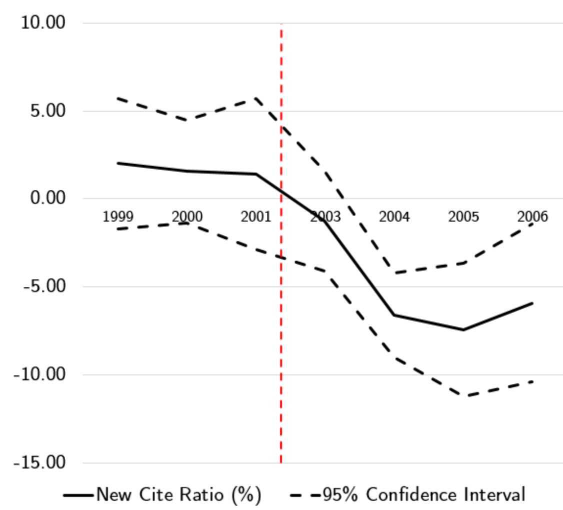
In addition to innovation quantity, it is important to understand the frictions that constrain firms from conducting risky yet potentially radical innovation investment, rather than safe yet incremental innovation. This problem has broad implications on the idiosyncratic route of both corporate growth and economic development (Acemoglu and Cao, 2015).

[Insert Table 3 Here.]

Table 3 Panel A investigates innovation riskiness by estimating model (1) with measurements capturing the novelty and underlying riskiness of innovation. In columns (1) to (3), the dependent variable is the ratio of explorative citations, defined as the number of citations made to patents that the firm has never before cited at the time of filing, divided by the total number of citations made by the firm's new patents. Coefficients associated with $MedOwn \times Post2003$ are both economically and statistically insignificant, suggesting that the common wisdom that aligning incentives through pay-for-performance leads to better performance does not hold in motivating radical innovation. Meanwhile, coefficients associated with $HighOwn \times Post2003$ are negative and significant, consistent with the idea that firms' choice of risky innovation projects is very sensitive to the risk attitude of managers. In terms of economic magnitude, the -3.038 estimate in column (3) means a 5% decrease from the unconditional mean of the ratio of explorative citations (62% as reported in Table 1). In columns (4) to (6), the standardized average number of patent citations is analyzed. The results are consistent with the explanation that aggravated managerial risk aversion leads to incremental innovation, which in turn attracts fewer external future citations. Figures 6 and 7 plot the dynamic of explorative citation ratio and standardized patent quality in response to the 2003 Dividend Tax Cut in medium-ownership firms and high-ownership firms.



(a) Medium Ownership

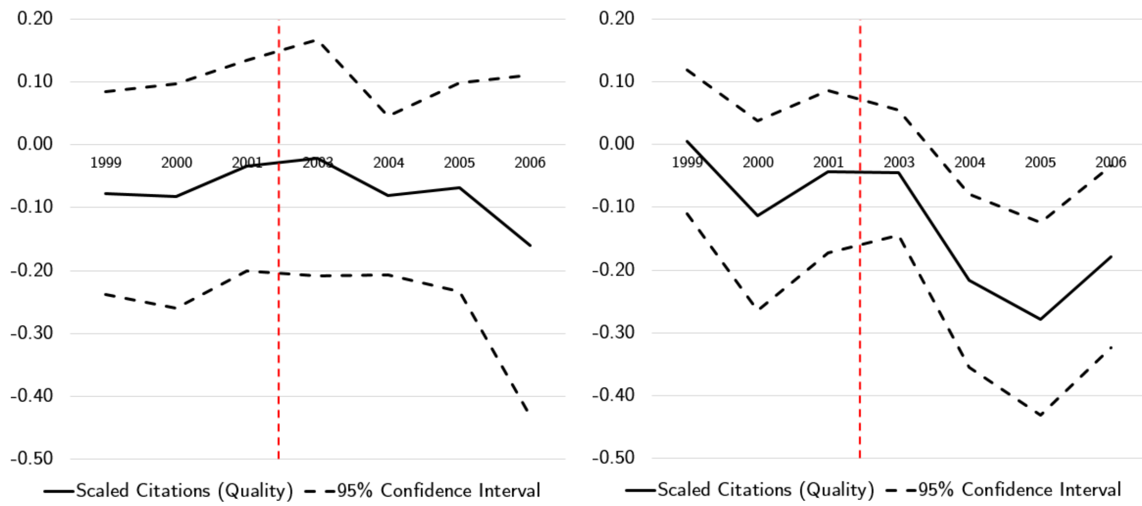


(b) High Ownership

Figure 6. Dynamic Effect of Dividend Tax Cut on Explorative Citation Ratio (%) of Innovation

This figure presents the dynamics in the ratio of explorative citations in innovation around the 2003 Dividend Tax Cut for firms with a medium level of managerial ownership (Panel (a)) and a high level of managerial ownership (Panel (b)), respectively. The sample retains only those firms that file for a patent at least once prior to 1999. The unit of observation is at the firm-year level. Coefficients and 95% confidence intervals are estimated following model (2). Year 2002 is taken as the omitted reference year and works as the empirical benchmark of the estimation. Control variables include Tobin's Q, leverage, firm age, and detailed size controls. All specifications include firm and year fixed effects. Standard errors are clustered at the firm level.

Note that the fact that innovation riskiness and quality decrease in high-ownership regions can hardly be explained without exacerbated managerial risk aversion. If only incentive alignment matters, we would expect a flat response in the high-ownership region. The fact that riskiness choices decrease means the additional risk aversion force plays a role.



(a) **Medium Ownership** (b) **High Ownership**

Figure 7. Dynamic Effect of Dividend Tax Cut on Standardized Patent Citation

This figure presents the dynamics in patent quality (measured using standardized patent citations) around the 2003 Dividend Tax Cut for firms with a medium level of managerial ownership (Panel (a)) and a high level of managerial ownership (Panel (b)), respectively. The sample retains only those firms that file for a patent at least once prior to 1999. The unit of observation is at the firm-year level. Coefficients and 95% confidence intervals are estimated following model (2). Year 2002 is taken as the omitted reference year and works as the empirical benchmark of the estimation. Control variables include Tobin's Q, leverage, firm age, and detailed size controls. All specifications include firm and year fixed effects. Standard errors are clustered at the firm level.

4.4. Evidence from Technology Officers

Although all executives and officers could affect a firm's innovation strategies, technology officers (Chief Technology Officer, Chief Information Officer, etc.) are the most relevant in determining the implementation of innovative activities. It is important, therefore, to confirm that the results are robust when focusing on their influence. However, data limitations make it empirically difficult to identify incentives provided to technology officers. The closest evidence in the literature is Lerner and Wulf (2007), who show a positive correlation between R&D officer equity incentives and innovation using a survey sample of 141 firms.

This paper identifies technology officers' ownership by combining the HBS inventor database with Form 4 insider trading data, both described above in Section 3. A namematching process identifies all the officers who are inventors and removes those innovative officers with titles of "CEO" or "CFO." Those that remain are considered to be officers with technological expertise and with innovation-related positions. This approach, which admittedly needs restrictive assumptions on the patenting ability of technology officers, actually helps to select those who are most likely to be involved and influential in innovation decisions. Despite the restrictive assumptions, technology officers are identified for more than 50% of the original sample of innovative firms.

[Insert Table 4 Here.]

The analysis in Table 2 and Table 3 is repeated using ownership of those technology officers, and Table 4 presents the results. Across all the main innovation quantity and riskiness measures, results are quantitatively similar to those that lean on aggregate managerial ownership levels.[18]

4.5. Evidence from Product Innovation

The results above focus mostly on patent-based innovation measures. The narrow focus on patent-based measures, however, necessarily overlooks many interesting dimensions in innovation investment. I turn briefly now to two new datasets to study innovation investment in another important dimension—the development of new and unique products. Following Cohen, Diether, and Malloy (2013), the Compustat Segment Data File is used to compute the number of new products introduced per year for each firm. The Compustat Segment File, which is available from 2000 to 2008, assigns a unique product number to each new product in each firm and carries that product number through time. By calculating the number of products newly introduced by each firm, I obtain an analogous measure to new patent applications in the product market.

How can we measure the novelty and riskiness of those new products? I use the Hoberg-Phillips data library (Hoberg and Phillips, 2016), which collects data on product market activities of a selected set of firms. These data gather business descriptions from corporate 10-Ks filed with the SEC and process the text in those filings to derive a measure of a

[18] In the remainder of the paper, the aggregate managerial ownership will be the main measure because of its higher accuracy and its consistency with the vast literature.

product's uniqueness (compared to the products of industry competitors) using product market vocabularies.

[Insert Table 5 Here.]

Table 5 examines product market innovation. Columns (1) and (2) investigate the quantity of product innovation, measured using the number of new products introduced to the market by each firm in each year. Medium-managerial-ownership firms devote more effort to introducing new products into the market after the 2003 tax cut, consistent with the explanation that mitigating private benefit motives incentivizes managerial effort. In contrast, high-ownership firms appear to lower their rate of introducing new offerings to the market by 0.14 new products per year.

Columns (3) and (4) examine the uniqueness of firms' product portfolios as defined in Hoberg and Phillips (2016). Medium-ownership firms mildly decrease the uniqueness of their product offerings even though they increase the number of new products. Firms with high managerial ownership, meanwhile, significantly decrease the uniqueness of their products and stay within existing product lines. Overall, the product market evidence delivers a consistent message as the analysis on patents.

4.6. Operational Channels

So far, the evidence has supported the hypothesis that the dividend tax cut affected corporate innovation investment through the agency channel. The natural question is: what operational channels do managers (agents) adjust to achieve those changes? I look at two specific dimensions of particular interest in the literature: labor adjustment and acquisitions.

4.6.1. Innovative Labor. I start with labor adjustment by tracking inventor mobility. A substantial portion of R&D investment is in the form of wages for scientists and engineers, and this labor adjustment channel has been shown to be crucial when a firm undergoes innovation changes (Seru, 2014; Brav, Jiang, Ma, and Tian, 2019). In a broader sense, adjusting labor is an important margin when managers experience a shock to their incentives (Bertrand and Mullainathan, 2003).

[Insert Table 6 Here.]

I use the HBS patent and inventor database to classify three groups of inventors: a "leaver" is an inventor who leaves the firm during a given year; a "new hire" is an inventor who is newly hired by a given firm in a given year; and a "stayer" is an inventor who stays with the firm during a given year. For all three groups, an inventor must generate at least one patent prior to the event and generate at least one patent after the event. The analysis, therefore, is performed on those frequent patenters (Bernstein, 2015).

The analysis is conducted in two steps. First, I investigate inventor mobility after the 2003 tax cut in firms with different levels of managerial ownership, using the same specification as in model (1). The results are reported in Table 6 Panel A. The insignificant coefficients in columns (1) and (2) indicate that the size of the inventor base is largely unaffected by the event. Nevertheless, when switching to examine the inventor turnover pattern in columns (3) to (6), medium-ownership firms show abnormally active inventor mobility, replacing about 5% more of their inventors annually. This is in line with Bertrand and Mullainathan (2003), who find that private benefit motives lead to a "quiet life," while the data here show that managers choose a "busier life" in response to better incentives. High-ownership firms show a mild downsizing of the inventor base, mostly from slowing their new hiring at a rate of 4.5% fewer new hires annually.

Next, the characteristics of innovation produced by different types of inventors are traced to infer the underlying economic consideration when managers adjust their inventor base. The sample now consists of inventor-firm-year observations. The regression specification is the same as in model (1). Columns (1) and (2) show that inventors in medium-ownership firms (both stayers and new hires) experience improvements in patenting quantity, suggesting that managers expand corporate R&D not only via expanding the inventor base but also by passing along the incentives to the inventor level to stimulate productivity. In columns (1) and (2), patenting intensity mildly decreases in the high-ownership firms, but in columns (3) and (4), the response in the riskiness of new patents is strong and clear, especially in new hires. This means that when managers experience a shock to the risk attitude, they can actively choose the type of inventors they hire to balance the innovation portfolio.

4.6.2. The Organization of Innovation. Organizational decisions are important fields where managers respond to agency conflicts (Amihud and Lev, 1981; Denis, Denis, and Sarin, 1997; Gormley and Matsa, 2016). Meanwhile, organizational decisions regarding innovation projects are important for us to understand how firms view and allocate risks and control (Aghion and Tirole, 1994; Robinson, 2008).

[Insert Table 7 Here.]

Table 7 columns (1) and (2) study firms' patent-purchasing activities and find that high-ownership firms, whose managers experience greater risk exposure, significantly increase their purchase of patents. This is in sharp contrast to their decrease of innovation input and output quantity within the firm, as shown in Table 2. One explanation is that managers shift the risk of innovation investment outside the boundaries of the firm and further hedge the risk by buying successful investments. Consistent with columns (1) and (2), columns (3) to (6) show that increased managerial risk aversion also motivates firms to acquire more and to focus more on diversifying acquisitions, which is in line with Gormley and Matsa (2016).

4.7. Heterogeneity of the Agency Channel

By far, the empirical evidence lends support to the agency channel through which payout taxation affects corporate innovation, and the underlying operational activities. In this section, I study how the agency channel varies across different subsamples, categorized by governance mechanisms, market competition, and compensation structures.

4.7.1. Governance Mechanisms. I first study the interactive effect of two governance mechanisms with the tax cut—institutional shareholder monitoring and anti-takeover protections. Shareholder monitoring intensity is measured using the total shareholdings of the top ten institutional shareholders of the firm; anti-takeover threat is measured using the well-accepted measure of G-index (Gompers, Ishii, and Metrick, 2003). For each measure, the full panel sample of firms is categorized into two subgroups based on whether a firm's governance intensity, recorded in 2002, is higher or lower than the sample median of that year. "Well-governed" firms are those that have high institutional shareholding and low anti-takeover protections.

[Insert Table 8 Here.]

Table 8 estimates model (1) in these subgroups and DiD coefficients are reported for each of those regressions. In Panel A, the sorting variable is institutional shareholding, and the results show that the effects of both mitigated private benefit motives and aggravated managerial risk aversion are stronger in firms with lower shareholder monitoring. One explanation of this finding is that stronger governance propels corporate R&D strategy to an efficient level, and managerial incentive changes brought about by the tax cut have minimal effects on such an allocation. The same pattern and interpretation hold true when using G-index to categorize the sample in Panel B.

4.7.2. Industry Competition. Agency effects could also vary across firms based on how competitive their industries are. Giroud and Mueller (2010) show that firms in competitive industries are less sensitive to governance and incentive changes, consistent with the notion that competition as an important type of external governance mitigates agency conflicts. Similarly, Giroud and Mueller (2011) show that firms with weak governance have a worse performance only in noncompetitive industries. Kim and Lu (2011) show, in a more specific setting, that industry competition weakens managers' incentive to "play it safe."

Table 8 Panel C studies how the effects of agency conflicts on motivating innovation differ when the industry is competitive or noncompetitive. The sorting variable is the 3-digit SIC Herfindahl-Herschman index (HHI) calculated using sales. A firm is defined as being in a competitive (noncompetitive) industry if its industry HHI is lower (higher) than the sample median. The DiD effects are weaker in firms in more competitive industries, consistent with the explanation that agency conflicts are governed by industry competition.

4.7.3. Options and Compensation Convexity. I now examine the role of managerial compensation structure. The specific focus is on option grants, a crucial contracting device used to motivate managers to take on healthier risks and invest in R&D projects (Francis and Smith, 1995; Manso, 2011). Following Guay (1999) and Coles, Daniel, and Naveen (2006), I calculate the *vega* of a manager's option portfolio, which quantifies the sensitivity of managerial income to firm stock volatility, and this measure is available for about one-third of the sample. In Panel D of Table 8, the sorting variable is the *vega* of the CEO's option holding, and it can be seen that exacerbating managerial risk aversion has a weaker effect on firms with high convexity (high *vega*) in the compensation package, which means that such a mechanism could govern and smoothen innovation investment.

5. Additional Results and Discussions

Section 4 establishes how payout taxation affects corporate investment through the agency channel. Specifically, the 2003 Dividend Tax Cut aligned shareholder-manager incentives and exacerbated managerial risk aversion, which in turn affected investment behaviors in firms with different exposures to the shock. In this section, I provide additional analyses to further validate the empirical approach and discuss potential alternative interpretations.

5.1. Placebo Tests with Pseudo Events

A key identifying concern for the DiD empirical design is that it simply estimates some phenomena along the time trends that would happen even without the 2003 Dividend Tax Cut. This is unlikely to be the case, given the dynamic parallel-trend analysis provided by estimating model (2). Here I further rule out this concern by conducting placebo tests following the same framework as model (1) with pseudo-events. Specifically, I estimate model (1) assuming counterfactual "pseudo-tax cuts" by scrambling the tax cut year but maintaining the same ownership portfolio assignment methodology, which assigns ownership categories using data in the two years leading to the pseudo-cuts. Table 9 reports analyses using pseudo-years 1995 and 1999. I find no effects for any placebo tax cut year.

[Insert Table 9 Here.]

5.2. Alternative Incentive Measures Accounting For Wealth

Throughout the main analyses, the main ownership measure is fractional managerial ownership, defined as the percentage of outstanding shares owned by managers, officers, and the board of directors. This measure is consistent with similar studies, including Chetty and Saez (2005), Masulis and Reza (2015), and Cheng et al. (2016), and is the measure most commonly used in related studies (Edmans and Holderness, 2017). Importantly, this measure is motivated by the agency model of Chetty and Saez (2010), where this ownership share is an informative statistic to measure incentives in the setting of the dividend tax cut.

[Insert Table 10 Here.]

This approach does not take into account the effect of a manager's wealth and his or her overall compensation package, which affect the contracting environment and incentive structure (Lewellen, 2006). This is a common challenge in the literature (Frydman and Jenter, 2010). To confirm that the inability to observe managerial wealth is not a crucial problem for the interpretation of this paper's findings, two new measures are constructed to capture the heterogeneity of the exposure to the dividend tax cut. The first measure is the value of managerial ownership in the firm as a fraction of the manager's materialized compensation package; the second is for the dividend payers, to measure the exposure using dividend income as a fraction of the materialized compensation package. Table 10 presents the results when using the two measures above to categorize how the 2003 Dividend Tax Cut affects the agency conflicts within the firm. The results are both qualitatively and quantitatively similar to the results found when using managerial ownership.

5.3. Shareholder Effects

Because the 2003 Dividend Tax Cut affects the incentives not only of managers but also of all dividend-receiving equity holders, a natural concern is that institutional investors could play an important role in corporate governance, which in turn could affect corporate behaviors. To rule out the possibility that the institutional shareholder channel is the underlying driver of the results, I exploit the fact that some institutional investors, such as pension funds and insurance companies, have tax-favored accounts and are thus not affected by the reform. If the results simply reflect this increased incentive of institutional investors to change corporate innovation, then the results should either not show up or become much weaker in firms where such non-affected entities could play an important role (Chetty and Saez, 2005).

[Insert Table 11 Here.]

Table 11 Panel A estimates the model with both innovation quantity and riskiness measures using a subsample of firms whose largest institutional owner is not affected by the tax cut: pension funds, insurance companies, nonprofit organizations, non-financial corporations, and government agencies. More specifically, in the Thomson Reuters database, unaffected entities are those classified as insurance companies (type 2) and "others" (type 5) whose names indicate whether they are a pension fund, nonprofit organization, government agency, or non-financial corporation.[19] The results confirm all the findings in Table 2 and Table 3, demonstrating that the effects of the 2003 Dividend Tax Cut on motivating innovation are not driven by influence from institutional investors.

5.4. The Cost of Capital Channel and Project Financing

5.4.1. The Cost of Capital Channel. The traditional cost of capital channel could certainly be still at play in aggregate. Yet this channel is unlikely to affect firms differently with respect to their pre-event managerial ownership level. Nevertheless, Table 11 Panel A can be considered further ruling out this concern empirically. Specifically, Lin and Flannery (2013) categorize firms as either likely or unlikely to be affected via the cost of capital channel based on whether the marginal equity pricer is likely to be affected by the shock. Table 11 Panel A shows that the main results hold even in the subsample where the cost of capital effect is likely to be secondary. Panel B follows Lin and Flannery (2013) more closely by constructing a measure of holdings directly owned by individual investors (excluding managerial ownership), who are likely to price the tax cut into the equity. The main results hold when such individual shareholding is low. Overall, the conceptual analysis and empirical results presented in Table 11 suggest that the findings are unlikely to be driven by either the institutional shareholder channel or the cost of capital channel.

5.4.2. The Effect of the Tax Holiday and Internal Financing Availability. Another concern regarding the empirical strategy is that the 2003 Dividend Tax Cut coincides with the American Jobs Creation Act (AJCA) of 2004, signed into law on October 22, 2004. The act creates a one-time tax holiday for multinational corporations (MNCs) to repatriate

[19] Chetty and Saez (2005) hand-classify type 5 institutions throughout to address the misclassification issue in Thomson Reuters. I use this reclassification to correct for the errors in 13(f).

undistributed foreign earnings at an unusually low tax cost. Under the act, 85% of the repatriated earnings are exempt from additional US taxes, resulting in a significant tax rate reduction from a maximum of 35% to 5.25%. Earlier papers show that this tax holiday altered the friction in MNCs' internal capital market and the value of cash (Blouin and Krull, 2009; Blouin, Krull, and Robinson, 2012; Harford, Wang, and Zhang, 2017), and this effect could change corporate investment decisions.

[Insert TABLE 12 Here.]

As in discussions of other potentially confounding events or channels, it is not obvious why such an event should deliver the nonlinear results regarding innovation quantity and significant results at the right tail of managerial ownership. To further confirm that this tax holiday concern is secondary in this setting, I repeat the analysis in Table 2 and Table 3 in the subsample of non-MNCs, which are unlikely to be affected by the tax holiday.[20] Table 12 shows the results. The main findings of the paper hold robustly in this domestic sample, suggesting that it is unlikely that the tax holiday in 2004 is driving the results.

5.5. Implications on Firm Valuation

Corporate investment, and corporate innovation in particular, is closely related to firm valuation (Kogan, Papanikolaou, Seru, and Stoffman, 2017). One implication of the agency channel is that firm valuation should change accordingly. Cheng, Hong, and Shue (2016) find that firms with medium managerial ownership have an 8.2% cumulative abnormal return from -31 calendar days before the tax cut event date to 180 days after. This suggests that those firms that increased R&D, though mostly in incremental innovation projects, received higher valuations. One aspect that is reported in Cheng, Hong, and Shue (2016) but omitted in the authors' interpretation (it is irrelevant to their setting) is that firms with high managerial ownership received particularly low valuations, as reflected in negative cumulative abnormal returns. This is again consistent with this paper, which shows that high-ownership firms decrease R&D investment, particularly along novel paths.

[20] A firm is categorized as a non-MNC if its foreign income taxes are lower than or equal to one million USD in all sample years from 1999 to 2006, following Harford, Wang, and Zhang (2017).

6. Concluding Remarks

This paper documents a new channel through which payout taxation reform affects corporate investment: the agency channel. A dividend tax cut increases managers' cash flow right to the firm via managerial ownership, which in turn further aligns shareholder-manager incentives but exacerbates managerial risk exposure to the firm. I provide evidence consistent with this agency channel using a setting of corporate innovation around the 2003 Dividend Tax Cut. I find that aligning incentives stimulates the quantity of innovation input and output. Aggravated managerial risk aversion impedes innovation quantity and also shifts innovation to safer and more incremental directions. Firms adjust innovative labor and their organizational structures to achieve these changes. The agency channel is mitigated by governance, compensation, and competition.

Several questions beyond the scope of this paper or data availability are nevertheless of great interest: First, it would be informative to understand how firms in practice adjust compensation contracting in different types of investment projects taking into consideration the agency channel. Second, little research has been focused on the agency implication of taxation policy, which in turn feeds into long-term economic growth through aggregating individual corporate responses. It could be a fruitful path toward understanding the welfare implications of this mechanism and how this concern could help us design a better taxation scheme.

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Table 1
Sample Overview and Summary Statistics

This table overviews the sample and reports summary statistics. The sample is an annual panel of firm innovation from four years prior to the tax cut (1999) to four years subsequent to the tax cut (2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Panel A reports the number of firms covered in each of the Fama-French 12 industries, and the average managerial ownership across different industries. Panel B reports summary statistics for the sample, including the mean, standard deviation, and the 25th, 50th, and 75th percentile for each of the firm characteristics. Panel C shows that the firm characteristics summarized above vary across firms with different levels of managerial ownership. In this panel, firms are categorized into low, medium, and high based on the average fractional managerial ownership level in 2001 and 2002 (two years leading to the dividend tax cut).

Panel A: Industry Distribution of the Sample

	Number of Firms	Average Managerial Ownership
Consumer Durables	77	14.19%
Manufacturing	352	12.44%
Oil, Gas and Related	32	12.53%
Chemicals and Allied Products	95	14.49%
Business Equipment	943	15.91%
Telephone and Television Transmission	30	12.16%
Wholesale, Retail	52	18.83%
Healthcare, Medical Equipment, and Drug	476	14.00%
Other (Construction, Transportation, etc.)	108	18.70%
Total (Average)	2243	15.00%

Panel B: Pooled Summary Statistics

	N	Mean	Std.Dev	25th	Median	75th
Managerial Ownership	16295	0.15	0.19	0.01	0.06	0.22
R&D/Assets	16295	9.97	11.21	1.67	6.05	13.73
Number of New Patent Applications	16295	7.22	15.89	0.00	0.00	5.00
Explorative Citations	7678	0.62	0.29	0.41	0.64	0.88
Scaled Patent Citations	7678	1.01	0.82	0.00	0.00	0.95
Total Assets	16295	1076.45	2185.78	38.23	158.86	780.84
Leverage	16295	0.16	0.18	0.00	0.10	0.28
Payout Ratio	16295	0.07	0.16	0.00	0.00	0.00
Dividend Ratio	16295	0.01	0.02	0.00	0.00	0.00
Dummy (Paying Dividend)	16295	0.22	0.41	0.00	0.00	0.00

Panel C: Summary Statistics by Managerial Ownership

	Low Ownership		**Medium Ownership**		**High Ownership**	
	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
Managerial Ownership	3%	8%	11%	12%	32%	21%
R&D/Assets	8.97	10.54	11.08	11.73	9.88	11.24
Number of New Patent Applications	13.86	21.51	4.18	10.78	3.36	10.04
Explorative Citations	0.61	0.26	0.61	0.32	0.64	0.31
Scaled Patent Citations	0.71	0.83	0.51	0.84	0.39	0.75
Total Assets	2169.69	2959.31	554.24	1358.70	461.79	1297.72
Leverage	0.18	0.18	0.14	0.17	0.17	0.20
Payout Ratio	0.10	0.19	0.05	0.14	0.05	0.15
Dividend Ratio	0.01	0.02	0.01	0.02	0.01	0.02
Dummy (Paying Dividend)	0.33	0.47	0.16	0.36	0.16	0.36

Table 2
Diff-in-Diffs of Innovation Quantity after the 2003 Dividend Tax Cut

This table documents the difference-in-differences of innovation quantity (both input and output) after the 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership. The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t \geq 2003} + \beta_{high} \times I_{high} \times I_{t \geq 2003}$$
$$+ \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn(I_{medium}) = 1$), and high ($HighOwn(I_{high}) = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. Columns (1) to (3) investigate innovation input, and the dependent variable is R&D expenditures scaled by firm assets. In columns (4) to (6) the dependent variable is the natural logarithm of the number of new patent applications plus one. In column (7) the dependent variable is the number of new patent applications transformed using the inverse hyperbolic sine function. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t \geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	R&D/Assets			ln(1+New.Patent)			Asinh(New.Patent)
MedOwn × Post2003	0.479*	0.325*	0.482***	0.045*	0.070**	0.072**	0.060**
	(1.842)	(1.753)	(4.370)	(1.956)	(2.225)	(2.401)	(2.572)
HighOwn × Post2003	-0.824***	-0.586***	-0.383**	-0.043	-0.093**	-0.084**	-0.081**
	(-2.963)	(-3.828)	(-2.208)	(-1.319)	(-2.661)	(-2.622)	(2.227)
Tobin's Q			0.257**			-0.010**	-0.012**
			(2.501)			(-2.633)	(-2.581)
Leverage			2.824***			-0.062	-0.117
			(4.016)			(-0.842)	(-1.453)
Firm Age			-1.581**			-0.042	-0.037
			(-2.120)			(-0.844)	(-0.705)
Observations	16,295	16,295	16,295	16,295	16,295	16,295	16,295
R^2	0.808	0.849	0.851	0.890	0.870	0.873	0.869
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size Controls	No	Yes	Yes	No	Yes	Yes	Yes

Table 3
Diff-in-Diffs of Innovation Riskiness after the 2003 Dividend Tax Cut

This table documents the difference-in-differences of innovation riskiness and novelty after the 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership. The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t\geq 2003} + \beta_{high} \times I_{high} \times I_{t\geq 2003} \\ + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. Columns (1) to (3) investigate innovation novelty and the dependent variable is the ratio of citations made to new knowledge (patents that the firm never cited before) in new innovation. In columns (4) to (6) the dependent variable is the standardized patent citations, calculated as lifetime citations divided by the average quality of patents in the same vintage and technological class. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t\geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Explorative Citations (in %)			Scales Patent Citations (Quality)		
MedOwn×Post2003	-1.709	-0.445	-0.362	-0.117*	-0.036	-0.014
	(-1.178)	(-0.337)	(-0.237)	(-1.678)	(-0.492)	(-0.186)
HighOwn×Post2003	-4.694***	-3.404***	-3.038*	-0.257***	-0.175***	-0.168***
	(-2.917)	(-3.316)	(-1.785)	(-4.279)	(-2.743)	(-2.597)
Tobin's Q			0.298*			-0.011
			(1.685)			(-1.547)
Leverage			-5.340*			-0.134
			(-1.656)			(-0.964)
Firm Age			-2.458***			-0.034
			(-5.193)			(-1.639)
Observations	7,678	7,678	7,678	7,678	7,678	7,678
R^2	0.559	0.560	0.563	0.432	0.433	0.437
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Size Controls	No	Yes	Yes	No	Yes	Yes

Table 4
Effect Based on Ownership Levels of Technology Officers

This table documents the difference-in-differences of innovation after the 2003 Dividend Tax Cut across firms with different levels of pre-event shareholding of technological officers. Technological officers are identified by combining the HBS inventor database with SEC Form 4 Insider data. The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t\geq 2003} + \beta_{high} \times I_{high} \times I_{t\geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional technology officer ownership level in 2001 and 2002 (the two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. Column (1) investigates innovation input, and the dependent variable is R&D expenditures scaled by firm assets. In column (2) the dependent variable is the natural logarithm of the number of new patent applications plus one. Column (3) investigates innovation novelty and the dependent variable is the ratio of citations made to new knowledge (patents that the firm never cited before) in new innovation. In column (4) the dependent variable is the standardized patent citations, calculated as lifetime citations divided by the average quality of patents in the same vintage and technological class. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t\geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1) R&D/Assets	(2) ln(1+New.Patent)	(3) Explorative Citations (in %)	(4) Scaled Patent Citations
MedOwn × Post2003	0.480**	0.054*	0.055	0.015
	(2.598)	(1.701)	(0.033)	(0.164)
HighOwn × Post2003	-0.789**	-0.118***	-3.558**	-0.197**
	(-2.604)	(-3.215)	(-2.218)	(-2.564)
Tobin's Q	0.421***	-0.011***	0.179	-0.007
	(2.737)	(-2.846)	(0.804)	(-0.879)
Leverage	3.347***	-0.133	-5.367	-0.008
	(4.072)	(-1.287)	(-1.133)	(-0.038)
Firm Age	-0.041	0.071***	-0.896	-0.030
	(-0.288)	(3.206)	(-1.458)	(-0.911)
Observations	9,129	9,129	5,223	5,223
R^2	0.835	0.897	0.563	0.436
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes

Table 5
Diff-in-Diffs of Product Market Innovation after the 2003 Dividend Tax Cut

This table documents the difference-in-differences of product market innovation (number and overlying riskiness) after the 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership. The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t \geq 2003} + \beta_{high} \times I_{high} \times I_{t \geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. Columns (1) to (2) investigate the number of new product introductions, and the data are from the Compustat Segment File. In columns (3) to (4) the dependent variable is the uniqueness of the product compared to industry competitors' products, and the data are from Hoberg and Phillips (2016). Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t \geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Number of New Products		Product Uniqueness	
MedOwn×Post2003	0.194*	0.210**	-0.102	-0.106
	(2.005)	(2.220)	(-1.425)	(-1.660)
HighOwn×Post2003	-0.142**	-0.131**	-0.189***	-0.180***
	(-2.119)	(-2.142)	(-3.520)	(-3.432)
Tobin's Q		-0.026		0.002
		(-0.908)		(0.216)
Leverage		-0.185		-0.778***
		(-0.679)		(-5.683)
Firm Age		-0.147		-0.030
		(-1.064)		(-0.666)
Observations	5,212	5,212	8,187	8,187
R^2	0.827	0.827	0.966	0.967
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes

Table 6
Innovative Labor Adjustment after the 2003 Dividend Tax Cut

This table documents the difference-in-differences of inventor mobility (inventor base size and turnover activities) and innovation productivity at the inventor level after the 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership. Panel A conducts the analysis focusing on inventor mobility, and the effects are estimated using OLS with the following specification:

$$InventorMobility_{i,t} = \beta_{medium} \times I_{medium} \times I_{t \geq 2003} + \beta_{high} \times I_{high} \times I_{t \geq 2003} \\ + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. A "leaver" is an inventor who leaves the firm during a given year, who generates at least one patent in the firm before the year of leaving, and who generates at least one patent in a different firm afterward. A "new hire" is an inventor who has been newly hired by a given firm in a given year, who generates at least one patent in a different firm before the year of hiring, and who generates at least one patent in the current firm afterward. A "stayer" is an inventor who stays with the firm during a given year and who generates at least one patent both before and after the year of intervention (or the pseudo-event year). An inventor is considered as generating a patent if he or she files for a patent during the relevant time period and that request is ultimately granted. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t \geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Inventor Mobility after the 2003 Dividend Tax Cut

	Inventor Base		**Inventor Turnover**			
	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(1+Stayers)		Ln(1+Leavers)		Ln(1+New Hires)	
MedOwn × Post2003	0.069	0.045	0.047*	0.053*	0.088***	0.082***
	(1.485)	(0.970)	(1.862)	(2.002)	(2.797)	(2.597)
HighOwn × Post2003	-0.031	-0.036	0.003	0.002	-0.045	-0.047
	(-0.730)	(-0.844)	(0.087)	(0.074)	(-1.501)	(-1.553)
Tobin's Q		- 0.003***		- 0.001***		-0.001*
		(-2.780)		(-2.961)		(-1.865)
Leverage		0.194**		0.107		0.008
		(2.183)		(1.283)		(0.151)
Firm Age		-0.013		-0.006		-0.003
		(-1.330)		(-1.013)		(-0.508)
Observations	4,214	4,214	4,214	4,214	4,214	4,214
R^2	0.940	0.945	0.852	0.855	0.873	0.880
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes	Yes	Yes

Panel B examines the innovation quantity and riskiness of stayer inventors and newly hired inventors after the 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership, and the effects are estimated using OLS with the following specification at the inventor(j)-year(t) level:

$$Innovation_{j,t} = \beta_{medium} \times I_{medium} \times I_{t \geq 2003} + \beta_{high} \times I_{high} \times I_{t \geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. A "new hire" is an inventor who has been newly hired by a given firm in a given year, who generates at least one patent in a different firm before the year of hiring, and who generates at least one patent in the current firm afterward. A "stayer" is an inventor who stays with her firm during a given year and who generates at least one patent both before and after the year of intervention (or the pseudo-event year). An inventor is considered as generating a patent if she files for a patent during the relevant time period and that request is ultimately granted. In columns (1) to (2) the dependent variable is the natural logarithm of patent counts at the inventor-year level (plus one). Columns (3) to (4) investigate the average explorative citation ratio of patents produced at the inventor-year level. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t \geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel B: Innovation Characteristics after the 2003 Dividend Tax Cut, Inventor-level

	Innovation Quantity		**Innovation Riskiness**	
	(1)	(2)	(3)	(4)
	Stayers	New Hires	Stayers	New Hires
MedOwn × Post2003	0.091**	0.183*	3.617	-4.104
	(2.224)	(1.731)	(0.834)	(-1.241)
HighOwn × Post2003	-0.102	-0.132	-6.237**	-10.515*
	(-1.072)	(-1.145)	(-2.185)	(-1.734)
Tobin's Q	0.003	-0.001	0.007***	0.003
	(1.631)	(-0.438)	(2.898)	(0.550)
Leverage	-0.185**	0.233	0.108	0.230
	(-2.170)	(1.080)	(0.566)	(0.908)
Firm Age	-0.118***	-0.119	-0.241***	-0.194*
	(-6.351)	(-0.810)	(-8.211)	(-1.954)
Observations	73,164	5,826	73,164	5,826
R^2	0.134	0.239	0.424	0.511
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes

Table 7
DiD of Innovation Organizational Structure after the 2003 Dividend Tax Cut

This table documents the difference-in-differences of innovation organization structure after the 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership. The effects are estimated using OLS with the following specification:

$$InnovationOrganization_{i,t} = \beta_{medium} \times I_{medium} \times I_{t \geq 2003} + \beta_{high} \times I_{high} \times I_{t \geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. Columns (1) to (2) investigate the purchase of patents on the market for technology. The dependent variable is the numbers of patents bought by a firm in a given year scaled by the total patents owned by the firm. Patent transactions are identified from the United States Patent and Trademark Office (USPTO) and accessed through the Google Patent database. In columns (3) to (4) the dependent variable is the natural logarithm of one plus the value of acquisition deals conducted in each firm-year, and acquisition data are from Thomson Reuters SDC Platinum. In columns (5) and (6), the sample is restricted to those firm-year observations that have at least one acquisition deal. The dependent variable is the ratio of diversifying deals, defined as those acquisitions in which the acquirer buys a target outside the acquirer's main business line. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t \geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Purchase/PatentStock		ln(1+Total M&A Value)		% of Div M&A	
MedOwn×Post2003	0.007	-0.038	0.020	-0.022	-2.060	-2.366
	(0.075)	(-0.394)	(0.192)	(-0.206)	(-0.728)	(-0.859)
HighOwn×Post2003	0.280**	0.221**	0.153**	0.119*	7.812*	8.258*
	(2.523)	(2.077)	(2.425)	(2.003)	(1.852)	(1.843)
Tobin's Q		-0.000		0.004		0.161
		(-0.034)		(0.321)		(0.521)
Patent Stock		-0.070		-0.368**		7.299
		(-0.360)		(-2.038)		(0.895)
Log(1+New Patents)		-0.077***		0.112**		-1.268
		(-3.217)		(2.474)		(-1.234)
Observations	16,295	16,295	16,295	16,295	4,385	4,385
R^2	0.209	0.234	0.355	0.362	0.589	0.594
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes	Yes	Yes

Table 8
Heterogeneous Effects across Governance, Competition, and Compensation

This table documents the difference-in-differences of innovation after the 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership. The analyses are performed on subsamples of firm categorized by their pre-event level of corporate governance. They are sorted by the institutional shareholding of the top ten investors (Panel A), and by G-Index (Panel B); by their industry competition intensity measured using HHI at the 3-digit SIC level (Panel C); and by compensation convexity measured by option VEGA (Guay, 1999; Coles et al., 2006) (Panel D). The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t\geq 2003} + \beta_{high} \times I_{high} \times I_{t\geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (the two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. The upper panel is sorted by institutional shareholding and the bottom panel is sorted by G-Index. Column (1) investigates innovation input, and the dependent variable is R&D expenditures scaled by firm assets. In column (2) the dependent variable is the natural logarithm of the number of new patent applications plus one. Column (3) investigates innovation novelty and the dependent variable is the ratio of citations made to new knowledge (patents that the firm never cited before) in new innovation. In column (4) the dependent variable is the standardized patent citations, calculated as lifetime citations divided by the average quality of patents in the same vintage and technological class. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t\geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1) R&D/Assets	(2) ln(1+New.Patent)	(3) Explorative Citations (in %)	(4) Scaled Patent Citations
		Panel A: Institutional Shareholding		
Weak Monitoring (Low Inst)				
MedOwn×Post2003	0.681*	0.071***	-0.997	0.154**
	(1.913)	(3.364)	(-0.454)	(2.109)
HighOwn×Post2003	-0.815***	-0.090***	-5.221***	-0.276***
	(-3.659)	(-3.285)	(-3.559)	(-3.928)
Strong Monitoring (High Inst)				
MedOwn×Post2003	0.361	0.066*	-0.599	-0.108
	(1.388)	(1.924)	(-0.349)	(-1.190)
HighOwn×Post2003	-0.147	-0.072*	-3.884	-0.071
	(-0.347)	(-2.108)	(-1.306)	(-0.560)
		Panel B: G-Index		
Weak Corporate Governance (High G-Index)				
MedOwn×Post2003	0.741***	0.084*	1.438	0.218
	(3.430)	(1.744)	(0.700)	(0.843)
HighOwn×Post2003	-1.027***	0.118**	-4.230**	-0.276*
	(-3.014)	(2.588)	(-2.300)	(-1.981)
Strong Corporate Governance (Low G-Index)				
MedOwn×Post2003	0.564**	0.055	2.930	-0.141
	(2.572)	(1.132)	(1.050)	(-1.624)
HighOwn×Post2003	-0.322	-0.074	-2.745	-0.043
	(-1.392)	(-0.973)	(-1.068)	(-0.417)
		Panel C: Industry Competition (*HHI*)		
Weak Competition (High HHI)				
MedOwn×Post2003	0.810***	0.082**	-0.251	-0.149**
	(3.597)	(2.048)	(-0.112)	(-2.629)
HighOwn×Post2003	-0.802***	-0.124***	-3.555**	-0.217***
	(-3.706)	(-3.581)	(-2.041)	(-2.810)
Strong Competition (Low HHI)				
MedOwn×Post2003	0.689	0.062**	0.586	-0.096*
	(1.445)	(2.609)	(0.239)	(-1.834)
HighOwn×Post2003	-0.273	-0.040	-3.645***	0.075
	(-0.615)	(-1.551)	(-3.443)	(1.555)
		Panel D: VEGA		
Low VEGA (Less Convex Payment)				
MedOwn×Post2003	0.517	0.076	7.377	-0.107
	(0.857)	(1.536)	(1.715)	(-0.505)
HighOwn×Post2003	-0.719**	-0.118*	-4.393***	-0.394*
	(2.023)	(-1.753)	(-2.255)	(-2.028)
High VEGA (Higher Convex Payment)				
MedOwn×Post2003	1.032*	0.047	0.280	-0.302
	(1.744)	(1.247)	(0.093)	(-1.444)
HighOwn×Post2003	0.768	0.136	-2.616*	-0.116
	(0.599)	(0.782)	(-1.738)	(-0.487)

Table 9
Placebo Tests Using Pseudo-Event Years

This table documents the difference-in-differences of innovation after two pseudo-Dividend Tax Cut (1995 and 1999), across firms with different levels of pre-pseudo-event managerial ownership. The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t \geq eventyear} + \beta_{high} \times I_{high} \times I_{t \geq eventyear} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the pseudo tax cut to four years subsequent to the pseudo tax cut. The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before the sample starts and has at least one positive R&D expenditure within the five-year window prior to that year. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in the two years leading to the pseudo-dividend tax cut. *Post#* is a dummy variable equal to one if the observation is post-# (with "#" being the year in question). Column (1) investigates innovation input, and the dependent variable is R&D expenditures scaled by firm assets. In column (2) the dependent variable is the natural logarithm of the number of new patent applications plus one. Column (3) investigates innovation novelty and the dependent variable is the ratio of citations made to new knowledge (patents that the firm never cited before) in new innovation. In column (4) the dependent variable is standardized patent citations, calculated as lifetime citations divided by the average quality of patents in the same vintage and technological class. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in the two years before the pseudo events. Size controls include interactions of those size category dummies and $I_{t \geq eventyear}$. All specifications include firm and year fixed effects. The *t*-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1) R&D/Assets	(2) ln(1+New.Patent)	(3) Explorative Citations (in %)	(4) Scaled Patent Citations
		Panel A: Placebo Year: 1999		
MedOwn×Post1999	0.180	-0.015	0.152	-0.008
	(0.692)	(-0.322)	(0.099)	(-0.171)
HighOwn×Post1999	0.080	0.062	0.324	0.023
	(0.405)	(1.332)	(0.288)	(0.413)
Observations	17,412	17,412	8,029	8,029
R^2	0.844	0.848	0.533	0.526
		Panel B: Placebo Year: 1995		
MedOwn×Post1995	-0.122	0.065	-0.440	-0.041
	(-0.775)	(1.600)	(-0.265)	(-0.867)
HighOwn×Post1995	0.593	-0.034	-1.896	-0.051
	(1.509)	(-0.668)	(-0.975)	(-0.948)
Observations	16,289	16,289	7,147	7,147
R^2	0.817	0.878	0.506	0.548
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes

Table 10
Alternative Managerial Ownership Measures

This table documents the difference-in-differences of innovation after the 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership. Managerial ownership is defined as the value of insider shareholding as a fraction of total compensation package (upper panel), and as the total dividend income as a fraction of total compensation package (bottom panel). The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t\geq 2003} + \beta_{high} \times I_{high} \times I_{t\geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (the two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. Column (1) investigates innovation input, and the dependent variable is R&D expenditures scaled by firm assets. In column (2) the dependent variable is the natural logarithm of the number of new patent applications plus one. Column (3) investigates innovation novelty and the dependent variable is the ratio of citations made to new knowledge (patents that the firm never cited before) in new innovation. In column (4) the dependent variable is the standardized patent citations, calculated as lifetime citations divided by the average quality of patents in the same vintage and technological class. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t\geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1) R&D/Assets	(2) ln(1+New.Patent)	(3) Explorative Citations (in %)	(4) Scaled Patent Citations
	Panel A: Ownership/Compensation (%)			
MedOwn×Post2003	0.234*	0.070**	-0.940	-0.155**
	(1.907)	(2.214)	(-0.525)	(-2.191)
HighOwn×Post2003	-0.758***	-0.061**	-4.744***	-0.143**
	(-6.371)	(-2.000)	(-2.818)	(-2.011)
	Panel B: Dividend/Compensation (%), For Dividend Payers			
MedOwn×Post2003	0.234*	0.037**	-0.001	-0.222**
	(2.005)	(2.290)	(-0.000)	(-2.289)
HighOwn×Post2003	-0.670***	-0.055***	-3.317**	-0.275***
	(-5.963)	(-3.670)	(-2.498)	(-2.921)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes

Table 11
The Effect of Shareholder Composition

This table documents the difference-in-differences of innovation after the 2003 Dividend Tax Cut across firms with different compositions of pre-event ownership. The sample is restricted to a sample of firms whose largest institutional investor is a tax-favored investors therefore was not affected by the shock (upper panel), and a sample of firms whose level of individual direct ownership is below sample median in year 2001 and 2002 (bottom panel). The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t\geq 2003} + \beta_{high} \times I_{high} \times I_{t\geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years subsequent to the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm has filed and been granted at least one patent before 1999 and has at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (the two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. Column (1) investigates innovation input, and the dependent variable is R&D expenditures scaled by firm assets. In column (2) the dependent variable is the natural logarithm of the number of new patent applications plus one. Column (3) investigates innovation novelty and the dependent variable is the ratio of citations made to new knowledge (patents that the firm never cited before) in new innovation. In column (4) the dependent variable is the standardized patent citations, calculated as lifetime citations divided by the average quality of patents in the same vintage and technological class. Control variables include Tobin's Q, leverage, and firm age. Detailed size controls are also included in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t\geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1) R&D/Assets	(2) ln(1+New.Patent)	(3) Explorative Citations (in %)	(4) Scaled Patent Citations
	Panel A: High Ownership of Nontaxable Institutional Investors			
MedOwn×Post2003	0.685*	0.050**	-1.410	-0.097
	(1.874)	(2.084)	(-0.807)	(-0.954)
HighOwn×Post2003	-0.598***	-0.093***	-4.265**	-0.231**
	(-2.950)	(-2.938)	(-2.092)	(-2.675)
	Panel B: Low Ownership of Individual Investors			
MedOwn×Post2003	0.856**	0.047*	-0.875	-0.090
	(2.681)	(1.707)	(-0.525)	(-0.850)
HighOwn×Post2003	-0.480*	-0.058*	-4.139***	-0.249***
	(-1.835)	(-1.883)	(-2.870)	(-4.075)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes

Table 12
Effects Estimated from Domestic (non-MNC) Firms

This table documents the difference-in-differences of innovation after 2003 Dividend Tax Cut across firms with different levels of pre-event managerial ownership. The sample is restricted to a sample of firms who are domestic and therefore were not affected by 2004 tax holiday. A firm is categorized to be a non-MNC if its foreign income taxes are less than or equal to one million USD in all sample years from 1999 to 2006. The effects are estimated using OLS with the following specification:

$$Innovation_{i,t} = \beta_{medium} \times I_{medium} \times I_{t \geq 2003} + \beta_{high} \times I_{high} \times I_{t \geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$

The sample is an annual panel of firm innovation from four years prior to the tax cut to four years after the tax cut (1999 to 2006). The sample is limited to potentially "innovative firms," requiring that a firm file at least one patent before 1999 and with at least one positive R&D expenditure within the five-year window prior to 1999. Firms are categorized into low, medium ($MedOwn = 1$), and high ($HighOwn = 1$) based on the average fractional managerial ownership level in 2001 and 2002 (the two years leading to the dividend tax cut). $Post2003$ is a dummy variable equal to one if the observation is post-2003. Column (1) investigates innovation input and the dependent variable is R&D expenditures scaled by firm assets. In column (2) the dependent variable is the natural logarithm of the number of new patent applications plus one. Column (3) investigates innovation novelty and the dependent variable is the ratio of citations made to new knowledge (patents that the firm neven cited before) in new innovation. In column (4) the dependent variable is the standardized patent citations, which is calculated as the life-time citation divided by the average quality of patents in the same vintage and technological class. Control variables include Tobin's Q, leverage, and firm age. I also include detailed size controls in the specification. That is, firms are ranked into size categories (small, medium, large) based on their average book assets in 2001 and 2002. Size controls include interactions of those size category dummies and $I_{t \geq 2003}$. All specifications include firm and year fixed effects. The t-statistics based on standard errors clustered at the firm level are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1) R&D/Asset	(2) ln(1+New.Patent)	(3) Explorative Citations (in %)	(4) Scaled Patent Citations
MedOwn×Post2003	0.555*	0.077***	-0.331	0.045
	(1.817)	(2.937)	(-0.203)	(0.798)
HighOwn×Post2003	-0.706*	-0.023*	-4.381***	-0.177**
	(-1.772)	(-1.695)	(-3.173)	(-2.300)
Tobin's Q	0.438***	-0.005***	0.118	-0.011
	(3.531)	(-2.888)	(0.588)	(-1.441)
Leverage	2.864***	-0.107	-7.697*	-0.128
	(4.045)	(-1.493)	(-2.005)	(-1.062)
Firm Age	-0.092	0.021	-0.914	-0.017
	(-0.893)	(1.426)	(-1.584)	(-0.642)
Observations	13,708	13,708	5,455	5,455
R-squared	0.813	0.843	0.568	0.459
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Size Controls	Yes	Yes	Yes	Yes

Appendix (Not For Publication)

A. Illustrative Model

To fix the idea of the empirical strategy, I build a stylized agency model following Chetty and Saez (2010) and Cheng, Hong, and Shue (2016). Two new ingredients are added to their original model in the same vein as the workhorse model of contracting theory as surveyed in Prendergast (1999) and covered in textbooks like Bolton and Dewatripont (2005) Chapter 4. The first is that the manager is risk-averse with CARA utility; and the second is that the investment project is risky and has a normally distributed return. These additional components help to jointly identify the effects of private benefit motives and managerial risk aversion. The original model of Chetty and Saez (2010) and Cheng, Hong, and Shue (2016) needs only private benefit motives in its mechanism.

A.1. Setup

The model has two periods, $t = 0, 1$. At $t = 0$, the risk-averse manager, who has CARA exponential utility function $u(c) = -e^{-\gamma c}$, is endowed with a cash flow Γ. She has three options: paying out D as a dividend, investing S in an R&D project whose expected return $\tilde{R}$ is normally distributed with mean $R > 1$ and variance δ^2, and investing J in a perk project to enjoy a private benefit with a converting rate of B. Managerial ownership is α of the firm, the discount rate is normalized to 0, and the dividend tax rate is τ. The corporate tax rate is omitted for simplicity and does not affect the model implication.

At $t = 1$, project $R \cdot S$ pays off. The firm is assumed to be liquidated and will pay out everything to shareholders. As a result, α of the realized value will be given to the manager.

The optimization problem of the manager is

$$\max_{D,S,J \geq 0;\ D+S+J=\Gamma} E[-e^{-\gamma\{\alpha(1-\tau)[D+\tilde{R}\cdot S]+B\cdot J\}}], \tag{A1}$$

subject to the budget constraint, $D + S + J = \Gamma$, $D, S, J \geq 0$. Due to the special form of

CARA and normalized return, the problem can be equivalently restated as

$$\max_{D,S,J\geq 0;\ D+S+J=\Gamma} \alpha(1-\tau)[D+R\cdot S]-\frac{1}{2}\gamma\alpha^2(1-\tau)^2\delta^2S^2+B\cdot J. \tag{A2}$$

A.2. Solution

The marginal utility of paying out a dividend is $\alpha(1-\tau)$; the marginal utility of investing in the perk project is B; and the marginal utility of investing in the risky project is $\alpha(1-\tau)R-\gamma\alpha^2(1-\tau)^2\delta^2S$, which is a decreasing function of S. Since the marginal utility of investing in S when $S=0$ is $\alpha(1-\tau)R>\alpha(1-\tau)$, one simple observation from the model is that firms will invest in the risky but profitable project before paying out any dividends.

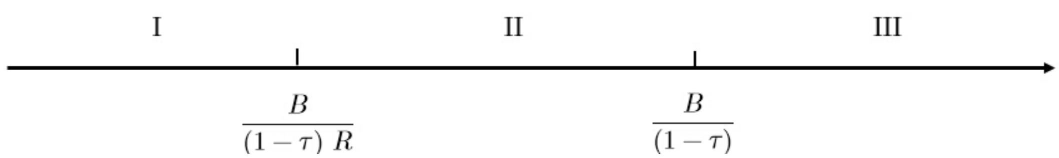


Figure A1. Cutoffs Based on Managerial Ownership

There are two important cutoffs. The first is when the ownership level α is very high, such that even dividends are more beneficial than the private benefit—that is, when

$$\alpha(1-\tau)\geq B \Leftrightarrow \alpha\geq\frac{B}{(1-\tau)},$$

the firm is free of private benefit motives.

The second cutoff is when α is very small, such that even the highest possible marginal utility from S is lower than the private benefit, i.e.,

$$\alpha(1-\tau)R\leq B \Leftrightarrow \alpha\leq\frac{B}{(1-\tau)R}.$$

In region I, the manager invests all the cash flow in the perk project to enjoy a private benefit. That is, $J^*=\Gamma, S^*=D^*=0$.

In region II, the firm invests in both R&D and the perk project. Specifically, the manager invests in S to the optimum level and invests the rest in the perk project. The optimal S is

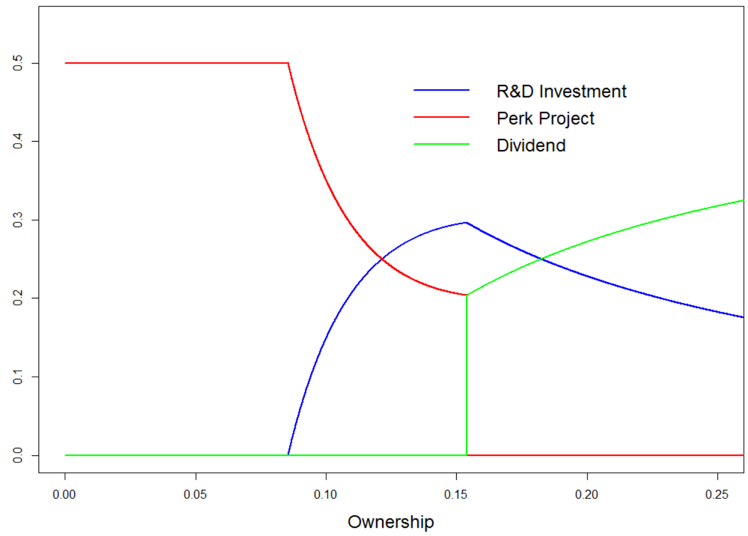


Figure A2. Solutions to the Model

determined by

$$\alpha(1-\tau)R - \gamma\alpha^2(1-\tau)^2\delta^2 S = B \Rightarrow S^* = \frac{\alpha(1-\tau)R - B}{\gamma\alpha^2(1-\tau)^2\delta^2},$$

and $D^* = 0, J^* = 1 - S^*$. In this region, both private benefit motives and managerial risk aversion exist.

In region III, the firm is free of private benefit motives, and the firm invests in the profitable project to the optimum level and pays out the remaining. The optimal S is determined by

$$\alpha(1-\tau)R - \gamma\alpha^2(1-\tau)^2\delta^2 S = \alpha(1-\tau) \Rightarrow S^* = \frac{R-1}{\gamma\alpha(1-\tau)\delta^2},$$

and $J^* = 0, D^* = 1 - S^*$. Note that managerial risk aversion is the dominating agency problem in this region, and investments in S decreases with ownership α.

A.3. Economics of the Tax Cut

A.3.1. Insensitive Region. In region I, $J^* = \Gamma, S^* = D^* = 0$. The effect from a decline in τ on investment level S is

$$\frac{\partial S^*}{\partial \tau} = 0.$$

Notice, however, that at the extensive margin, when τ decreases to τ', certain firms with $\alpha \in [\frac{B}{(1-\tau')R}, \frac{B}{(1-\tau)R}]$ start to invest in S.

A.3.2. Managerial Risk Aversion Dominating. In the private benefit-free region III, the manager invests in S to the optimum level and pays out the rest. The optimal S is determined by

$$\alpha(1-\tau)R - \gamma\alpha^2(1-\tau)^2\delta^2 S = \alpha(1-\tau) \Rightarrow S^* = \frac{R-1}{\gamma\alpha(1-\tau)\delta^2},$$

which naturally leads to

$$\frac{\partial S^*}{\partial \tau} > 0, \ \frac{\partial S^*}{\partial \alpha} < 0, \ \frac{\partial^2 S^*}{\partial \tau \partial \alpha} < 0,$$

so a decrease in τ leads to a decrease in S.

A.3.3. Private Benefit Motives Dominating. In region II, the manager invests in S to the optimum level and invests the rest in the perk project. The optimal S is determined by

$$\alpha(1-\tau)R - \gamma\alpha^2(1-\tau)^2\delta^2 S = B \Rightarrow S^* = \frac{\alpha(1-\tau)R - B}{\gamma\alpha^2(1-\tau)^2\delta^2},$$

which leads to

$$\frac{\partial S^*}{\partial \tau} = \frac{\alpha(1-\tau)R - 2B}{\gamma\alpha^2(1-\tau)^3\delta^2} = \begin{cases} < 0, & \text{if } \alpha \in [\frac{B}{(1-\tau)R}, \frac{2B}{(1-\tau)R}]; \\ > 0, & \text{if } \alpha \in [\frac{2B}{(1-\tau)R}, \frac{B}{(1-\tau)}]. \end{cases}$$

Actually, if $R < 2$, then we always have $\frac{\partial S^*}{\partial \tau} < 0$.[21] Under this case, $\frac{\partial S^*}{\partial \alpha} > 0$. Meanwhile, we can show that

$$\frac{\partial^2 S^*}{\partial \tau \partial \alpha} = \frac{-\alpha(1-\tau)R + 2B + 2B}{\gamma\alpha^3(1-\tau)^3\delta^2} > 0.$$

A.3.4. Simple Numerical Example. In Figure A3, I present a very simple numerical example to illustrate the pattern of response curve of innovation after the tax cut. Parameter setting: $\gamma = 3, \tau = 35\%, \tau_{after\ cut} = 15\%, R = 1.8, \delta = 3, B = 0.1, \Gamma = 0.5$. On the left panel I

[21] This case is for illustration purposes; the implication for the empirical design remains unchanged.

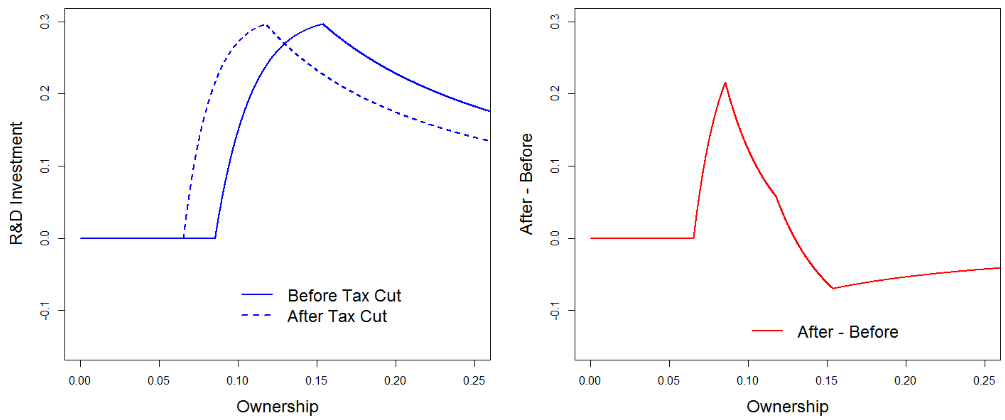


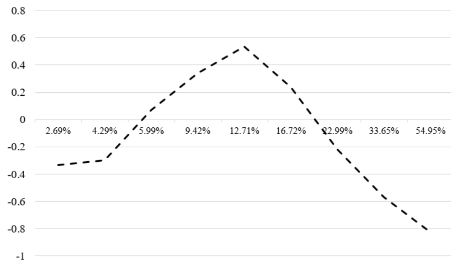
Figure A3. Response Curve to the Dividend Tax Cut Across Ownership Levels

show the optimal innovation level before and after the tax cut, and on the right panel I show the difference between the two—this is the theoretical analogy of the difference-in-differences estimate.

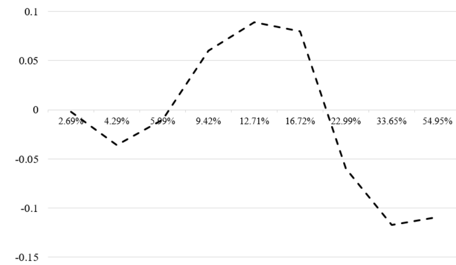
A.3.5. Empirical Exploration of Ownership Cutoffs. In the paper, I mainly use tercile cutoffs and identify the agency effects via comparing medium- and high-managerial ownership firms with low-ownership firms. To provide a more complete picture of how firms with different managerial ownership structures respond to the tax cut differently, I expand the specification in model (1) to estimate responses from deciles of managerial ownership levels. Specifically, the new expanded model is

$$Innovation_{i,t} = \sum_{decile=2}^{10} \beta_{decile} \times I_{decile} \times I_{t \geq 2003} + \beta \cdot X_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}. \tag{A3}$$

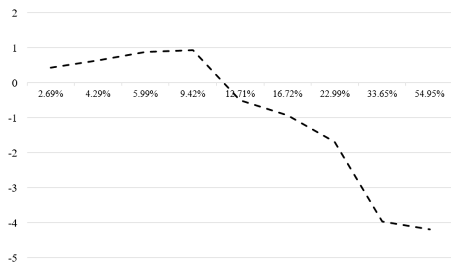
I_{decile} is a set of dummy variables indicating the decile that firm i belongs to, and the coefficients β_{decile} then pick up the response of those firms to the dividend tax cut across various innovation dimensions. Those β-coefficients are plotted in Figure A4.



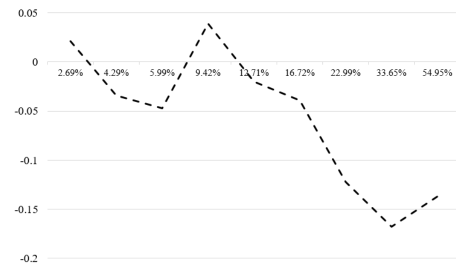
(a) R&D/Assets



(b) Ln(1+New.Patents)



(c) Explorative Citations



(d) Scaled Patent Citations

Figure A4. Responses to the Tax Cut Across Deciles of Managerial Ownership

B. Key Variable Definitions

Variable	Definition and Construction
	a. Innovation Variables
R&D/Assets	R&D expenditure scaled by total assets of the firm
New Patents	Number of patent applications filed by a firm in a given year. The natural logarithm of this variable plus one is used in the paper, i.e., $\ln(NewPatent) \equiv \ln(New\ Patent + 1)$. The inverse hyperbolic sine-transformed variable is used as a robustness check.
Scaled Patent Citations	Lifetime citations received by the patent scaled by the average lifetime citations received by patents in the same vintage (application year) and technological class. Converted to firm-year level by averaging across all patents produced in the firm in each year.
Explorative Citations (%)	The ratio of citations made to patents not belonging to a firm's existing knowledge, divided by the number of total citations made by the patent. Converted to firm-year level by averaging across all patents produced in the firm in each year.
Inventor Leavers	An inventor is defined as a leaver of firm i in year t, if he or she generates at least one patent in firm i between $[t-3, t-1]$ and generates at least one patent in a different firm between $[t+1, t+3]$. Identified from the Harvard Business School patenting database.
Inventor New Hires	An inventor is defined as a new hire of firm i in year t, if he or she generates at least one patent in another firm between $[t-3, t-1]$ and generates at least one patent in firm i between $[t+1, t+3]$. Identified from the Harvard Business School patenting database.
	b. Firm Characteristics
Firm Age	Number of years since IPO. The natural logarithm of this variable is used in the paper.
Size (Log of Assets)	The natural logarithm of total assets in millions, adjusted to 2007 US dollars.
Firm ROA	Earnings before interest, taxes, depreciation, and amortization scaled by total assets.
Tobin's Q	The market value of common equity scaled by the book value of the common equity.
Leverage	Book debt value scaled by total assets.
Institutional Shareholding	Total shares (in %) held by the top five institutional shareholders in the firm.