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Director Job Security and Corporate Innovation

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Abstract

In this article, we show that firms can become conservative in innovation when their directors face job insecurity. We find that after the staggered enactment of majority voting legislation that strengthens shareholders' power in director elections, firms produce fewer patents, particularly exploratory patents, and fewer forward citations. This effect is stronger for directors facing higher dismissal costs or threats and for firms with greater needs for board expertise and is mitigated by institutional investors' expertise in innovation. Overall, our results suggest that heightened job insecurity induces director myopia, which leads to a reduction in investment in risky, long-term innovation projects.

I. Introduction

Technological innovation plays a critical role in determining firms' future growth and survival under the escalating global competition in recent decades. The literature has suggested that corporate governance enhances firms' innovation performance by motivating "lazy managers" who would otherwise prefer a quiet life (Bertrand and Mullainathan (2003), Atanassov (2013)) or insulating managers

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against the reputational consequences of random realizations of bad performance (Aghion, Van Reenen, and Zingales (2013)). As an important type of "agents" who are elected by shareholders to excise governance missions, a growing literature also examines the role of director composition and profiles in shaping corporate innovation (e.g., Balsmeier, Fleming, and Manso (2017)). Overall, the existing literature finds that improvement in corporate governance can promote innovation.

However, boards of directors are also subject to self-interest, time constraints, and limited energy as are managers. Theories and empirical evidence suggest that a lack of job security due to excessive shareholder monitoring and capital market exposure could induce firms to do short-term, myopic investments (Stein (1988), (1989), Lazear (1990), Manso (2011), He and Tian (2013), Sapra, Subramanian, and Subramanian (2014), and Chemmanur and Tian (2018)). Thus, while governance tools that aim at holding directors accountable via increasing their job insecurity can incentivize them to exert more effort in monitoring and advising corporate innovation, directors who are concerned about job security may very well re-orient their governance mission toward promoting safer investments rather than riskier ones, even though the latter may in fact enhance firms' long-term value.

In this article, we empirically examine whether and how governance mechanisms that subject directors to greater job insecurity impact corporate innovation. We exploit a novel, quasi-natural experiment utilizing the staggered enactment of legislative changes at the state level known as majority voting (MV) legislation. Since 2006, this new law has empowered shareholders to change the voting standard of director elections from the default plurality voting to the more stringent MV in 11 states, thus introducing a plausibly exogenous threat to directors' job security.

In nearly all U.S. states, a plurality voting standard was the default rule in director reelections before 2006. This standard, however, has attracted increasing criticism for its disregard of withheld votes, as a single vote could be sufficient to ensure that a candidate is elected. Hence, shareholders who advocate "shareholder democracy" have requested a shift to a more stringent voting standard, that is, MV, under which a candidate must receive a majority of the shares voting or present at the meeting in order to be elected.[1] In 2006, the Delaware legislature and the American Bar Association passed changes to the Delaware General Corporation Law (DGCL) and Model Business Corporation Act (MBCA), respectively.[2] Both entitle shareholders to change director election voting rules through firms' bylaw

[1]Under the plurality voting regime, the candidate who receives the most votes wins, regardless of whether those votes constitute a majority. When a director runs unopposed, a single affirmative vote (a "for" vote) can thus ensure reelection. To express dissatisfaction with a candidate, shareholders have the option to withhold their authority to vote (a "withhold" or "withheld" vote), but withheld votes will not prevent a candidate from getting elected under the plurality voting system. Under the majority voting regime, shareholders have the option to cast a "for" vote, cast an "against" vote, or "abstain" from voting, and nominees in general are required to receive more "for" votes than "against" votes to be elected. See the SEC voting procedures FAQ for more information on the mechanics of voting (https://www.sec.gov/spotlight/proxymatters/voting_mechanics.shtml).

[2]The Model Business Corporation Act (MBCA) is a model set of laws prepared by the Committee on Corporate Laws of the Section of Business Law of the American Bar Association. It has been influential in shaping corporate laws in many U.S. states. More institutional background information about the legislative change is provided in Section II.B.

amendments. Moreover, once such rules are adopted, firms can no longer unilaterally amend or repeal shareholders' changes. Delaware, as well as several states that use the MBCA as the basis for their corporation laws, subsequently enacted the MV legislation.[3]

We start our analysis by showing that directors indeed face higher job insecurity after the adoption of MV legislation. We examine directors' turnover-performance sensitivity before and after the legislation. We find that after MV enactment, the sensitivity of directors' turnover to firms' industry-adjusted ROA and to industry-adjusted stock returns increases significantly, by 151% and 67%, respectively.

We then examine how the MV rule influences firms' innovation activities using a difference-in-differences (DiD) approach that exploits the enactment of MV legislation as a shock to directors' job security. Specifically, we explore the relation between the staggered introduction of the MV legislative changes in different states and four firm-level patent-based variables that capture key corporate innovative activities: the number of total patents, the number of total forward citations, the number of exploratory patents, and the number of exploitative patents. Exploratory patents are radical innovations that deviate from a firm's current trajectory to meet the possible needs of new customers or emerging markets. These patents require either new knowledge or a departure from existing expertise sets, and their payoffs not only typically take longer to realize but also have higher uncertainty. In contrast, exploitative patents are incremental innovations that meet the needs of a firm's current customers or existing markets. These patents build on existing knowledge and reinforce existing skills, processes, and structures, and their payoffs are realized more quickly and with less uncertainty. [4]

We find that the passage of MV legislation in a firm's incorporation state is associated with a reduction of approximately 6.7% in the number of total patents and 7.8% in the number of total forward citations.[5] These results indicate that the passage of MV legislation may indeed deter firms' innovation activities. Moreover, we find that the reduction in total patents is concentrated in exploratory patents: The number of exploratory patents sees a reduction of 5.2% after MV legislation, while the number of exploitative patents does not change significantly. These findings suggest that firms become more conservative in project choices after the adoption of the MV rule, resulting in weaker innovation performance that could subsequently hurt their innovation output and reduce their opportunity to create new competitive advantages.[6]

[3]Our sample period starts in 2003 and ends in 2018. Delaware, California, and Florida were the first to adopt MV legislation (in 2006), and New Hampshire was the last in our sample to do so (in 2013). The legislative changes are based on the states where firms are incorporated rather than their headquarters states.

[4]See also Kamien and Schwartz (1975), Griliches (1990), Levinthal and March (1993), McGrath (2001), Benner and Tushman (2002), Manso (2011), Balsmeier et al. (2017), Gao, Hsu, and Li (2018), and Brav, Jiang, Ma, and Tian (2018)), which examine similar variables.

[5]These estimates are value-relevant because producing one additional patent increases a firm's market value by 2% (Hall, Jaffe, and Trajtenberg (2005b)), and receiving one additional forward citation is worth about 1 million U.S. dollars (Harhoff, Narin, Scherer, and Vopel (1999), Hall et al. (2005b)).

[6]Both exploitative and exploratory patents are necessary for firms: The former convert technologies into competitive advantages and profits, while the latter help firms adapt radical technology changes to create future advantages (Levinthal and March (1993), McGrath (2001)).

Enactment of MV legislation works as a plausibly exogenous threat to directors' job security to the extent that the legislation is passed by state legislators and is not endogenously driven by firm-specific conditions. We validate our use of a DiD design by showing i) that the treatment and control groups exhibit parallel trends in terms of firms' innovation activities prior to the enactment of MV legislation; ii) that the random assignment of legislation passage years does not replicate our results; and iii) that the adoption of MV legislation is not related to the average levels of innovation outcomes in states. In addition, no major state-level innovation policies exist that coincide with MV enactment. In our DiD specifications, we control for time-varying firm characteristics related to innovation, firm fixed effects, and headquarters state region-year fixed effects that absorb all local business conditions.

We propose that the intriguing negative effect of the MV enactment on corporate innovation is driven by the weakened job security of directors, who play an important role in exercising firms' governance missions to create an environment conducive to innovation.[7] This proposition follows the prediction from the theoretical literature (Stein (1988), (1989), Lazear (1990), Manso (2011), and Sapra et al. (2014)) that a lack of job security due to excessive shareholder monitoring and stock market pressure could induce managers to pursue short-term, myopic investment strategies (He and Tian (2013)). When applied to corporate boards, directors with greater job insecurity may re-orient their governance mission toward promoting safer investments rather than riskier ones, and their weakened incentives to support highly risky and effort-costly innovation may lead firms to reduce innovation activities and/or change project choices.

We find evidence in support of the explanation based on director myopia. We show that after MV legislation, firms in treated states significantly reduce R&D investment and become less likely to miss earnings benchmarks. In addition, the originality and quality of patents, as well as firm-level patent values (estimated based on stock market reactions to patent announcements), all experience significant decreases after MV legislation. These findings indicate that the reduction in innovation has negative welfare implications: Heightened job insecurity induces directors to focus on short-term firm performance at the expense of long-term investment in innovation and leads to a reduction of firm value created by new patents.

We next explore cross-sectional variations to provide further insights into how directors' job insecurity leads to reduced innovation. We examine factors that influence the relation between MV legislation and innovation activities. The idea is

[7]In practice, the business community has increasingly emphasized the role board members play in building a purpose, direction, and focus for innovation (Deschamps and Nelson (2014)). Across industries, boards have been involved at the idea generation stage of innovation and have a growing role in developing firms' capacity to pivot into uncharted territory with new products, services, and business models (Hill and Davis (2017)). Directors are entitled to evaluate a management team's innovation strategies, as these issues are often tied to major investment decisions for which board approval is required. Directors also have a fiduciary responsibility to monitor a company's risks, which include the uncertainties and opportunities that follow innovation. In recognizing the importance of boards' role in innovation, many firms, such as Procter & Gamble and Pfizer, have established board committees in charge of innovation.

that the effect of MV legislation on corporate innovation should be particularly strong in situations where job loss is more costly to directors, thereby enhancing their incentives for myopic behavior. Conversely, the effect should be mitigated by mechanisms that weaken such incentives. Examining cross-sectional variations also helps mitigate the concern that the new law may lead firms to change other corporate policies that direct more resources toward areas other than risky innovation, in which case the effect of the new law on innovation output may not be directly caused by directors actively trying to protect job security. If an omitted factor is instead driving the observed effect, the factor must also align with these cross-sectional interactive effects, and such a plausible factor is hard to find.

We first examine the job loss severity for directors. When the expected cost of losing the current directorship is higher (e.g., when the director compensation is higher) or when the threat of dismissal is greater (e.g., when a firm's local director pool is deeper and thus its directors face more labor market competition), we should expect the effect of director job insecurity on innovation outcomes to be stronger. Indeed, we find stronger effects when directors' compensation is higher and when there is a greater supply of directors in the local area.

Second, whether the directors' job insecurity translates into myopic innovation decisions depends crucially on the monitoring shareholders. The presence of investors with expertise in innovation could mitigate the myopic incentives and short-term actions taken by directors, as these investors have more knowledge and information about the nature and value of innovation activities and are thus more likely to tolerate short-term failures. Consistent with our expectation, we find that when a firm's institutional investors have more innovation expertise, the negative effect of directors' job insecurity on innovation activities is weaker.

Our final piece of analysis explores the channels through which directors' heightened job insecurity can influence corporate innovation: Directors may change their advising strategy to encourage less innovation or the pursuit of safer, short-term projects, and/or they may adjust their monitoring intensity of managers, which can in turn lead to changes in innovation activities. To investigate directors' advisory role, we explore cross-sectional variations in CEO experience. We find that the enactment of MV legislation reduces innovation to a greater extent in firms where the CEO is less experienced. This finding is consistent with the conjecture that firms with less experienced CEOs are more likely to rely on board advice and expertise in guiding innovations and provides support for the advisory channel. To investigate directors' monitoring role, we explore cross-sectional variations in managerial entrenchment. We do not find supportive evidence for the monitoring channel: The effect of MV legislation on innovation outcomes does not differ significantly across firms with different levels of managerial entrenchment.

Additionally, we examine two alternative explanations. We show that our results are robust to restricting the sample to firms that do not experience any director changes, ensuring that our findings are not driven by changes in the composition of directors on boards after the MV legislation. Moreover, we show that the changes in innovation choices are unlikely to be driven by CEOs who aim to secure outside directorships. Finally, we conduct a battery of robustness tests. Our findings remain robust to various alternative sample constructions and regression specifications, such as excluding firms that are incorporated in Delaware, keeping

only firms that have at least 1 patent, extending the sample with various earlier starting years, and examining innovation activities in 2 or 3 years after the legislation.

Our article contributes to a number of related literatures. First, we contribute to the literature on the determinants of firms' innovation strategy and performance.[8] In particular, we explore how directors' career incentives affect innovation strategies. Because exploratory innovation can help firms adapt to radical technology changes and create future advantages (Levinthal and March (1993), McGrath (2001)), our article highlights the importance of aligning directors' long-term incentives with those of shareholders in order to foster innovation. Second, from a broader perspective, our article extends and contributes to the literature on the role of agency issues in determining firms' risk-taking and investment choices.[9] While enhanced shareholder monitoring and capital market exposure can encourage innovation (Atanassov (2013)), our study suggests that directors facing greater job insecurity may become myopic and discourage exploratory innovation projects. Our results thus highlight the importance of balancing the two forces when designing optimal director incentives. The idea that directors factor in career concerns in exercising their governance missions is also broadly related to the literature on directors' incentives and the director labor market (e.g., Harford (2003), Harford and Schonlau (2013)), which shows that external control mechanisms serve to discipline directors through the labor market. Third, we add to prior studies on the MV standard (e.g., Cai, Garner, and Walkling (2009), Ertimur, Ferri, and Oesch (2015)), which generally focus on the management's response to the adoption of a MV standard. Our findings complement this literature by highlighting the real effect of MV legislation from the perspective of corporate innovation.

II. Determinants of Corporate Innovation and Institutional Backgrounds

A. Determinants of Corporate Innovation and the Role of the Board of Directors

Corporate innovation is an important class of intellectual investment and shapes firms' intangible capital. Researchers in finance and economics have examined possible determinants of corporate innovation along a multitude of dimensions. These determinants include both external economic forces (such as product market and import competition, market conditions and business cycles, banking development and deregulation, laws and institutions, financial market development, and country/region-level cultural and demographic factors) and internal

[8]See Ederer and Manso (2011), He and Tian (2018), and He and Tian (2020) for a comprehensive overview. We discuss in detail the related literature on the determinants of corporate innovation in Section II.A.

[9]While prior studies in this field mostly examine executives and rank-and-file employees (e.g., Lerner and Wulf (2007), Ederer and Manso (2011), Manso (2011), Gao et al. (2018), Chemmanur and Tian (2018), and Hsieh, Hsu, and Liu (2022)), our analysis focuses on boards of directors, an important class of agents that act on behalf of shareholders to govern firms. See Hermalin and Weisbach (2001), Adams (2003), Adams and Ferreira (2007), and Adams, Hermalin, and Weisbach (2010) for detailed discussions of the various roles of directors.

firm-level characteristics (such as internal and external governance, ownership structures, financial constraints, managerial skills, styles and traits, compensation schemes, analyst coverage, investor composition, and stock trading and price dynamics). Recent surveys by He and Tian (2018), (2020) provide a comprehensive review of this fast-growing literature.

Our article studies the role of the board of directors in corporate innovation. Recent studies show that various board characteristics can affect innovation. For example, using regulatory changes that require the adoption of independent boards, Balsmeier et al. (2017) find that firms that transition to independent boards focus on innovation in familiar areas of technology instead of new, unexplored technologies. An, Chen, Wu, and Zhang (2020) and Griffin, Li, and Xu (2020) show that board diversity is conducive to an improved innovative performance. Chang and Wu (2021) examine board networks and report that well-connected boards have a positive effect on innovation activities.

We focus on how director myopia induced by heightened job insecurity affects innovation outcomes. Previous studies show that managers who are subject to excessive monitoring and stock market pressure may become myopic in their decision-making and lead firms to invest less in risky, long-term innovation and put more effort into routine tasks (Stein (1988), He and Tian (2013), and Sapra et al. (2014)). When applied to corporate boards, this reasoning suggests that directors' job (in)security can be an important determinant of corporate innovation outcomes, as directors with greater job insecurity are more likely to be subject to myopia and thus have weakened incentives to support risky, long-term innovation activities.

The role of directors' job security in corporate innovation is an important yet unexplored research question in the finance literature. Job security is difficult to quantify, especially at the board level, as it varies across directors and over time; its impact on innovation activities is thus even more difficult to estimate. In our empirical analysis, we overcome this challenge by utilizing the staggered enactment of MV legislation as a plausibly exogenous shock to directors' job security. This setup allows us to gauge the effect of director job security while controlling for a host of firm, board, and CEO characteristics that may affect innovation. Moreover, we show that our results still hold in the subsample of firms that do not experience any director changes after the enactment of MV legislation, ensuring that our findings are not driven by changes in director profiles or director compositions after the legislative change. Our analysis thus identifies, in a relatively clean setting, a new determinant of corporate innovation that is independent of the known factors in the existing literature.

B. Institutional Backgrounds of MV Legislation

Director election is an important mechanism for holding boards of directors accountable, as indicated in prior studies on issues related to shareholder voting in director elections (e.g., Fischer, Gramlich, Miller, and White (2009), Iliev, Lins, Miller, and Roth (2015), and Aggarwal, Dahiya, and Prabhala (2019)).[10]

[10]For example, Aggarwal et al. (2019) find that directors subject to dissent are more likely to leave a board, particularly if they are neither lead directors nor chairs of an important committee. Directors who do not leave when subject to dissent then move to less prominent board positions.

Before 2006, the default standard for director election for almost all U.S. states was the plurality standard. Under this standard, a director candidate with the most "for" votes is elected. In uncontested elections, this means that a single "for" vote is sufficient for a director to be elected, irrespective of the number of "withheld" votes. For this reason, the plurality voting standard, together with a lack of contested elections (Bebchuk (2007)), has come under criticism for its failure to effectively promote corporate democracy.

Under the MV standard, a director candidate (even in uncontested elections) must receive the majority of votes (i.e., the number of "for" votes exceeds that of "against" votes). One challenge for MV proposals was that even if they are passed, boards still have discretion over their implementation. However, due to recent law changes, shareholder proposals involving amendments to bylaws that introduce the MV standard into director elections have recently become *binding* in some states. Two major legislative amendments, the DGCL and the MBCA, pioneered legislative changes across different states by prescribing packages of rules that facilitated the adoption of the MV standard in director elections.[11] After 2006, both the MBCA and DGCL allowed for an opt-out of the default plurality voting system via bylaw amendments and prevented boards from repealing such amendments if they are made by shareholders.

Effective from Aug. 1, 2006, the Delaware Amendments prevented boards from repealing or amending any bylaw amendments passed by shareholders that specify the votes required for board election. Specifically, the amendment states: "A bylaw amendment adopted by stockholders which specifies the votes that shall be necessary for the election of directors shall not be further amended or repealed by the board of directors" (Delaware 1.VII.216). Similarly, on June 20, 2006, amendments to the MBCA stated that a bylaw amendment may not be repealed or amended by boards if it prevents those elected by the plurality voting standard from serving for more than 90 days if they received more votes "against" than "for."[12] Over time, other states that based their corporation laws on the MBCA have gradually followed this trend and facilitated binding resolutions for MV proposals for director elections.[13]

Between 2004 and 2009, more than 500 proposals were about adopting a MV standard; moreover, on average, about 50% of these passed, which is a level of support that shareholder proposals rarely enjoy (Georgeson (2010)). In 2013, shareholder proposals on this topic received average shareholder support of 58%, and approximately 90% of S&P 500 firms had adopted the MV standard in director elections and/or a policy requiring resignation if a director fails to receive majority

[11]Prior to 2006, most states, including Delaware, allowed the plurality voting standard for the election of directors, and most public companies have traditionally kept to the same standard.

[12]See http://www.stblaw.com/docs/default-source/cold-fusion-existing-content/publications/pub560.pdf?sfvrsn=2. The American Bar Association (ABA) Committee also made other amendments to the MBCA to facilitate the adoption of the MV standard. For example, some amendments facilitate MV policies by expressly recognizing that a director resignation may be irrevocable if it is conditioned on the failure to receive a specified vote ratio.

[13]Prior to the legislation, shareholders could also submit proposals to change director election voting standards; however, management could unilaterally undo these changes. After the legislation, once a voting standard is changed by shareholders, management cannot unilaterally undo it.

support.[14] These statistics represent a substantial increase from the mere 10% of S&P 500 companies that did so in 2004. Recent evidence from Cuñat, Lü, and Wu (2019) suggests that after the enactment of MV legislation, firms in states that enacted MV legislation are substantially more likely to install MV than those in states that did not.

As the MV system institutionally enables shareholders to more easily remove a director with whom they are not satisfied, directors will face an increased threat of turnover even if they are not displaced in the end. Indeed, anecdotal evidence suggests that director job insecurity heightens after the enactment of MV. For example, Quest Software Inc., headquartered and incorporated in California, maintained a plurality voting standard in director elections until 2007, when the MV standard was adopted. In the annual shareholder meeting in May 2008, an independent director, Jerry Murdock Jr., received 47,942,292 for votes and 49,709,270 against votes. Consequently, Mr. Murdock lost his board seat as he was required by law to resign his directorship upon failure to receive majority votes. In contrast, no board member was cast out due to a shareholder vote when plurality voting was in place at the company. In Section IV.A, we systematically examine the effect of MV legislation on the relation between director turnover and firm performance and provide consistent evidence that MV legislation increases directors' turnover-performance sensitivity.

III. Empirical Design and Sample Construction

A. Research Design: MV Legislation and Innovation

Eleven states adopted MV legislation during our 2003–2018 sample period. In Table 1, we list these states and the year of adoption for each. We posit that the enactment of MV legislation can be regarded as an exogenous policy shock to the extent that they are passed by state legislators and are not endogenously driven by firm-specific conditions. We then examine how such staggered enactment of MV

TABLE 1

The Adoption of Majority Voting (MV) Legislation Across States

In Table 1, we report the years in which MV legislation was passed in 11 states in the United States. We also provide the sections of this legislation in the state corporate law.

State	Year	Sections
Delaware	2006	§8.1.206
California	2006	*S.B.*1027
Florida	2006	§33.607.728
Washington	2007	§23B.10.205
Utah	2008	§16-10a-102
Hawaii	2009	§23.414.149
Indiana	2010	§23.1.39
Wyoming	2010	§17-16-1022
Connecticut	2011	§33.601.809
District of Columbia	2012	§29.308.22
New Hampshire	2013	§27.293A.10

[14]More details are available at https://www.skadden.com/insights/publications/2014/01/us-corporate-governance-boards-of-directors-face-i.

legislation influences firms' innovation activities and performance. Each year, the treatment group consists of firms *incorporated* in states that have adopted MV legislation, and the control group consists of firms incorporated in states that have not. Specifically, the staggered adoption of MV legislation means that our control group includes firm-year observations in states that did not adopt MV legislation throughout our sample period, as well as firm-year observations before the legislation was adopted in states that eventually adopted MV. In other words, the staggered nature of MV legislation provides a set of counterfactuals for how innovation outcomes would have evolved in the absence of director job insecurity, thereby allowing us to disentangle the effect of directors' job security on innovation activities from the other forces that could influence it.

We use a DiD design with multiple treatment groups and time periods, as in Bertrand and Mullainathan (2003), Imbens and Wooldridge (2009), and Atanassov (2013). We implement this test using the following regression specification:

$$\begin{aligned}(1)\quad \text{INNOVATION\_OUTCOME}_{i,t} = {} & \alpha + \beta_1 \text{MV}_{s,t-1} + \text{OTHER\_CONTROLS}_{i,t-1} \\ & + \text{FIRM\_FE}_i + \text{HEADQUARTERS\_REGION} \\ & \times \text{YEAR\_FE}_{j,t} + \varepsilon_{i,t},\end{aligned}$$

where i indexes the firm, s indexes the state where firm i is incorporated, j indexes the region where firm i's headquarters state is located, and t indexes the year. The dependent variable, INNOVATION_OUTCOME, is one of the following four variables that captures firm i's patent output and its direction in year t: PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS (we provide detailed definitions for these in the next section). These variables are commonly used in the literature to measure firm-level innovation activities and performance (Kamien and Schwartz (1975), Griliches (1990), and Benner and Tushman (2002)). The variable MV is an indicator variable that takes the value of 1 if MV legislation is in effect in state s in year $t-1$, and 0 otherwise. Our variable of interest is MV, and its coefficient β_1 captures the difference in the time-series changes in innovation outcomes between the treatment and control firms due to MV legislation.

Following the literature, we define our innovation outcome variables by the application year, which reflects when the invention output occurs (Hall, Jaffe, and Trajtenberg (2005a), Hall et al. (2005b)). With equation (1), we examine whether there is any association between the adoption of MV legislation in year $t-1$ and firm-level innovation outcomes starting from year t. As it may take some years for MV legislation to affect innovation outcomes, we further examine this time lag in such associations in a later analysis in Section IV.C; when we do, we find that the effect of MV legislation mostly starts taking place in $t+1$. We also show in robustness tests (Section VI.B) that our results are robust to increasing the time lag to 2 or 3 years (i.e., innovation outcomes in $t+1$ or $t+2$, relative to MV in year $t-1$).

We control for a host of firm, board, and CEO characteristics that may affect innovation, including CEO_TENURE, CEO_DUALITY, CEO_OUTSIDE_DIRECTORSHIP, BOARD_INDEPENDENCE, BUSY_BOARD, BOARD_DIVERSITY, BOARD_SIZE, BOARD_NETWORK, FIRM_AGE, FIRM_SIZE, MTB, ROA, LEVERAGE, SALES_GROWTH, INSTITUTIONAL_OWNERSHIP,

HHI, HHI^2, ASSET_INTANGIBILITY, and R&D/ASSETS. We provide definitions of all these variables in the Appendix. In addition to including firm fixed effects to control for firm-level, time-invariant omitted variables, we also control for a full set of HEADQUARTERS_REGION × YEAR fixed effects. We do so because for more than half of U.S. public firms, there is an incongruence between the state of incorporation and the state where the firm's headquarters is located (and where the firm's business operations actually occur). This discrepancy allows us to, in theory, control for various shocks to the latter states by including this set of fixed effects in our regression (Bertrand and Mullainathan, 2003). Given that our treatment is defined at the state of incorporation level, we cluster standard errors by the state of incorporation.

Several issues related to our DiD design are worth discussion before we proceed: To the best of our knowledge, no major state-level innovation policies coincide with MV law enactment. One might still worry about the political economy of the laws (i.e., they may have been passed because of a changing economic climate in a given state). Although the adoption of MV laws may be subject to some firms' or interest groups' lobbying efforts, no perceived link between lobbying for such a rule and innovation activities exists.[15] In addition, we control for headquarters region-year joint fixed effects in our empirical analysis to mitigate the influence of local economic policies. In Section IV.C, we conduct a formal test to show that MV legislation enactment cannot be explained by state-level innovation activities, which further justifies our DiD design.

B. Sample Construction and Summary Statistics

Our sample starts from 2003, the first year that BoardEx provides a complete coverage of board data, from which we extract information on corporate directors.[16] We exclude firms in regulated industries (SIC codes between 4400 and 5000) and also financial institutions (SIC codes between 6000 and 6500). Following the literature (e.g., Fresard (2010), Almeida, Kim, and Kim (2015)), we also delete firms with negative book equity values because these values are unusual (i.e., they may indicate firms experiencing unusual conditions). In sum, we obtain 51,120 firm-year observations from 2003 to 2018.[17]

To construct firm-level patent measures for our sample firm, we first collect all patent and citation information from Patentsview, a U.S. Patent and Trademark Office (USPTO) database that includes all patents granted by the USPTO over the period from 1976 to 2020. We first use CRSP firm identifiers (permno) for patents granted by the end of 2010 in the database of Kogan, Papanikolaou, Seru, and

[15]In fact, if innovative firms had opposed MV legislation, they could have lobbied against it, which would have prevented us from finding any positive effect of MV legislation with respect to firm-level innovation.

[16]In Section VI.B, we show that our results are robust to extending the sample to earlier starting years of 2001 and 2002, for which BoardEx provides partial data coverage.

[17]Our patent data end in 2020, which include all patents granted by 2020. Since we use the application year as the time placer for patents, we end our sample in 2018 to accommodate a 2-year application-approval lag.

Stoffman (2017). Second, we use fuzzy algorithm and manual matching methods to match the assignee names for patents granted after 2010 to assignee names that appeared in the NBER patent database (which includes patents granted to the end of 2006) initially constructed by Hall et al. (2005a) and in the database of Kogan et al. (2017). Finally, for the assignee names of patents granted after 2010 that cannot be matched in the second step, we use fuzzy algorithm and manual matching methods to match them to all public firm names in the Compustat/CRSP database.

In Table 2, we report the summary statistics for our sample. Approximately 47% of our firm-year observations are post-MV adoption. Our main dependent variables in equation (1) include the following four variables: PATENTS is the natural logarithm of 1 plus the number of patents filed by firm *i* in a given year; FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted forward citations received within 5 years by patents filed by firm *i* in a given year; EXPLORATORY_PATENTS is the natural logarithm of 1 plus the number of exploratory patents filed by firm *i* in a given year; and EXPLOITATIVE_PATENTS is the natural logarithm of 1 plus the number of exploitative patents filed by firm *i* in a given year. To mitigate the truncation bias in patent citation measures, we follow Hall et al. (2005a), (2005b) and Seru (2014) to adjust each patent's number of forward citations by the average number of forward citations of all patents filed in the same cooperative patent classification (CPC) subsection and granted in the same year. Additionally, to further alleviate the bias, we impose a 5-year window for calculating forward citations (Lerner, Sorensen, and Strömberg (2011), Bernstein (2015)). Hence, each patent's number of adjusted forward citations is calculated as its number of 5-year forward citations scaled by the average of 5-year forward citations received by all patents filed in the same technology subsection in the same year. We use logarithmic transformations following Lerner (1994) and Aghion et al. (2013) to mitigate the skewness of the distribution of patent counts. We report the summary statistics for both the raw numbers and the logarithmic transformations of these innovation variables in Table 2.

We follow Benner and Tushman (2002) and construct exploratory and exploitative patents in 3 steps. First, for each patent applied for by firm *i* in year *t*, we calculate the percentage of its backward citations (i.e., the prior patents it cites) that are based on existing knowledge: The combination of firm *i*'s portfolio of patents and citations made by its portfolio of patents over the past 5 years (i.e., years $t-5$ to $t-1$). Second, we categorize a patent as "exploratory" if 80% or more of its backward citations are outside of firm *i*'s existing knowledge, as defined in the first step. We categorize a patent as "exploitative" if 80% or more of its citations are based on firm *i*'s existing knowledge. Finally, we compute firm *i*'s number of exploratory patents and number of exploitative patents in year *t*.[18]

As we show in Table 2, a firm in our sample has, on average, 8.5 patents, 10.3 forward citations from all its patents, 3.1 exploratory patents, and 2.5 exploitative patents. These numbers are generally consistent with prior studies (e.g., Balsmeier

[18]In unreported results, we confirm that our results are robust to alternative definitions of exploratory and exploitative patents that use 60% or 90% as alternative cutoffs to categorize patents into "exploratory" and "exploitative."

TABLE 2

Summary Statistics

In Table 2, we report the descriptive statistics for the main variables in our sample. Variable definitions are in the Appendix.

Variables	Mean	Std. Dev.	5th Percentile	Median	95th Percentile
MV	0.471	0.499	0	0	1
NUMBER_OF_PATENTS	8.453	35.386	0	0	38
NUMBER_OF_FORWARD_CITATIONS	10.342	44.869	0	0	48
NUMBER_OF_EXPLORATORY_PATENTS	3.059	12.578	0	0	14
NUMBER_OF_EXPLOITATIVE_PATENTS	2.510	10.268	0	0	12
PATENTS	0.634	1.260	0	0	3.664
FORWARD_CITATIONS	0.589	1.310	0	0	3.882
EXPLORATORY_PATENTS	0.418	0.952	0	0	2.708
EXPLOITATIVE_PATENTS	0.365	0.900	0	0	2.565
CEO_TENURE	5.267	5.663	0	3	16.950
CEO_DUALITY	0.466	0.499	0	0	1
CEO_OUTSIDE_DIRECTORSHIPS	0.248	0.432	0.000	0.000	1.000
BOARD_INDEPENDENCE	0.747	0.135	0.500	0.778	0.909
BUSY_BOARD	0.152	0.170	0.000	0.125	0.500
BOARD_DIVERSITY	0.386	0.133	0.092	0.407	0.565
BOARD_SIZE	8.430	2.448	5.000	8.000	13.000
BOARD_NETWORK	1.355	0.929	0.186	1.176	3.218
INSTITUTIONAL_OWNERSHIP	0.525	0.387	0.000	0.594	1.000
FIRM_AGE	2.981	0.705	1.946	2.996	4.060
FIRM_SIZE	6.568	2.036	3.184	6.578	10.038
MB	3.177	4.224	0.610	1.961	9.272
ROA	−0.017	0.197	−0.383	0.024	0.152
LEVERAGE	0.202	0.193	0.000	0.163	0.575
SALES_GROWTH	0.135	0.434	−0.299	0.070	0.712
HHI	0.063	0.057	0.019	0.043	0.178
HHI^2	0.007	0.017	0.000	0.002	0.032
ASSET_TANGIBILITY	0.216	0.241	0.000	0.118	0.767
R&D/ASSETS	0.052	0.118	0.000	0.000	0.263
AVERAGE_TURNOVER	0.273	0.180	0.000	0.250	0.600
NONRETIREMENT_RELATED_TURNOVER	0.006	0.028	0.000	0.000	0.071
MISS_EPS	0.385	0.487	0	0	1
MISS_ROA	0.313	0.464	0	0	1
PATENT_ORIGINALITY	0.364	0.178	0.000	0.370	0.677
PATENT_QUALITY	1.281	3.009	0.000	0.783	3.813
INNOVATIVE_EFFICIENCY	0.217	0.361	0.000	0.036	1.342
PATENT_VALUE	0.894	1.973	0.000	0.000	5.725

et al. (2017)). We also provide the summary statistics for all the control variables in Table 2. All continuous variables are winsorized at 1% and 99%. Variable definitions are provided in the Appendix.

IV. Main Results

A. Director Turnover-Performance Sensitivity

We argue that after the adoption of MV legislation, directors face higher short-term job insecurity that intensifies their turnover risk. In this subsection, we first validate this argument by examining directors' turnover-performance sensitivity before and after the legislation. To construct the board-level average turnover of directors, we first use the BoardEx database to construct a director turnover indicator. A director is classified as "departed" if they are no longer on the board of a firm that they had served on in the previous year. We estimate the following regression:

$$\begin{aligned}(2)\quad \text{AVERAGE\_TURNOVER}_{i,t} = {} & \alpha + \beta_1 \text{MV}_{s,t-1} + \beta_2 \text{FIRM\_PERFORMANCE}_{i,t-1} \\ & + \beta_3 \text{FIRM\_PERFORMANCE}_{i,t-1} \times \text{MV}_{s,t-1} \\ & + \text{OTHER\_CONTROLS}_{i,t-1} + \text{FIRM\_FE}_i \\ & + \text{HEADQUARTERS REGION} \times \text{YEAR\_FE}_{j,t} + \varepsilon_{i,t}\end{aligned}$$

The dependent variable, AVERAGE_TURNOVER, is calculated as the fraction of firm i's nonexecutive directors on the board in year $t-1$ who depart in year t. Following the literature on the turnover-performance relationship (e.g., Morck, Shleifer, and Vishny (1989), Gao, Harford, and Li (2012), Kaplan and Minton (2012), and Jenter and Lewellen (2021)), we use two industry-adjusted performance measures, namely the industry-adjusted return on assets (IND_ADJ_ROA) and industry-adjusted stock returns (IND_ADJ_STOCK_RETURN), defined as a firm's ROA and annual stock return minus their corresponding industry medians, respectively.[19] Our variable of interest is β_3, the coefficient on FIRM_PERFORMANCE × MV, which reflects the change in directors' turnover sensitivity to firm performance due to MV legislation.

We report our results in Table 3. Both the coefficient on MV × IND_ADJ_ROA (in column 1) and the coefficient on MV × IND_ADJ_STOCK_RETURN (in column 2) are negative and statistically significant at the 1% level, indicating that after the legislation, director turnover becomes significantly more sensitive to performance. This increase in turnover-performance sensitivity is also economically significant. Compared to the magnitude of the sensitivity prior to MV legislation as captured by the coefficients on the standalone terms IND_ADJ_ROA and IND_ADJ_STOCK_RETURN, director turnover sensitivity to industry-adjusted ROA and to industry-adjusted stock return increases substantially after the MV regulation, by 151% and 67%, respectively.

In columns 3 and 4 of Table 3, we refine our average turnover measure by focusing on only director turnovers that are likely to be involuntary in nature, which are more relevant for assessing turnover-performance sensitivities (Jenter and Kanaan (2015)). We follow the turnover literature (e.g., Jenter and Kanaan (2015)) and treat turnovers of directors who are at or beyond their retirement age as voluntary (or retirement-related) turnovers. We use the age of 70 as the retirement age in our categorization following Yermack (2004).[20] We examine NONRETIREMENT_RELATED_AVERAGE_TURNOVER, which is calculated as the fraction of a firm's directors who depart in a given year and are below the age of 70. Consistently, the coefficients on MV × IND_ADJ_ROA and MV × IND_ADJ_STOCK_RETURN are negative and significant both statistically and economically, confirming that the effect of MV legislation on heightening turnover-performance sensitivity is robust among director turnovers that are more likely to be involuntary.

[19] Our results are robust to using 3-year average industry-adjusted ROA and 3-year industry-adjusted stock returns as alternative performance measures.

[20] Yermack (2004) reports that the retirement age for outsider directors is typically higher than that for corporate executives such as CEOs and that directors over age 70 retire at a significantly higher rate than other directors. Our results are robust to using the age of 72 as an alternative retirement age.

TABLE 3

Director Turnover-Performance Sensitivity

In Table 3, we report the results on the change in director turnover-performance sensitivity after the enactment of MV legislation. The dependent variable in columns 1 and 2 is AVERAGE_TURNOVER, calculated as the fraction of a firm's nonexecutive directors who depart in each year. The dependent variable in columns 3 and 4 is NONRETIREMENT_RELATED_AVERAGE_TURNOVER, which is calculated as the fraction of a firm's nonexecutive directors who depart in each year and are below age 70. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. Variable definitions are in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	AVERAGE_TURNOVER		NONRETIREMENT_RELATED_AVERAGE_TURNOVER	
	1	2	3	4
IND_ADJ_ROA × MV	−0.077***		−0.065***	
	(0.013)		(0.012)	
IND_ADJ_STOCK_RETURN × MV		−0.006***		−0.006***
		(0.002)		(0.002)
MV	−0.001	−0.001	0.001	0.001
	(0.006)	(0.006)	(0.005)	(0.005)
IND_ADJ_ROA	−0.051***		−0.046***	
	(0.017)		(0.016)	
IND_ADJ_STOCK_RETURN		−0.009***		−0.008***
		(0.003)		(0.002)
CEO_TENURE	−0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
CEO_DUALITY	−0.002	−0.002	−0.005**	−0.005**
	(0.003)	(0.003)	(0.002)	(0.002)
CEO_OUTSIDE_DIRECTORSHIPS	0.000	−0.000	−0.000	−0.001
	(0.002)	(0.002)	(0.001)	(0.001)
BOARD_INDEPENDENCE	−0.122***	−0.120***	−0.120***	−0.119***
	(0.011)	(0.011)	(0.009)	(0.009)
BUSY_BOARD	0.007	0.006	0.027***	0.026***
	(0.007)	(0.007)	(0.006)	(0.006)
BOARD_DIVERSITY	0.028	0.027	0.069***	0.068***
	(0.017)	(0.017)	(0.015)	(0.015)
BOARD_SIZE	0.019***	0.019***	0.010***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)
BOARD_NETWORK	−0.001	−0.000	0.006**	0.006**
	(0.003)	(0.003)	(0.002)	(0.002)
INSTITUTIONAL_OWNERSHIP	0.005	0.004	0.003	0.003
	(0.007)	(0.007)	(0.006)	(0.006)
FIRM_AGE	0.165***	0.170***	0.138***	0.142***
	(0.013)	(0.014)	(0.011)	(0.010)
FIRM_SIZE	−0.038***	−0.041***	−0.031***	−0.033***
	(0.002)	(0.002)	(0.002)	(0.002)
MB	−0.003***	−0.002***	−0.002***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
LEVERAGE	0.061***	0.052***	0.054***	0.046***
	(0.017)	(0.017)	(0.017)	(0.017)
SALES_GROWTH	−0.014***	−0.012***	−0.012***	−0.010***
	(0.003)	(0.003)	(0.002)	(0.002)
HHI	0.263*	0.291*	0.247**	0.270**
	(0.143)	(0.151)	(0.109)	(0.117)
HHI^2	−1.443***	−1.514***	−1.209***	−1.269***
	(0.421)	(0.443)	(0.356)	(0.376)
ASSET_TANGIBILITY	0.025*	0.017	0.019**	0.012
	(0.014)	(0.014)	(0.009)	(0.009)
R&D/ASSETS	−0.120***	−0.104***	−0.093***	−0.080***
	(0.015)	(0.015)	(0.015)	(0.015)
ROA		−0.081***		−0.072***
		(0.008)		(0.005)
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	49,304	49,304	49,304	49,304
Adj. R^2	0.131	0.132	0.153	0.154

Overall, these results suggest that directors do face higher turnover risk after MV legislation enactment. Our results are consistent with findings from studies examining the relation between firm-level votes withheld in director elections and board-level turnover after the adoption of MV. These studies document a positive association between firm-level votes withheld and board-level turnover, suggesting that firms whose directors receive higher votes withheld are more likely to experience board shake-ups, and the association is stronger after the MV regulation (Fischer et al. (2009), Ertimur et al. (2015)).[21]

B. Majority Voting Legislation and Innovation

We estimate our main result following equation (1) and report our results in Table 4. In column 1 for PATENTS, we find that the coefficient on MV is −0.067, significant at the 1% level. This suggests that firms' patenting activities drop by 6.7% following an increase in directors' job insecurity. In column 2 for FORWARD_CITATIONS, the coefficient on MV is −0.078, with significance at the 1% level, indicating that quality-weighted patent output drops by 7.8% following an increase in director job insecurity.

We then turn to the effect of MV laws on innovation directions. In columns 3 and 4 of Table 4, our dependent variables are EXPLORATORY_PATENTS and EXPLOITATIVE_PATENTS, respectively. As discussed earlier, exploratory innovation is riskier, as it deviates from a firm's current technological trajectory and expertise, requires new knowledge and takes longer to pay off (if it is realized at all as the payoff realization is highly uncertain). Nonetheless, a firm's long-term survival and sustainability depend on exploratory innovation, because it helps a firm build new competitive advantages and adapt to new markets and industry structures (Levinthal and March (1993), McGrath (2001)). We find that the coefficient on MV in column 3 is negative and significant at the 1% level. After the enactment of MV legislation, firms' exploratory patents drop by 5.2%. The coefficient on MV in column 4 is of small magnitude and statistically insignificant. These findings show that the increase in directors' job insecurity reduces exploratory projects significantly but not exploitative ones.

The existing literature suggests that patents and forward citations are significantly and positively associated with firms' future profits, and in particular, exploratory patents, which reflect firms' pursuit of new knowledge and technology trajectories, are important to firms' long-term stability.[22] Overall, our baseline results thus suggest that firms' innovation performance is weaker after MV legislation.

[21]Ertimur et al. (2015) find that at the individual director level, there is no significant relation between votes withheld and individual director turnover, even under the MV standard, but they show that aggregating at the firm level, there is a strong positive relation between firm-level votes withheld and board-level turnover after the adoption of the MV standard. In our turnover-performance sensitivity analysis, we examine board-level turnover in relation to firm-level performance, including director turnovers in which a director chooses not to run for the next term and therefore no election or vote is involved.

[22]See Griliches (1981), Levinthal and March (1993), Harhoff et al. (1999), McGrath (2001), and Hall et al. (2005b) for detailed discussions.

TABLE 4

Majority Voting Legislation and Innovation

In Table 4, we report the results on the effect of MV legislation on corporate innovation. The dependent variables are PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS, respectively, in columns 1–4. PATENTS is the natural logarithm of 1 plus the number of patents. FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted citations of a firm's patents. EXPLORATORY_PATENTS is the natural logarithm of 1 plus the number of exploratory patents. EXPLOITATIVE_PATENTS is the natural logarithm of 1 plus the number of exploitative patents. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	PATENTS	FORWARD_CITATIONS	EXPLORATORY_PATENTS	EXPLOITATIVE_PATENTS
	1	2	3	4
MV	−0.067***	−0.078***	−0.052***	−0.011
	(0.013)	(0.013)	(0.013)	(0.011)
CEO_TENURE	0.001	0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.000)
CEO_DUALITY	−0.002	0.000	0.002	−0.002
	(0.006)	(0.006)	(0.007)	(0.004)
CEO_OUTSIDE_DIRECTORSHIPS	−0.011	−0.032***	−0.005	−0.014**
	(0.008)	(0.008)	(0.008)	(0.006)
BOARD_INDEPENDENCE	0.120***	0.037	0.078***	0.109***
	(0.033)	(0.047)	(0.027)	(0.026)
BUSY_BOARD	−0.061**	−0.048	−0.030	−0.035
	(0.030)	(0.046)	(0.019)	(0.022)
BOARD_DIVERSITY	0.030	−0.028	0.019	0.015
	(0.039)	(0.060)	(0.035)	(0.026)
BOARD_SIZE	−0.002	−0.006***	−0.002	−0.001
	(0.002)	(0.002)	(0.001)	(0.002)
BOARD_NETWORK	0.006	0.013*	0.002	0.011**
	(0.007)	(0.008)	(0.006)	(0.005)
INSTITUTIONAL_OWNERSHIP	−0.007	0.001	0.003	−0.020
	(0.016)	(0.021)	(0.012)	(0.015)
FIRM_AGE	0.108***	0.158***	0.138***	0.032
	(0.038)	(0.048)	(0.037)	(0.020)
FIRM_SIZE	0.095***	0.086***	0.055***	0.075***
	(0.009)	(0.012)	(0.006)	(0.010)
MB	0.001	0.002*	−0.000	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
ROA	−0.003	−0.016	−0.000	−0.019*
	(0.016)	(0.025)	(0.025)	(0.011)
LEVERAGE	−0.226***	−0.244***	−0.158***	−0.153***
	(0.018)	(0.021)	(0.020)	(0.019)
SALES_GROWTH	−0.010***	−0.007*	−0.006***	−0.006**
	(0.003)	(0.004)	(0.002)	(0.002)
HHI	−0.057	−0.174	−0.436	0.375**
	(0.280)	(0.300)	(0.338)	(0.169)
HHI^2	1.566**	2.163**	2.042***	−0.506
	(0.755)	(0.870)	(0.729)	(0.815)
ASSET_TANGIBILITY	0.170***	0.249***	0.140***	0.107***
	(0.030)	(0.031)	(0.024)	(0.025)
R&D/ASSETS	0.119***	0.179***	0.043	0.023
	(0.039)	(0.044)	(0.033)	(0.033)
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	51,120	51,120	51,120	51,120
Adj. R^2	0.875	0.821	0.815	0.843

C. Validation Tests of the DiD Design

Next, we validate our use of the DiD design by showing i) that the treatment and control groups exhibit parallel pre-trends in terms of firms' innovation variables; ii) that the adoption of MV legislation is related to neither macroeconomic conditions nor the average level of innovation outcomes in states; and iii) that the random assignment of legislation passage years does not replicate our results.

First, the validity of the DiD test depends on the assumption that without MV legislation, the treated firms' innovation outcomes would have evolved similarly to those of the control firms. While this assumption is not directly testable, we examine whether, before the legislative changes, the treated and control groups exhibit parallel trends with respect to innovation outcomes. We compare the pre-treatment trend by replacing the indicator MV in equation (1) with six new variables: MV_2, MV_1, MV0, MV1, MV2, and MV3. MV_2, MV_1, MV0, MV1, and MV2 are all dummy variables that equal 1 if a firm is in the treated state and in years $t-2$, $t-1$, t, $t+1$, and $t+2$, with year t denoting the MV legislation adoption year, and 0 otherwise. MV3 is a dummy variable that equals 1 if a firm is in the treated state and in years $t+3$ or later, and 0 otherwise. We report our results in Table IA1 of the Supplementary Material.

We find that the coefficients on MV_2, MV_1, and MV0 are generally insignificant in all columns where the dependent variables are PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS. The absence of significant lead effects indicates that it is unlikely that the change in innovation outcomes after legislative changes is caused by unobservable heterogeneity between the treated and control groups. The treated and control groups share a similar overall trend in innovation outcomes prior to the adoption of MV legislation.

Moreover, the effect of MV legislation becomes significant 1 year after the enactment: The coefficients on MV1, MV2, and MV3 all turn significantly negative in columns 1–3 for PATENTS, FORWARD_CITATIONS, and EXPLORATORY_PATENTS, respectively. Importantly, we observe that the coefficients on the post-enactment dummies, in general, increase in absolute magnitude over time across columns 1–3. Such a pattern is consistent with the intuition that it takes time for MV legislation to influence innovation outcomes; this pattern also suggests that the impact is long-lived. Overall, our findings in Table IA1 of the Supplementary Material not only confirm the parallel trends, but also show that innovation activities decrease only after the adoption of MV statutes, thereby supporting a causal interpretation of our baseline results.

Second, one might worry about the political economy of the laws, as they may have been passed either because of the changing economic climates in the individual states or because of a higher level of innovation outcomes or opportunities that would cause more active shareholders (firms) to adopt (resist) the legislative changes. We first examine whether poor state-level innovation outcomes and macroeconomic conditions occur before the adoption of MV legislation in a particular state. Following Acharya, Baghai, and Subramanian (2014), we validate this assumption by using a Weibull hazard model in which the "failure event" is the adoption of MV legislation in a state, and the explanatory variables include

state-level innovation outcomes in prior years.[23] To construct the sample for this test, we begin with our initial sample of all U.S. states; however, once a state adopts MV legislation, we then drop it from our sample.[24] As we report in Table IA2 of the Supplementary Material, we find that a state's adoption of MV legislation is not related to local innovation outcomes and opportunities, which validates our assumption that the adoption of MV legislation is likely to be exogenous to local firms' innovation outcomes and alleviates concerns of reverse causality.

Third, we conduct a placebo test to check whether MV legislation's effect remains when we randomly pick an adoption year other than the actual one. Specifically, for each state that enacted the legislative change, we assign a pseudo-adoption year that we randomly choose from the sample period of 2003 to 2018. We then re-estimate our baseline regressions in Table 4 based on those pseudo-event years and save the coefficient on MV. We repeat this procedure 1,000 times and plot the empirical distribution of the coefficient estimates based on these pseudo-events in Figure IA1 in the Supplementary Material. In Panels A–D, we plot the distribution of the coefficient estimates for PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS, which respectively compare to columns 1–4 of Table 4. We find that the coefficient estimates from columns 1–3 of Table 4 lie well to the left of the entire distribution of the coefficient estimates from the placebo test. For example, in Panel A, the coefficient estimate from column 1 of Table 4 (−0.067) is approximately 7-standard-deviations (0.006) below the mean (−0.025) of the distribution. These results thus confirm that MV legislation enactment indeed leads to our main finding.

Additionally, because the new law empowers shareholders to change a firm's voting standard to MV, it should impact firms that have a plurality voting rule in place rather than those that already adopted the MV standard. While we do not have voting rule information for all Compustat firms, we check the fraction of S&P 1500 firms that had a plurality voting standard in place 1 year before the legislation was enacted in each treated state (untabulated but available from the authors). More than 90% of firms in the treated states had a plurality voting standard in place before the legislation's enactment, suggesting that our DiD coefficient should largely capture the effect of MV legislation on the firms for which the legislation was intended (i.e., those that had a plurality voting standard in place).

D. Director Myopia and Value Implications

We propose that the negative effect of the MV enactment on corporate innovation is driven by the weakened job security of directors. This proposition follows the prediction from the theoretical literature and empirical evidence that a lack of job security due to excessive shareholder monitoring and stock market pressure could induce managers to pursue short-term, myopic investment strategies (Stein (1988), (1989), Lazear (1990), Manso (2011), He and Tian (2013), and Sapra et al.

[23]Previous state-level innovation captures innovation opportunities because innovative activities are fairly persistent (Hall et al. (2005a)) and subject to geographic clustering to a great extent (Jaffe, Trajtenberg, and Henderson (1993)).

[24]Adoption only happens once, rendering all observations after adoption useless for this test.

(2014)). Directors with greater job insecurity may become more short-term oriented and thus have weakened incentives to support highly risky and effort-costly innovation, thereby leading firms to reduce innovation activities and/or change project choices. In this subsection, we examine and provide evidence for increased director myopia in the post-MV period and explore the value implications of the resulting change in innovation activities.

1. R&D and Short-Term Earnings Benchmark

To examine directors' increased focus on short-term performance after the enactment of MV legislation, we study two measures of myopia: Firms' R&D expenditures and their tendency to miss short-term earnings goals. Reducing R&D expenditures is one of the major real earnings management tools that firms use to meet short-term earnings targets and is indicative of myopic investment behavior (e.g., Bushee (1998), Bereskin, Hsu, and Rotenberg (2018)), and overall, myopia can lead to decisions that sacrifice long-term firm value to meet the desired short-run performance goals, resulting in a lowered likelihood of missing earnings targets (e.g., Graham, Harvey, and Rajgopal (2005)).

In Table 5, we examine the effect of MV legislation on these myopia measures. Our estimation follows equation (1), with R&D/ASSETS, MISS_EPS, and MISS_ROA as dependent variables in columns 1–3, respectively. R&D/ASSETS is defined as a firm's annual R&D expenses scaled by total assets. Following prior studies on short-term performance targets (e.g., Brown and Marcus (2005), Brown and Spina (2007), and Bhojraj, Hribar, Picconi, and McInnis (2009)), we define MISS_EPS as a dummy variable that equals 1 if the firm's actual earnings per share (EPS) is below the analyst consensus forecast, and 0 otherwise, and we define MISS_ROA as a dummy variable that equals 1 if the firm's ROA is below 0, and 0 otherwise.

In column 1 of Table 5, the coefficient on MV is negative and significant at the 1% level, indicating that treated firms reduce R&D expenditures significantly after MV legislation compared to control firms. Moreover, treated firms are less likely to miss short-term earnings benchmarks after MV legislation, as indicated by the negative coefficients on MV in columns 2 and 3, both significant at the 1% level. These findings provide evidence that is consistent with directors' myopic behavior after the enactment of MV legislation: Directors' increased job insecurity pressures them to focus on short-term performance, and such myopia induces incentives to reduce R&D investment and meet short-term earnings targets.

2. Innovation Quality, Efficiency, and Value

Having documented evidence of myopic behavior in the post-MV period, we directly explore in this subsection the value implications of the resulting changes in innovation activities by examining how patent quality, efficiency, and value are influenced by the legislation. Specifically, we examine PATENT_ORIGINALITY, PATENT_QUALITY, INNOVATIVE_EFFICIENCY, and PATENT_VALUE, respectively, in columns 1–4 of Table 6.

Following the prior literature on innovation (e.g., Hall et al. (2005b), Hirshleifer, Hsu, and Li (2013), (2018), and Kogan et al. (2017)), PATENT_ORIGINALITY is calculated as the average of the originality scores of all patents

TABLE 5

Majority Voting Legislation and Director Myopia

In Table 5, we report the results on the effect of MV legislation on director myopia. The dependent variables are R&D/ASSETS, MISS_EPS, and MISS_ROA, respectively, in columns 1–3. R&D/ASSETS is defined as a firm's annual R&D expenses scaled by total assets. MISS_EPS is a dummy variable that equals 1 if the firm's actual earnings per share (EPS) is below the analyst consensus forecast, and 0 otherwise. MISS_ROA is a dummy variable that equals 1 if the firm's ROA is below 0, and 0 otherwise. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	R&D/ASSETS	MISS_EPS	MISS_ROA
	1	2	3
MV	−0.002***	−0.042***	−0.022***
	(0.001)	(0.015)	(0.008)
CEO_TENURE	0.000	−0.001	−0.001**
	(0.000)	(0.001)	(0.000)
CEO_DUALITY	−0.000	−0.003	−0.012*
	(0.001)	(0.006)	(0.006)
CEO_OUTSIDE_DIRECTORSHIPS	−0.001***	−0.003	−0.009**
	(0.000)	(0.007)	(0.004)
BOARD_INDEPENDENCE	0.007***	0.003	−0.046***
	(0.002)	(0.030)	(0.017)
BUSY_BOARD	−0.001	−0.062***	0.040*
	(0.001)	(0.015)	(0.022)
BOARD_DIVERSITY	−0.003*	0.049	0.042
	(0.002)	(0.045)	(0.036)
BOARD_SIZE	0.001***	−0.002	−0.000
	(0.000)	(0.002)	(0.001)
BOARD_NETWORK	0.001	0.001	0.009*
	(0.000)	(0.006)	(0.004)
INSTITUTIONAL_OWNERSHIP	−0.001***	−0.006	−0.063***
	(0.000)	(0.022)	(0.011)
FIRM_AGE	−0.002	−0.016	0.048
	(0.002)	(0.032)	(0.031)
FIRM_SIZE	−0.008***	0.055***	0.052***
	(0.001)	(0.011)	(0.006)
MB	0.000***	0.000	−0.010***
	(0.000)	(0.001)	(0.000)
ROA	−0.012***	0.035	−0.400***
	(0.001)	(0.024)	(0.019)
LEVERAGE	−0.018***	−0.067**	0.139***
	(0.002)	(0.027)	(0.021)
SALES_GROWTH	−0.001	−0.013*	−0.044***
	(0.000)	(0.007)	(0.005)
HHI	−0.002	0.289	0.004
	(0.014)	(0.276)	(0.363)
HHI^2	0.024	−0.014	−0.284
	(0.035)	(0.842)	(0.997)
ASSET_TANGIBILITY	0.014***	0.060	0.164***
	(0.003)	(0.041)	(0.043)
R&D/ASSETS	0.109***	0.115***	0.090***
	(0.011)	(0.017)	(0.025)
HQ region × year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
No. of obs.	51,120	32,509	51,120
Adj. R^2	0.889	0.117	0.462

filed by a firm in a given year, with each patent's originality score defined as 1 minus the Herfindahl index of the technology subsection distribution of backward citations made by the patent; PATENT_QUALITY is defined as the average number of 5-year adjusted forward citations of all patents filed by a firm in a given year;

TABLE 6

Majority Voting Legislation and Innovation Quality, Efficiency, and Value

In Table 6, we report the results on the effect of MV legislation on innovation quality, efficiency, and value. The dependent variables are PATENT_ORIGINALITY, PATENT_QUALITY, INNOVATIVE_EFFICIENCY, and PATENT_VALUE, respectively, in columns 1–4. PATENT_ORIGINALITY is calculated as the average of the originality scores of all patents filed by a firm in a given year, with each patent's originality score defined as 1 minus the Herfindahl index of the technology class distribution of backward citations made by the patent. PATENT_QUALITY is defined as the average number of 5-year adjusted forward citations of all patents filed by a firm in a given year. INNOVATIVE_EFFICIENCY is defined as the number of patents filed by a firm in a given year scaled by the firm's R&D expenditure. PATENT_VALUE is defined as the value of all patents filed by a firm in a given year, based on the sum of stock market reactions to news of patent grants. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	PATENT_ ORIGINALITY	PATENT_ QUALITY	INNOVATIVE_ EFFICIENCY	PATENT_ VALUE
	1	2	3	4
MV	−0.013*	−0.130*	−0.040***	−0.097***
	(0.008)	(0.074)	(0.015)	(0.027)
CEO_TENURE	−0.000	−0.001	0.000	0.003**
	(0.000)	(0.004)	(0.001)	(0.001)
CEO_DUALITY	−0.008***	−0.119***	0.006	0.003
	(0.002)	(0.030)	(0.007)	(0.008)
CEO_OUTSIDE_DIRECTORSHIPS	0.004	−0.059**	−0.002	−0.018
	(0.004)	(0.023)	(0.005)	(0.013)
BOARD_INDEPENDENCE	0.027**	−0.370**	0.043*	0.156***
	(0.011)	(0.149)	(0.023)	(0.044)
BUSY_BOARD	−0.030***	0.148	0.006	−0.007
	(0.007)	(0.117)	(0.010)	(0.035)
BOARD_DIVERSITY	−0.006	−0.396**	0.068	−0.081*
	(0.017)	(0.184)	(0.043)	(0.048)
BOARD_SIZE	−0.001	−0.013	−0.003	−0.004
	(0.001)	(0.008)	(0.003)	(0.003)
BOARD_NETWORK	0.006***	−0.08	−0.009**	0.022**
	(0.002)	(0.065)	(0.004)	(0.009)
INSTITUTIONAL_OWNERSHIP	−0.003	−0.085	0.013	−0.071**
	(0.007)	(0.069)	(0.016)	(0.031)
FIRM_AGE	−0.021	−0.115	−0.014	0.291***
	(0.017)	(0.267)	(0.028)	(0.053)
FIRM_SIZE	0.007***	−0.127***	−0.058***	0.126***
	(0.002)	(0.027)	(0.004)	(0.009)
MB	0.000	−0.006**	0.002**	0.004***
	(0.000)	(0.003)	(0.001)	(0.001)
ROA	−0.000	0.259*	0.100***	−0.013
	(0.005)	(0.142)	(0.008)	(0.019)
LEVERAGE	−0.028**	0.561***	−0.013	−0.321***
	(0.012)	(0.177)	(0.019)	(0.037)
SALES_GROWTH	−0.002	0.041	0.003	−0.008**
	(0.001)	(0.035)	(0.003)	(0.004)
HHI	−0.003	3.525	−0.251	0.603
	(0.238)	(3.149)	(0.449)	(0.485)
HHI^2	−0.420	−5.584	1.104	2.245
	(0.699)	(5.865)	(1.508)	(1.427)
ASSET_TANGIBILITY	−0.013	0.542*	−0.119***	0.089
	(0.023)	(0.278)	(0.038)	(0.064)
R&D/ASSETS	−0.007	−0.349***	−0.242***	0.322***
	(0.011)	(0.098)	(0.020)	(0.055)
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	14,090	14,096	21,932	51,120
Adj. R^2	0.460	0.467	0.589	0.857

INNOVATIVE_EFFICIENCY is defined as the number of patents filed by a firm in a given year scaled by the firm's R&D expenditure. We find that treated firms have less original patents, lower-quality (less cited) patents, and lower efficiency of innovation compared to control firms after MV legislation, as indicated by the negative and significant coefficients on MV across columns 1–3 of Table 6.[25]

To complement our analysis of patent quality and efficiency, we examine firm's total patent value in column 4 of Table 6. PATENT_VALUE is defined as the value of all patents filed by a firm in a given year, based on the sum of stock market reactions to news of patent grants. Following Kogan et al. (2017), the value of each patent is calculated as the product of the 3-day abnormal return around the patent announcement times the market capitalization of the firm on the day prior to the announcement. This is a market-based measure that offers a plausibly fair assessment of the economic value associated with a firm's patent output each year. We find that MV legislation leads to a significant reduction in firm-level patent value, as indicated by the negative coefficient on MV in column 4.

Together, these results are consistent with the director myopia story of directors faced with heightened job insecurity focusing on short-term firm performance at the expense of long-term performance and investment in innovation. We find that MV legislation has a negative impact on patent originality, patent quality, and innovative efficiency, which are important indicators for firms' innovation performance and profitability (Hirshleifer et al. (2013), (2018)), as well as on firm value created by new patents. These findings provide new insight into the investigation on the effect of the MV standard on firm value. Existing studies examining firm returns offer mixed evidence: For example, Ertimur et al. (2015) show that, on average, shareholder proposals related to MV in director elections receive positive short-term market reactions, while, in contrast, Cai, Garner, and Walkling (2013) find that the announcement returns surrounding the voting dates of MV proposals as well as the actual adoption of an MV standard are insignificant on average. Our analysis shows that in terms of corporate innovation, MV legislation has clear negative implications: Director job insecurity induced by MV legislation leads to a reduction of patent originality and quality, innovative efficiency, as well as firm-level patent values. Therefore, a thorough evaluation of the effect of the MV standard on firm value and performance must take into consideration not only the resulting enhanced shareholder protection but also any negative (and perhaps unintended) consequences in the long run, such as the potential costs of weakened innovation prospects.

V. Heterogeneous Treatment Effects

So far, our results on changes in firms' innovation choices following the adoption of MV legislation are consistent with the interpretation that the legislation leads to an exogenous threat to directors' job security and thus heightens their incentive to take myopic actions. In other words, because the MV system ex-ante

[25]The lower numbers of observations in the first 3 columns of Table 6 are due to the fact that only firms with patents (for columns 1 and 2) or nonzero/nonmissing R&D expenses (for column 3) are included in the regressions.

increases directors' job insecurity, they respond by influencing firms' innovation activities to secure short-term performance. In this section, we explore cross-sectional variations to provide further insights into how directors' job insecurity leads to reduced innovation. The effect of MV legislation on corporate innovation should be particularly strong in situations where job loss is more costly to directors, thereby enhancing their incentives for myopic behavior. Conversely, the effect should be mitigated by mechanisms that weaken such incentives. Specifically, we examine the following factors that strengthen or mitigate the effect of MV legislation on innovation: director compensation, directors' dismissal threat, and shareholders' expertise in innovation. Furthermore, we investigate whether directors' heightened job insecurity influences innovation through their advising or monitoring roles (or both) by exploring cross-sectional variations in CEO experience and managerial entrenchment.

A. Job Loss Severity

In this subsection, we examine the job loss severity for directors. To the extent that job insecurity leads directors to be more myopic and reduce innovation activities, we should expect the effect of MV legislation on innovation outcomes to be stronger when the expected cost of losing the job or the threat of dismissal is higher. We focus on two aspects of job loss severity: Directors' compensation from their current firm and the potential competition in the local director market.

1. Director Compensation

We conjecture that the higher the compensation a firm offers to its directors, the more attractive the director position is. A director is then less willing to leave and has greater incentives to keep their current directorship by acting myopically. We obtain information on the total compensation for nonexecutive directors for all the firm-years in our observations from the BoardEx database and end up with 10,161 firm-year observations.[26] We define HIGH_DIRECTOR_COMPENSATION as a dummy variable that equals 1 when the median of a firm's nonexecutive director compensation is above the sample median, and 0 otherwise. We then include this variable and its interaction with MV in equation (1) for our analysis of heterogeneous treatment effects.

The results are reported in Table 7. We find that across all columns, the coefficients on HIGH_DIRECTOR_COMPENSATION $\times$ MV are negative and significant at the 1% or 5% level. These findings confirm our intuition and suggest that the effect of director job insecurity on innovation is stronger when directors' expected cost of losing their directorship is higher.

2. Dismissal Threat

Prior studies find that when the local director pool is deeper, that is, the supply of directors is greater, a director's job insecurity is greater. For example, Zhao (2018) finds that in denser labor markets, executives face stronger performance-

[26]Because public firms are not required to disclose director total compensation in proxy statements, information on director compensation is sparse. We hence use the most recent compensation information available in the 3-year window before each firm-year in our estimation.

TABLE 7

Majority Voting Legislation and Innovation: The Role of Director Compensation

In Table 7, we report the results on the role of director compensation in the effect of MV legislation on corporate innovation. The dependent variables are PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS, respectively, in columns 1–4. PATENTS is the natural logarithm of 1 plus the number of patents. FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted citations of a firm's patents. EXPLORATORY_PATENTS is the natural logarithm of 1 plus the number of exploratory patents. EXPLOITATIVE_PATENTS is the natural logarithm of 1 plus the number of exploitative patents. HIGH_DIRECTOR_COMPENSATION is a dummy variable that equals 1 when a firm's average nonexecutive director compensation is higher than the median, and 0 otherwise. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. In all columns, we control for other variables as included in Table 4. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	PATENTS	FORWARD_ CITATIONS	EXPLORATORY_ PATENTS	EXPLOITATIVE_ PATENTS
	(1)	(2)	(3)	(4)
HIGH_DIRECTOR_COMPENSATION × MV	−0.066***	−0.062**	−0.038**	−0.043**
	(0.021)	(0.023)	(0.017)	(0.020)
MV	−0.047*	−0.046	−0.049	−0.000
	(0.027)	(0.037)	(0.029)	(0.032)
HIGH_DIRECTOR_COMPENSATION	0.027	0.055**	0.021	0.029
	(0.021)	(0.022)	(0.018)	(0.019)
Other controls	Yes	Yes	Yes	Yes
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	10,160	10,160	10,160	10,160
Adj. R^2	0.918	0.877	0.874	0.895

based dismissal threats. To the extent that job insecurity leads to myopia and hence induces directors to avoid risky innovation activities, we should expect this effect to be stronger when a firm's local director pool is deeper.

We follow Knyazeva, Knyazeva, and Masulis (2013) and calculate the local director pool as the number of firms in a firm's headquarters state, excluding those in the same industry.[27] We define DEEP_LOCAL_DIRECTOR_POOL as a dummy variable that equals 1 when the number of firms is above the sample median, and 0 otherwise. We then include this variable and its interaction with MV in equation (1) for our analysis of heterogeneous treatment effects.

We report our results in Table 8. We find that MV legislation still has a significantly negative effect on firms with less deep local director pools: The coefficients on MV are negative and significant across columns 1–3. The effect of MV is even stronger for firms with deeper local director pools: The coefficients on DEEP_LOCAL_DIRECTOR_POOL × MVare also negative and significant. These findings suggest that firms whose directors face more severe job security concerns due to greater competition in local director markets are more likely to be affected by the law change as their directors have greater incentives to keep their current directorship.

B. Shareholder Expertise in Innovation

In this subsection, we investigate the effect of shareholders' expertise in innovation on the relation between directors' job insecurity and firms' innovation

[27]By construction, the local director pool (which captures local availability of general business experts, excluding same-industry firms) is unrelated to local industry clusters.

TABLE 8

Majority Voting Legislation and Innovation: The Role of Local Director Pool

In Table 8, we report the results for the role the local director pool plays in the effect of MV legislation on corporate innovation. The dependent variables are PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS, respectively, in columns 1–4. PATENTS is the natural logarithm of 1 plus the number of patents. FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted citations of a firm's patents. EXPLORATORY_PATENTS is the natural logarithm of 1 plus the number of exploratory patents. EXPLOITATIVE_PATENTS is the natural logarithm of 1 plus the number of exploitative patents. DEEP_LOCAL_DIRECTOR_POOL is a dummy variable that equals 1 when the number of public firms in a firm's headquarters state, excluding those in the same industry, is above the median, and 0 otherwise. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. In all columns, we control for other variables as included in Table 4. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	PATENTS	FORWARD_CITATIONS	EXPLORATORY_PATENTS	EXPLOITATIVE_PATENTS
	1	2	3	4
DEEP_LOCAL_DIRECTOR_POOL × MV	−0.028**	−0.053***	−0.030*	−0.001
	(0.012)	(0.011)	(0.017)	(0.005)
MV	−0.053***	−0.051***	−0.036**	−0.011
	(0.013)	(0.012)	(0.017)	(0.010)
DEEP_LOCAL_DIRECTOR_POOL	0.005	0.035	0.016	−0.002
	(0.031)	(0.045)	(0.024)	(0.019)
Other controls	Yes	Yes	Yes	Yes
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	51,120	51,120	51,120	51,120
Adj. R^2	0.875	0.822	0.815	0.844

activities. We expect that the effect of MV legislation will be weaker when firms' shareholders possess more expertise in innovation, as such investors have more knowledge and information about the nature and value of innovation activities and are thus more likely to tolerate risky investments and short-term failures.

Using institutional investor holdings data from Thomson Reuters 13F, we measure shareholder expertise in innovation in two steps. First, for each institutional investor, we calculate its individual shareholder expertise as the median number of forward citations across all firms in the institutional investor's portfolio. Second, we calculate each firm's shareholder expertise as the median of the individual shareholder expertise measures among all institutional investors holding the firm's stocks. We define HIGH_SHAREHOLDER_EXPERTISE as a dummy variable that equals 1 if a firm's shareholder expertise is higher than the sample median, and 0 otherwise. We then include this variable and its interaction with MV in equation (1).

Table 9 reports the results. We find that across all columns, the coefficients on MV are negative and significant while the coefficients on HIGH_SHAREHOLDER_EXPERTISE × MV are positive and significant, suggesting that the reduction in innovation is mitigated by the presence of institutional investors with expertise in innovation. These results support the idea that shareholder expertise in innovation can mitigate the negative effect of directors' job insecurity on innovation outcomes as it can serve as insurance against the short-termism that the additional job insecurity imposes on directors due to the legislative shock.

TABLE 9

Majority Voting Legislation and Innovation: The Role of Shareholder Expertise

In Table 9, we report the results for the role of shareholder expertise plays in the effect of MV legislation on corporate innovation. The dependent variables are PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS, respectively, in columns 1–4. PATENTS is the natural logarithm of 1 plus the number of patents. FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted citations of a firm's patents. EXPLORATORY_PATENTS is the natural logarithm of 1 plus the number of exploratory patents. EXPLOITATIVE_PATENTS is the natural logarithm of 1 plus the number of exploitative patents. HIGH_SHAREHOLDER_EXPERTISE is a dummy variable that equals 1 if a firm's shareholder expertise in innovation is above the sample median, and 0 otherwise. Shareholder expertise is defined as the median expertise among all institutional investors of a firm; each investor's expertise is defined as the median number of forward citations across all firms in the investor's portfolio. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. In all columns, we control for other variables as included in Table 4. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	PATENTS	FORWARD_ CITATIONS	EXPLORATORY_ PATENTS	EXPLOITATIVE_ PATENTS
	1	2	3	4
HIGH_SHAREHOLDER_EXPERTISE × MV	0.064***	0.100***	0.049***	0.035***
	(0.017)	(0.028)	(0.015)	(0.011)
MV	−0.099***	−0.129***	−0.075***	−0.028**
	(0.018)	(0.022)	(0.018)	(0.012)
HIGH_SHAREHOLDER_EXPERTISE	0.022*	0.112***	0.027**	0.022***
	(0.013)	(0.023)	(0.010)	(0.008)
Other controls	Yes	Yes	Yes	Yes
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	51,120	51,120	51,120	51,120
Adj. R^2	0.879	0.830	0.824	0.852

C. Directors' Advisory and Monitoring Roles

In this subsection, we examine the channels through which directors' heightened job insecurity can influence corporate innovation: Directors may change their advising strategy to encourage less innovation or the pursuit of safer, short-term projects, and/or they may adjust their monitoring intensity of managers, which can in turn lead to changes in innovation activities. We investigate directors' advisory and monitoring roles by exploring cross-sectional variations in CEO experience and in managerial entrenchment, respectively.

1. Directors' Advisory Role: CEO Experience

Prior studies emphasize the importance of board expertise in shaping corporate decisions, especially in firms with inexperienced CEOs (e.g., Westphal (1999), Adams (2003), and Naveen, Daniel, and McConnell (2013)). Boards' advisory function is particularly important to inexperienced CEOs, because they rely more on boards' advice and expertise in their decision-making. Thus, we conjecture that in our setting, the negative effect of the MV law change on innovation activities should be more prominent in firms with inexperienced CEOs.

To test this, we construct a dummy variable, INEXPERIENCED_CEO, which equals 1 if the number of years that the CEO has worked in their current firm's industry is below the sample median, and 0 otherwise. Table 10 reports the regression results when we include this dummy variable and its interaction with MV in equation (1). We find that, consistent with our conjecture, the coefficients on INEXPERIENCED_CEO × MV are significantly negative across all columns.

TABLE 10

Majority Voting Legislation and Innovation: The Role of CEO Experience

In Table 10, we report the results for the role of CEO experience plays in the effect of MV legislation on corporate innovation. The dependent variables are PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS, respectively, in columns 1–4. PATENTS is the natural logarithm of 1 plus the number of patents. FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted citations of a firm's patents. EXPLORATORY_PATENTS is the natural logarithm of 1 plus the number of exploratory patents. EXPLOITATIVE_PATENTS is the natural logarithm of 1 plus the number of exploitative patents. INEXPERIENCED_CEO is a dummy variable that equals 1 when the number of years the CEO has worked in their current firm's industry is above the median, and 0 otherwise. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. In all columns, we control for other variables as included in Table 4. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	PATENTS	FORWARD_ CITATIONS	EXPLORATORY_ PATENTS	EXPLOITATIVE_ PATENTS
	1	2	3	4
INEXPERIENCED_CEO × MV	−0.052***	−0.055***	−0.040***	−0.041***
	(0.008)	(0.012)	(0.006)	(0.007)
MV	−0.047***	−0.057***	−0.036***	0.005
	(0.013)	(0.014)	(0.013)	(0.011)
INEXPERIENCED_CEO	−0.012	−0.000	−0.004	−0.005
	(0.008)	(0.013)	(0.006)	(0.006)
Other controls	Yes	Yes	Yes	Yes
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	51,120	51,120	51,120	51,120
Adj. R^2	0.875	0.822	0.815	0.844

The estimates show that the negative effect of MV legislation on the number of total patents and citations are 96% to over 100% larger in magnitude in firms with inexperienced CEOs than in other firms. These results are consistent with boards' influence on innovation through the advisory channel: The effect of MV legislation on innovation is stronger when directors' advisory services are needed more (i.e., when directors' incentives are more likely to have a meaningful impact on firms' innovation choices).

2. Directors' Monitoring Role: Managerial Entrenchment

Directors may also affect corporate innovation through their monitoring roles in our setting of legislative change. For example, directors with heightened job insecurity may choose to reduce their monitoring intensity on managers who enjoy the quiet life and shirk on innovative projects, thereby leading to a reduction in innovation activities. In such a case, we would expect the effect of MV legislation on innovation to vary depending on the degree of ex ante managerial shirking at the firm. To investigate this question, we examine cross-sectional variations in managerial entrenchment (Bebchuk, Cohen, and Ferrell (2009)). Entrenched managers are more likely to shirk their responsibilities to the detriment of shareholders, and board monitoring helps mitigate this problem (Morck, Wolfenzon, and Yeung (2005), Faleye (2007), and Biggerstaff, Cicero, and Puckett (2017)).

The Entrenchment Index is measured as the sum of scores from six entrenching provisions: staggered boards, limits to shareholder amendments of the bylaws, supermajority requirements for mergers, supermajority requirements for charter amendments, poison pills, and golden parachute arrangements. We retrieve information on these provisions for S&P 1500 firms from RiskMetrics.

TABLE 11

Majority Voting Legislation and Innovation: The Role of Managerial Entrenchment

In Table 11, we report the results for the role of managerial entrenchment plays in the effect of MV legislation on corporate innovation. The dependent variables are PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS, respectively, in columns 1–4. PATENTS is the natural logarithm of 1 plus the number of patents. FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted citations of a firm's patents. EXPLORATORY_PATENTS is the natural logarithm of 1 plus the number of exploratory patents. EXPLOITATIVE_PATENTS is the natural logarithm of 1 plus the number of exploitative patents. HIGH_ENTRENCHMENT is a dummy variable that equals 1 if a firm's Entrenchment Index (Bebchuk et al. (2009)) is above the sample median, and 0 otherwise. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. In all columns, we control for other variables as included in Table 4. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	PATENTS	FORWARD_CITATIONS	EXPLORATORY_PATENTS	EXPLOITATIVE_PATENTS
	1	2	3	4
HIGH_ENTRENCHMENT × MV	0.005	0.011	0.018	−0.020
	(0.018)	(0.020)	(0.016)	(0.018)
MV	−0.058**	−0.073***	−0.055**	0.010
	(0.023)	(0.026)	(0.022)	(0.022)
HIGH_ENTRENCHMENT	−0.015	−0.024	−0.014	0.013
	(0.016)	(0.024)	(0.015)	(0.012)
Other controls	Yes	Yes	Yes	Yes
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	28,708	28,708	28,708	28,708
Adj. R^2	0.891	0.837	0.835	0.858

We then construct a dummy variable, HIGH_ENTRENCHMENT, which equals 1 if a firm's Entrenchment Index is above the sample median, and 0 otherwise. Table 11 reports the estimation results when we include HIGH_ENTRENCHMENT and its interaction with MV in equation (1). We find that the coefficients on the interaction terms are insignificant across all columns. In an untabulated analysis, we conduct similar tests using CEO excess compensation as an alternative proxy for entrenchment (Faleye, Hoitash, and Hoitash (2011)) and again find that all interaction terms are insignificant. These results do not seem to support the monitoring channel: The effect of MV legislation on innovation activities does not differ significantly across firms with different levels of managerial entrenchment.

VI. Alternative Explanations and Robustness Checks

A. Alternative Explanations

Our main result shows that director job insecurity reduces the quantity and quality of innovation outcomes by affecting directors' incentives. However, an alternative explanation could be that the regulation simultaneously affects the composition of director members, which consequently led to a change in corporate innovation policies. To rule out this alternative explanation, we remove from our main sample the treated firms that experience changes in directors. Specifically, once there are any changes in directors in a particular year, we drop that year and all subsequent years from the sample. In Table 12, we show that our main result is robust when we remove firms that experience changes in directors. Hence, our

TABLE 12

Majority Voting Legislation and Innovation: Firms Without Director Changes

In Table 12, we report the results on the effect of MV legislation on corporate innovation using a subsample of firms that do not experience any changes in directors throughout the sample period. The dependent variables are PATENTS, FORWARD_CITATIONS, EXPLORATORY_PATENTS, and EXPLOITATIVE_PATENTS, respectively, in columns 1–4. PATENTS is the natural logarithm of 1 plus the number of patents. FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted citations of a firm's patents. EXPLORATORY_PATENTS is the natural logarithm of 1 plus the number of exploratory patents. EXPLOITATIVE_PATENTS is the natural logarithm of 1 plus the number of exploitative patents. MV is a dummy variable that equals 1 if MV legislation is in effect in the state, and 0 otherwise. In all columns, we control for other variables as included in Table 4. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	PATENTS	FORWARD_CITATIONS	EXPLORATORY_PATENTS	EXPLOITATIVE_PATENTS
	1	2	3	4
MV	−0.071***	−0.070***	−0.066***	0.045
	(0.026)	(0.021)	(0.017)	(0.040)
Other controls	Yes	Yes	Yes	Yes
HQ region × year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs.	20,214	20,214	20,214	20,214
Adj. R^2	0.880	0.832	0.813	0.854

result is unlikely to be driven by changes in director compositions due to MV legislation.

Another explanation of our main result could be that the legislative changes that reduce director job security also affect CEO incentives. For example, because it now becomes harder to secure outside directorships in states that are also affected by MV legislation, CEOs might place more emphasis on employment at their current firm, thereby choosing less risky innovation projects. To examine this alternative explanation, we remove from our main sample the firms for which CEOs have outside directorships during our sample period; doing so ensures that the CEOs of the remaining firms are not subject to employment concerns about their outside directorships. We report our results in Table IA3 in the Supplementary Material. We find that our main result is robust to excluding CEOs with outside directorships.

B. Robustness Tests

In this subsection, we show that our main results are robust to a battery of robustness tests. We first consider alternative sample constructions in Panel A of Table 13. In columns 1 and 2 of Panel A, we exclude firms incorporated in Delaware, where most of the sample firms are incorporated, and find that the quantity and quality of innovation decline significantly after the passage of MV legislation, with similar magnitudes as those in Table 4, suggesting that MV legislation also has an impact in states other than Delaware. In columns 3 and 4, we re-estimate our baseline regressions using a sample of firms that have at least 1 patent during our sample period and find consistent results. The magnitudes of the coefficients on MV are more than 70% larger than those in our baseline regressions in Table 4, suggesting that the effect of MV legislation is stronger for innovative firms. We also extend our sample period by starting the sample from the year 2001 in columns 5 and 6, and from 2002 in columns

7 and 8. We find consistent results that the numbers of patents and patent citations decrease significantly after MV legislation; the results on exploratory and exploitative innovation (unreported for brevity) are also similar to those in the main results.

In Panel B of Table 13, we consider alternative regression specifications. As including CEO and board characteristics reduces our sample size due to data availability, we re-estimate our baseline regressions in columns 1 and 2 by excluding CEO and board characteristics (i.e., CEO_TENURE, CEO_DUALITY, CEO_OUTSIDE_DIRECTORSHIP, BUSY_BOARD, BOARD_INDEPENDENCE, BOARD_DIVERSITY, BOARD_SIZE, and BOARD_NETWORK) from the control variable set. We find robust results. In columns 3 and 4, we include CEO compensation measures as additional control variables. CEOs' compensation schemes and incentives can influence corporate innovation, as incentive plans that involve tolerance for early failures and reward for long-term successes may be effective in motivating innovation (Ederer and Manso (2013)). Thus, we control for unexercised options/total compensation and long-term incentive pay/total compensation (Baranchuk, Kieschnick, and Moussawi (2014)) in columns 3 and 4 and find consistent results.[28]

In columns 5 and 6 of Table 13, we examine the intensity of MV legislation. A director may hold more than one directorship, and directors who hold a greater fraction of directorships in firms that are incorporated in the treated states (i.e., states with MV legislation) should face greater job insecurity. Therefore, MV legislation can result in varying degrees of job insecurity for directors across different firms. To capture this variation, we first determine, for each director, the total number of directorships and the percentage of directorships at firms in the treated states. Then, at the firm level, we take the average of such percentages across all directors in each year to measure the intensity of MV legislation. In columns 5 and 6, we replace the MV dummy variable with the MV intensity measure and find that our results remain robust. In columns 7–10, we vary the timing of the innovation outcome variables in relation to the legislative change. Specifically, with MV measured in year $t-1$, the dependent variables in columns 7 and 8 are measured in year $t+1$, and the dependent variables in columns 9 and 10 are measured in year $t+2$. We find consistent results when we examine innovation outcomes a few years after the regulatory shock. The results on exploratory and exploitative innovation (unreported for brevity) are also robust to these alternative specifications.

VII. Conclusion

In this study, we examine the relation between director job security and firms' technological innovation using a specific law change (MV legislation) which is widely regarded as exogenously empowering shareholders to strengthen the voting standard in director elections, hence increasing job insecurity for directors. We find that the staggered passage of MV legislation leads to significant reductions in the total number of patents, the number of forward citations, and the number of exploratory patents, all of which indicate that firms become myopic and avoid risky

[28]These controls significantly reduce the sample size as compensation data from ExecuComp are available for S&P 1500 firms only.

TABLE 13
Robustness Tests

In Table 13, we present results from a battery of robustness tests. Panel A focuses on alternative sample constructions: in columns 1 and 2, we exclude firms incorporated in Delaware; in columns 3 and 4, the sample consists of firms that have at least one patent during our sample period; we extend our sample period by starting the sample from the year 2001 in columns 5 and 6, and from 2002 in columns 7 and 8. Panel B focuses on alternative regression specifications: in columns 1 and 2, we exclude CEO and board characteristics from the control variable set; in columns 3 and 4, we add additional controls for CEO_UNEXERCISED_OPTIONS, which is calculated as the value of CEO's unexercised options divided by total CEO compensation, and CEO LONG_TERM_INCENTIVE_PAY, which is calculated as the value of CEO's long-term incentive pay divided by total CEO compensation; in columns 5 and 6, we replace the MV dummy variable with an alternative measure of treatment exposure that captures the intensity of MV legislation, defined as the average percentage of directorships held by directors at firms in the treated states across all directors; in columns 7 and 8 and columns 9 and 10, the dependent variables are measured in year $t+1$ and year $t+2$, respectively (with MV measured in year $t-1$). The dependent variables are PATENTS and FORWARD_CITATIONS. PATENTS is the natural logarithm of 1 plus the number of patents. FORWARD_CITATIONS is the natural logarithm of 1 plus the number of adjusted citations of a firm's patents. In all columns, we control for other variables as included in Table 4. Variable definitions are provided in the Appendix. Robust standard errors clustered at the state of incorporation level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Alternative Sample Constructions

	No Delaware Firms		Firms with Patents		Starting from 2001		Starting from 2002	
	PATENTS	FORWARD_CITATIONS	PATENTS	FORWARD_CITATIONS	PATENTS	FORWARD_CITATIONS	PATENTS	FORWARD_CITATIONS
	1	2	3	4	5	6	7	8
MV	−0.043**	−0.051**	−0.126***	−0.133***	−0.064***	−0.078***	−0.067***	−0.080***
	(0.021)	(0.024)	(0.032)	(0.037)	(0.013)	(0.014)	(0.013)	(0.014)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HQ region × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	26,011	26,011	23,029	23,029	53,991	53,991	52,710	52,710
Adj. R^2	0.882	0.836	0.844	0.788	0.877	0.827	0.876	0.824

Panel B. Alternative Regression Specifications

	No Governance Controls		Additional Controls		Intensity of Legislation		2 Years Forward		3 Years Forward	
	PATENTS	FORWARD_CITATIONS	PATENTS	FORWARD_CITATIONS	PATENTS	FORWARD_CITATIONS	PATENTS	FORWARD_CITATIONS	PATENTS	FORWARD_CITATIONS
	1	2	3	4	5	6	7	8	9	10
MV	−0.059***	−0.073***	−0.073***	−0.090***	−0.072***	−0.084***	−0.074***	−0.081***	−0.091***	−0.106***
	(0.011)	(0.012)	(0.022)	(0.027)	(0.013)	(0.014)	(0.015)	(0.015)	(0.018)	(0.019)
CEO_UNEXERCISED_OPTIONS			−0.002*	−0.001						
			(0.001)	(0.001)						
CEO_LONG_TERM_INCENTIVE_PAY			0.139**	0.083						
			(0.058)	(0.064)						
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HQ region × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	64,835	64,835	24,151	24,151	51,120	51,120	47,948	47,948	44,745	44,745
Adj. R^2	0.880	0.828	0.897	0.847	0.875	0.822	0.839	0.787	0.800	0.747

innovation choices after the law enactment. Additional analyses of firms' tendency to miss short-term earnings benchmarks, R&D intensity, and the quality of innovation further confirm that following the legislative change, firms are likely to focus on short-term performance by reducing the quality and quantity of innovation.

We argue that MV legislation increases directors' job insecurity, which leads them to re-orient their governance mission toward promoting more conservative corporate decisions with respect to innovation. We show that directors' performance-related turnover risk intensifies after MV enactment. Moreover, our cross-sectional analyses indicate that the reduction in innovation output is enhanced when a director faces a higher cost of job loss or a greater threat of dismissal and is mitigated by shareholder expertise in innovation. In addition, the effect of MV legislation on innovation is stronger when directors' expertise is more needed, consistent with boards' influence on innovation through the advisory channel.

Overall, our findings indicate that job insecurity could result in short-term incentives for directors and lead them to compromise their role in governing risky innovation. While director elections by shareholders are generally viewed as a vital form of corporate governance for disciplining directors, they may create incentives that discourage innovative activities. Our study provides new insights into how director election systems aimed at empowering shareholders can unintentionally cause directors to adjust their governance effort to avoid risky projects that are important for firms' long-term value.

Appendix. Variable Definitions

AVERAGE_TURNOVER: The fraction of a firm's nonexecutive directors who depart from the firm in a given year.

NONRETIREMENT_RELATED_AVERAGE_TURNOVER: The fraction of a firm's nonexecutive directors who depart in a given year and are below age 70.

MV: Dummy variable that equals 1 if the state of incorporation has adopted MV legislation in a given year, and 0 otherwise.

FIRM_AGE: The natural logarithm of years since the firm appears on the Compustat database.

FIRM_SIZE: The natural logarithm of total assets.

MB: The book value of total assets to the market value of total assets.

LEVERAGE: Total debt divided by total assets.

ROA: Income before extraordinary items divided by total assets.

IND_ADJ_ROA: The difference between a firm's ROA and the median of the 2-digit SIC industry ROA.

IND_ADJ_STOCK_RETURN: The difference between a firm's stock return and the median of the 2-digit SIC industry stock return.

SALES_GROWTH: The growth rate of total sales.

INSTITUTIONAL_OWNERSHIP: Shares owned by institutional investors divided by the number of shares outstanding.

HHI: The Herfindahl–Hirschman Index of firm sales in the firm's 2-digit SIC industry.

HHI^2: The square of the Herfindahl–Hirschman Index.

ASSET_TANGIBILITY: Net value of property, plant, and equipment divided by total assets.

R&D/ASSETS: Research and development expenses divided by total assets.

CEO_TENURE: The number of years since serving as a CEO in the company.

CEO_DUALITY: Dummy variable that equals 1 if the CEO also serves as the chairman of the board, and 0 otherwise.

CEO_OUTSIDE_DIRECTORSHIP: Dummy variable that equals 1 if the CEO holds directorships outside the firm, and 0 otherwise.

BUSY_BOARD: A board's fraction of directors who hold three or more directorships.

BOARD_INDEPENDENCE: Fraction of independent directors on the board.

BOARD_DIVERSITY: The average of three diversity indexes based on a board's gender, ethnicity, and industry experience compositions. Each index is calculated as 1 minus the Herfindahl index of the respective diversity category. Ethnicity includes White, Hispanic, Black, Asian and Pacific Islander, American Indian, Alaskan Native, and others. Industry experience is based on directors' working experience in BoardEx industry sectors.

BOARD_SIZE: The number of directors on the board.

BOARD_NETWORK: Two individuals are defined as sharing a social connection if they share common current and past employment, educational background, or nonprofessional activities as reported by BoardEx. We count how many corporate directors and executives a firm's directors are connected to and compute the aggregate number of connections for the firm's board, divided by 1,000 for ease of presentation.

PATENTS: The natural logarithm of 1 plus the number of patents filed by the firm each year.

FORWARD_CITATIONS: The natural logarithm of 1 plus the number of adjusted citations received by patents filed by the firm each year. Each patent's adjusted citation is calculated as the number of forward citations it receives within 5 years after its grant year, scaled by the average 5-year forward citations received by all patents filed in the same technology subsection in the same year.

EXPLORATORY_PATENTS: The natural logarithm of 1 plus the number of exploratory patents filed by the firm each year. This measure is constructed in 3 steps following Benner and Tushman (2002). First, for each patent the firm applies for in year t, we calculate the percentage of its citations that are based on the firm's existing expertise: The combination of the firm's portfolio of patents and citations made by its portfolio of patents over the past 5 years (i.e., years $t - 5$ to $t - 1$). Second, a patent is categorized as "exploratory" if 80% or more of its citations are outside the firm's existing expertise, as defined in the first step. Finally, we take the natural logarithm of 1 plus the firm's number of exploratory patents in year t.

EXPLOITATIVE_PATENTS: The natural logarithm of 1 plus the number of exploitative patents filed by the firm each year. This measure is constructed in 3 steps following Benner and Tushman (2002). First, for each patent the firm applies for in year t, we calculate the percentage of its citations that are based on the firm's

existing expertise: The combination of the firm's portfolio of patents and citations made by its portfolio of patents over the past 5 years (i.e., years $t-5$ to $t-1$). Second, a patent is categorized as "exploitative" if 80% or more of its citations are based on the firm's existing expertise, as defined in the first step. Finally, we take the natural logarithm of 1 plus the firm's number of exploitative patents in year *t*.

MISS_EPS: A dummy variable that equals 1 if the firm's EPS is below the analyst consensus forecast, and 0 otherwise.

MISS_ROA: A dummy variable that equals 1 if the firm's ROA is below 0, and 0 otherwise.

PATENT_ORIGINALITY: The average of the originality scores of all patents filed by a firm in a given year. Each patent's originality score is defined as 1 minus the Herfindahl index of the technology class distribution of backward citations made by the patent.

PATENT_QUALITY: The number of 5-year adjusted forward citations divided by the total number of all patents filed by a firm in a given year.

INNOVATIVE_EFFICIENCY: The number of patents filed by a firm in a given year scaled by the firm's R&D expenditure.

PATENT_VALUE: The value of all patents filed by a firm in a given year, based on the sum of stock market reactions to news of patent grants. Following Kogan et al. (2017), the value of each patent is calculated as the product of the 3-day abnormal return around the patent announcement times the market capitalization of the firm on the day prior to the announcement.

DEEP_LOCAL_DIRECTOR_POOL: Dummy variable that equals 1 if the number of public firms in a firm's headquarters state, excluding those in the same industry, is above the median, and 0 otherwise.

HIGH_DIRECTOR_COMPENSATION: Dummy variable that equals 1 if the firm's median nonexecutive director compensation is above the sample median, and 0 otherwise.

HIGH_SHAREHOLDER_EXPERTISE: Dummy variable that equals 1 if a firm's shareholder expertise is above the sample median, and 0 otherwise. Shareholder expertise is defined as the median expertise among all institutional investors of a firm; each investor's expertise is calculated as the median number of forward citations across all firms in the investor's portfolio.

INEXPERIENCED_CEO: Dummy variable that equals 1 if the number of years the CEO has worked in their current firm's industry is below the sample median, and 0 otherwise.

CEO_UNEXERCISED_OPTIONS: The value of CEO's unexercised options divided by total CEO compensation.

CEO_LONG_TERM_INCENTIVE PAY: The value of CEO's long-term incentive pay divided by total CEO compensation.

Supplementary Material

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