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Shareholder Coordination and Corporate Innovation

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# Abstract

We show that greater shareholder coordination, as proxied by the geographic proximity between institutional investors, is positively related to corporate innovation outcomes. This relationship is driven by coordination among dedicated and independent institutions who have strong monitoring incentives and is more pronounced among firms with lower blockholder ownership and greater information asymmetry where there is greater benefit to monitoring. We propose that shareholder coordination promotes corporate innovation through a reduction in managerial agency problems. Overall, our results are consistent with the notion that greater shareholder coordination enables diffuse shareholders to monitor managers more effectively and enhances corporate innovation.

# KEYWORDS

agency problem, Innovation, monitoring, shareholder coordination

# 1 INTRODUCTION

Innovation is a key driver of economic growth. However, market frictions may hinder innovation. A fear of being fired due to bad luck under uncertain investment outcomes (Holmstrom, **1999**), the private benefits of effort shirking and avoiding difficult tasks (Hart, **1983**), and a focus on short-term stock price (Stein, **1988, 1989**) may hinder managers from innovating. Several studies suggest that the presence of institutional investors helps to alleviate this underinvestment problem. For example, Aghion, Van Reenen, and Zingales (**2013**) find that greater institutional ownership increases innovation productivity. Edmans (**2009**) contends that equity blockholders can gather private information about firms’ fundamental value and utilize their exit option to pressure managers to make optimal innovation decisions. Bushee (**1998**) provides evidence that firm managers are less likely to cut investment in research and development (R&D) to make up for an earnings decline when there is greater institutional ownership.

Nonetheless, the literature has largely ignored the fact that institutional ownership is often diffuse in practice. Huang (**2014**) documents that between 1980 and 2011 the median institution's equity holding accounts for only 0.06% of the firm's total outstanding shares, and the dispersion of ownership has increased over time. The diffusion of ownership gives rise to the classical free rider problem (Grossman & Hart, **1980**) and potentially weakens the monitoring efforts of institutional investors. This free rider problem may be more acute in the case of monitoring innovation productivity, where monitoring costs are greater due to the high uncertainty of innovation outcomes and the hard-to-verify private information and actions of managers (e.g., Fuente & Marin, **1996**).**1** However, if diffuse institutions are able to coordinate their monitoring efforts and share the gains of monitoring, then they may act like a large blockholder and exert greater pressure on management, resulting in improved corporate governance and better innovation outcomes.**2** For example, institutional investors may collaborate to improve managers’ incentive to innovate by monitoring the managers collectively and protecting them from being fired due to purely bad luck in innovation outcomes. Coordinated institutional investors may also force managers to exert costly effort to innovate and to focus less on short-term stock prices but more on value-increasing long-term innovation projects through enhanced monitoring, such as the threat of collectively selling their shares.

We empirically examine whether firms with a greater presence of coordinated shareholders have greater innovation productivity. Following the literature (e.g., Coval & Moskowitz, **2001**; Huang, **2014**), we measure shareholder coordination based on the geographic proximity of a firm's institutional investors. Our proxy for shareholder coordination builds upon the social network literature, which suggests that social networks are more likely to develop when individuals are able to associate and bond with others due to familiarity, often driven by geographic proximity (e.g., Marsden, **1988**; McPherson, Smith-Lovin, & Cook, **2001**). Institutional investors who work in the same region are more likely to share similar cultural values and to have repeated social interactions, for example at local investment conferences, which foster familiarity and mutual trust for cooperation and information sharing. The existing literature also suggests that geographic proximity is influential in building close personal and business relationships. For example, Hong, Kubik, and Stein (**2005**) show that geographic proximity promotes word-of-mouth communications between mutual fund managers and leads to similar trading decisions among managers in the same city.**3** Therefore, we contend that shareholders with closer geographic proximity are more likely to coordinate their monitoring efforts.

We find that firms with more coordinated institutional investors have greater innovation productivity, as measured by patent counts and patent citations. These findings are driven by coordination between institutional investors with stronger monitoring incentives. Specifically, we find that innovation is only positively associated with coordination among dedicated institutions with a long-term investment horizon (Bushee, **1998**) and independent investors with no business relationship with the firm (Chen, Harford, & Li, **2007**) and unrelated to the presence of geographically proximate institutions with short-term investment horizons or potential business relationships with the firm. To address potential endogeneity concerns, we conduct a series of tests. We implement a two-stage residual analysis to alleviate concerns that shareholder coordination may simply be an aggregate measure of other firm characteristics, such as institutional ownership or analyst coverage. We find that the unexplained portion of shareholder coordination is significantly and positively associated with patent counts and citations, suggesting that shareholder coordination is an important incremental factor beyond determinants of innovation previously documented in the literature. Reverse causality may also be a concern if institutional investors with a preference to invest in innovative firms are clustered in certain geographic areas. To address this issue, we use a generalized method of moments (GMM) specification and find that the positive, statistically significant relationship between shareholder coordination and corporate innovation continues to hold. To further alleviate concerns about potential reverse causality, we conduct a change-on-change analysis and find some evidence that changes in shareholder coordination are positively related to subsequent changes in corporate innovation, but not the reverse direction. Overall, our results are consistent with the notion that coordination among institutional investors fosters more effective monitoring and therefore promotes innovation.**4**

We also substantiate our main findings with cross-sectional evidence. We begin by examining the role of blockholders in the relationship between shareholder coordination and corporate innovation. Sapra, Subramanian, and Subramanian (**2014**) argue that greater blockholder ownership enhances monitoring of self-interested managers and spurs innovation. We expect that diffuse shareholders are more likely to coordinate their monitoring efforts to improve innovation productivity when there is a lower proportion of blockholder ownership to rely on for more intensive monitoring. Consistent with our predictions, we find that the positive effect of shareholder coordination on innovation is more pronounced in firms with a lower proportion of blockholder ownership. We also investigate the impact of information asymmetry. Holmstrom (**1979**) contends that firms with greater information asymmetry are more prone to moral hazard problems and argues that a remedy to this problem is to invest resources into monitoring of the agent. Therefore, we posit that firms with severe information asymmetry gain greater benefits from the enhanced monitoring by coordinated shareholders in the form of increased innovation productivity. Consistent with our expectation, we find that the effect of shareholder coordination on innovation is concentrated in firms with greater information asymmetry, proxied by analyst forecast dispersion as in Chemmanur and Tian (**2018**).

Lastly, we explore the potential mechanisms through which shareholder coordination enhances innovation. We hypothesize that the increased monitoring allowed by greater shareholder coordination serves to reduce managerial agency problems and increase innovation productivity. We first investigate whether greater shareholder coordination increases innovation by reducing managers’ career concerns and protecting them from being fired due to bad luck. Manso (**2011**) argues that tolerance for early failure is important to firms’ innovation activities. Coordinated shareholders may better monitor managers and improve their incentives to innovate by protecting managers against the reputational and career consequences of early failure due to bad luck. To test the reduced career concerns hypothesis, we examine whether greater shareholder coordination reduces the sensitivity of forced CEO turnover to declines in profitability as in Aghion et al. (**2013**). We find supportive evidence that greater shareholder coordination reduces the likelihood of CEOs being fired when firm profits decline. We also examine whether coordinated shareholders improve innovation through enhanced monitoring by reducing agency problems including managerial shirking and managerial myopia.**5** Innovation is a difficult task and requires costly effort from the managers. However, managers do not fully internalize the benefits their efforts bring to the firm due to the separation between ownership and control and may prefer to shirk their duties (Hart, **1983**; Jensen & Meckling, **1976**). In addition, a desire to boost current earnings (Porter, **1992**; Stein, **1989**) and a concern about market misevaluation of long-term projects (Stein, **1988**) may increase managerial myopia and decrease investment in innovation. We investigate the reduced shirking and reduced myopia hypothesis by examining whether the presence of more coordinated shareholders promotes greater investment in R&D, an important innovation input studied in the literature (e.g., Adhikari & Agrawal, **2016**; Balsmeier, Fleming, & Manso, **2017**; Sapra et al., **2014**). We find that firms with more coordinated shareholders spend more on R&D, which supports the notion that managers are discouraged from the underinvestment in innovation caused by shirking and myopia.

Our paper adds to the existing literature in the following ways. First, our paper contributes to the literature on corporate innovation. Although innovation is a key driver of economic growth, market frictions often hinder innovation. In particular, innovation projects are more susceptible to managerial agency problems given that managers possess hard-to-verify private information about the prospects of R&D projects and their private actions are hard to observe (Aboody & Lev, **2000**; Fuente & Marin, **1996**). The monitoring of innovation projects by outside investors can be difficult and costly given that the payoffs from R&D investments are uncertain and often not realized for many years. While the existing literature has examined the role of institutional ownership in influencing corporate innovation (e.g., Aghion et al., **2013**; Bushee, **1998**; Guadalupe, Kuzmina, & Thomas, **2012**), it treats institutional investors (or certain types of investors) as independent entities and largely ignores the interactions between institutional investors. The focus on total levels of institutional ownership misses the potential benefits of coordination that can be afforded by geographic proximity, which may exist even if overall institutional ownership is low. We fill the void by investigating how coordination between institutional investors, proxied by geographic proximity, improves corporate innovation. Our study is relevant and important given that institutional ownership is increasingly widely dispersed amongst many institutions, and diffuse ownership is more susceptible to the free rider problem discussed in Grossman and Hart (**1980**), and diminishes the monitoring power of individual institutional investors. While the existing literature mainly focuses on equity compensation and regulation against takeover defenses as potential remedies to dispersed ownership (Edmans, **2009**), we find that coordination between institutional investors is another important and overlooked mechanism that mitigates the free-rider problem and enhances managerial monitoring. Our empirical results suggest that shareholder coordination has incremental power in improving corporate innovation beyond the previously documented dimensions of institutional ownership such as total institutional ownership, dedicated institutional ownership, independent institutional ownership and local institutional ownership.

Our study also adds to the small but growing literature that examines the role of shareholder coordination in corporate governance (e.g., Huang, **2014**; Kim, Pantzalis, & Wang, **2017**; Pantzalis & Wang, **2017**). Pantzalis and Wang (**2017**) and Kim et al. (**2017**) find that shareholder coordination can enhance stock price efficiency through improvements in the information-sharing network between shareholders and increased firm voluntary disclosure. However, neither study examines the impact of shareholder coordination on firms’ long-term investment decisions. Huang (**2014**) shows that institutional shareholder coordination improves firm value. Our paper complements the findings in Huang (**2014**) by suggesting that better innovation productivity may be one channel for increased firm value in firms with greater shareholder coordination. Our paper concurs that shareholder coordination plays an alternative governance role, as greater shareholder coordination encourages innovation productivity.**6** We further add to the literature by showing that a reduction in managerial agency problems, including an increase in tolerance for failure and a decrease in managerial shirking and myopia are probably the primary drivers for greater innovation productivity gained through shareholder coordination.

# 2 DATA AND VARIABLE CONSTRUCTION

Our main sample consists of US firms from 1994 to 2005. We obtain institutional holdings data from Thomson Reuters 13F Institutional Holdings, firm accounting data from COMPUSTAT, analyst coverage and forecast data from Thomson Reuters, and patent data from the NBER Patent Citation database and the Harvard Business School (HBS) patent database. In some subsample and robustness tests, we also augment our sample with institutional investor classification data from Brian Bushee's website, stock price data from CRSP, and CEO turnover data from Andrea Eisfeldt's website. The augmented data further restricts the sample size in these analyses.**7** We limit the sample to US firms held by at least one institutional shareholder located in the United States.**8** In addition, we exclude closed-end funds, real estate investment trusts, American depository receipts, and firms in the financial and utility sectors. The main sample includes 24,794 firm-year observations.**9** With the exception of those variables that are log-transformed, we winsorize all variables at the top and bottom 1% level to reduce the influence of outliers on our empirical results.

## Innovation measures

Following the literature (e.g., Aghion, Bloom, Blundell, Griffith, & Howitt, **2005**; Mathers, Wang, & Wang, **2017**), we use patent grants and patent citations to measure innovation outcomes. Our primary data source is the NBER Patent Citation database originally created by Hall, Jaffe, and Trajtenberg (**2001**). It contains patent information including the patent assignee name, the filing year, the grant year, the number of patents granted, and the number of citations received by each patent from 1976–2006. Patent grants (*Patent*) are measured as the number of patents filed in a given year that are eventually granted and represent the overall innovation productivity in raw numbers. Patent citations (*CitePat*) are measured as the number of non-self citations per patent and reflect the significance of the granted patents. Due to the positive skew in both patent grants and citations, we use the natural logarithm of one plus the value for both patent variables in our regressions (*LnPatent* and *LnCitePat*). Consistent with other studies (e.g., Mathers et al., **2017**), we measure innovation outcomes three years in the future to account for the length of time required to turn innovation investments into patents.

As in He and Tian (**2013**), we adjust for truncation problems with patent counts and patent citations in the NBER Patent Citation database. The first concern is that patent counts are truncated. There is substantial lag, on average two years, between the patent filing year and its grant year. Therefore, many patents filed but still under review at the end of 2006 would not appear in the NBER dataset, which only includes information on patents granted by 2006. To address the truncation issue with the patent counts, we supplement the NBER data with the HBS patent data, which contains information on patents granted through 2010. Since the outcomes for patents filed on or before 2006 are mostly available by 2010, this approach largely corrects for the truncation issue in patent counts. The second problem is that patent citations are also truncated. This problem arises because a patent receives citations over many years after the patent is granted, but our databases only capture the citations that occur during our sample period. The truncation bias in citations is more acute for recently granted patents. To correct for the truncation issue in patent citations, we estimate total patent citations based on the estimated shape of the citation-lag distribution as suggested by Hall et al. (**2001, 2005**). More specifically, we scale up the observed citation counts using the variable ‘hjtwt’ in the NBER patent dataset, which estimates the fraction of predicted lifetime citations actually observed during the time interval.**10**

## Shareholder coordination measure

Following the literature (e.g., Coval & Moskowitz, **2001**; Huang, **2014**), we use the geographic proximity between US institutional investors of a firm to measure shareholder coordination.**11** The social network literature argues that social networks are more likely to develop when individuals have close geographic proximity as they are often able to associate and bond with others due to greater commonality (e.g., Marsden, **1988**; McPherson et al., **2001**). Institutional investors in the same region are more likely to share similar cultural values and to have repeated social interactions, which promotes familiarity and mutual trust for cooperation and information sharing, making them more likely to coordinate their monitoring efforts.

To create the shareholder coordination measure, we first obtain the zip codes of the institutional investors’ headquarters from their 13F filing on the Securities and Exchange Commission Electronic Data Gathering, Analysis, and Retrieval (SEC EDGAR) system. We then use the US Census Bureau's Gazetteer Place and Zip Code database to identify the latitude and longitude of the headquarters based on their zip codes. Following the prior literature (e.g., Coval & Moskowitz, 2001; Kim et al., 2017), we construct the geographic-proximity-based shareholder coordination variable as the weighted average geographic distance between US institutional shareholders of a firm over the four quarters in a year. Specifically, for each firm-quarter, we first calculate the shortest distance on the surface of the Earth between two US institutional investors based on the latitude and longitude of their headquarters using the following standard formula:12

(1)

where  is the distance in statutory miles,  denotes the radius of the Earth (approximately 3,963 statutory miles), and  and  are the latitudes and longitudes of institution headquarters, respectively.

Next, we weight the pairwise geographic distance between US institutional investors by their investment in the firm and calculate the weighted average geographic distance for the year. The weighting scheme delivers a more accurate measure of shareholder coordination than the simple average of the distances between institutional investors because institutional investors with a larger fractional holding in the company typically have greater influence on corporate governance. To reduce the influence of outliers, we take the logarithm of the weighted averaged distances between all US institutional investors of the firm. To facilitate interpretation, we further measure shareholder coordination by taking the product of –1 and the logarithm-transformation of the weighted averaged distances. Our measure of shareholder coordination, *COORD\_PROX*, is as follows:

(2)

where is the set of US institutional investors, *wj* is the ownership weight of institution  as a fraction of all US institutional ownership, and  is the geographic distance between institutions  and  as measured in Equation (1). A greater *COORD\_PROX* indicates closer geographic distance between a firm's US institutional investors, and therefore is associated with greater shareholder coordination.13

## Control variables

Following the existing literature (e.g., He & Tian, **2013**), we also construct a number of control variables that have been found to influence innovation outcomes. These variables include firm size (*LnSale*), R&D expense (*R&D*), firm age (*LnAge*), return on assets (*ROA*), leverage (*Leverage*), capital expenditures (*CapEx*), property, plant and equipment (*PPE*), institutional ownership (*IO*), the Herfindahl index of institutional ownership concentration (*IO\_HHI*), market-to-book ratio (*TobinQ*), the KZ index measure of financial constraint (*KZindex*) as proposed by Kaplan and Zingales (**1997**), the Herfindahl index measure of industry concentration (*HHI*), the squared Herfindahl Index (*HHI\_Square*), and analyst coverage (*Analyst*). Detailed variable definitions can be found in Appendix **A**.

# 3 EMPIRICAL MODEL AND RESULTS

## Empirical model

Following the prior literature (e.g., Balsmeier et al., 2017; Brav, Jiang, Ma, & Tian, 2018; He & Tian, 2013), we specify the baseline model as follows:

(3)

where  indexes firm andindexes year.14 The dependent variables are the natural logarithm of one plus the number of patents filed and eventually granted (*LnPatent*) and the natural logarithm of one plus the number of non-self citations per patent filed and eventually granted (*LnCitePat*). Both are measured at  to account for the long lag between investment in innovation and observed outcomes.15 *X* is a vector of control variables described in section 2.2 and  is the error term. Firm fixed effects are denoted by  and control for time-invariant firm characteristics such as corporate culture that may influence both innovation outcomes and shareholder coordination. Year fixed effects, denoted by , account for changes in the macroeconomic conditions that may affect innovation opportunities and the tendency to coordinate among institutional investors. We cluster standard errors by firm to account for the possibility of autocorrelation in innovation outcomes over time (Petersen, 2009). We expect to be positive and statistically significant if firms with greater shareholder coordination have better innovation productivity. Our empirical design reduces endogeneity concerns. In particular, the time lag between the measurement of the independent and dependent variables and the use of firm fixed effects lessens the concerns of the omitted variables and reverse causality.

## Summary statistics and baseline results

In Table **1**, we present summary statistics for all variables in our baseline regression. The average number of firm patents granted (*Patent*) and patent citations (*PatCite*) in our sample is 9.522 and 3.254, respectively. Both variables exhibit significant skewness with a median patent grant and citation count of zero. These summary results are in line with existing studies of innovation outcomes (e.g., He & Tian, **2013**) and suggest that a logarithmic transformation of the patent variables is warranted. The average of the geographic-proximity-based shareholder coordination measure (*COORD\_PROX*) is –6.263 with a standard deviation of 0.907, consistent with the summary statistics for the similarly constructed variable in Kim et al. (**2017**). The summary statistics of the control variables are generally compatible with previous studies (e.g., Mathers et al., **2017**).

**TABLE 1.**Summary statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Mean** | **StdDev** | **10th** | **Median** | **90th** |
| *Patentt+*3 | 9.522 | 86.675 | 0.000 | 0.000 | 7.000 |
| *CitePatt+*3 | 3.254 | 12.739 | 0.000 | 0.000 | 9.227 |
| *LnPatentt+*3 | 0.517 | 1.156 | 0.000 | 0.000 | 2.079 |
| *LnCitePatt+*3 | 0.445 | 1.032 | 0.000 | 0.000 | 2.325 |
| *COORD\_PROX* | −6.263 | 0.907 | −6.888 | −6.511 | −5.372 |
| *LnSale* | 5.690 | 1.929 | 3.379 | 5.660 | 8.152 |
| *R&D* | 0.056 | 0.105 | 0.000 | 0.002 | 0.172 |
| *LnAge* | 2.377 | 0.859 | 1.386 | 2.303 | 3.638 |
| *ROA* | −0.018 | 0.263 | −0.199 | 0.040 | 0.125 |
| *Leverage* | 0.205 | 0.187 | 0.000 | 0.178 | 0.466 |
| *CapEx* | 0.071 | 0.071 | 0.015 | 0.050 | 0.152 |
| *PPE* | 0.281 | 0.221 | 0.054 | 0.215 | 0.629 |
| *IO* | 0.490 | 0.249 | 0.136 | 0.503 | 0.814 |
| *IO\_HHI* | 0.022 | 0.019 | 0.004 | 0.018 | 0.043 |
| *TobinQ* | 2.154 | 2.011 | 0.924 | 1.550 | 3.964 |
| *KZindex* | 3.210 | 17.629 | −2.999 | 1.605 | 8.854 |
| *HHI* | 0.139 | 0.121 | 0.048 | 0.101 | 0.275 |
| *HHI\_square* | 0.034 | 0.083 | 0.002 | 0.010 | 0.076 |
| *Analyst* | 1.424 | 0.995 | 0.000 | 1.473 | 2.757 |

*Notes*: This table presents summary statistics for our sample of 24,794 US firms from 1994 to 2005. It provides the mean, standard deviation (StdDev), 10th percentile (P10), median, and 90th percentile (P90) for all of the variables in our baseline regression. *Patent* measures the number of patents filed (and eventually granted). *CitePat* is the total number of nonself-citations received on the firm's patents filed (and eventually granted) scaled by the number of patents filed (and eventually granted). *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure, calculated as the product of –1 and the natural logarithm of one plus the weighted-average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by US institutionto the total ownership held by all US institutions in the firm in that quarter. Detailed variable definitions are given in Appendix A.

In Table **2**, we present results of the baseline regression described in equation (**3**). We find that the opportunity for greater shareholder coordination presented by greater geographic proximity increases innovation productivity. Specifically, *COORD\_PROX* is a positive and statistically significant predictor of both the quantity (number of patents granted, *LnPatent*) and quality (number of non-self citations per patent, *LnCitePat*) of innovation output. Our results are also economically significant. On average, an increase in *COORD\_PROX* from the 10th percentile to the 90th percentile is associated with a 3.18% increase in the number of patents granted according to the results in column (1) and a 4.96% increase in patent citations based on results in column (2).**16**,**17** Since we control for R&D expense and capital expenditure, our results indicate that greater shareholder coordination increases innovation output for a given amount of investment input. We also control for institutional ownership (*IO*) to ensure that our results on shareholder coordination are not driven simply by the presence of institutional investors that encourage companies to invest for the long-term. For example, Aghion et al. (**2013**) show that institutional ownership increases innovation productivity. Consistent with their findings, we demonstrate that greater *IO* is a statistically significant predictor of the number of patents that a company is granted, although *IO* is statistically insignificant in predicting patent citations in our sample. Our results indicate that the presence of institutional investors is important to enhance innovation productivity, but these institutions have a more powerful impact on corporate innovation when they are more likely to coordinate their monitoring efforts.

**TABLE 2.**Baseline results on shareholder coordination and innovation

|  |  |  |
| --- | --- | --- |
|  | ***LnPatentt*+3** | ***LnCitePatt*+3** |
|  | **(1)** | **(2)** |
| *COORD\_PROX* | 0.019\*\*\* | 0.025\*\* |
|  | (2.68) | (2.54) |
| *LnSale* | 0.046\*\* | 0.027 |
|  | (2.50) | (1.21) |
| *R&D* | 0.490\*\*\* | 0.449\*\* |
|  | (3.08) | (2.27) |
| *LnAge* | 0.332\*\*\* | 0.387\*\*\* |
|  | (6.67) | (6.16) |
| *ROA* | 0.079\*\*\* | 0.088\*\* |
|  | (2.92) | (2.30) |
| *Leverage* | −0.317\*\*\* | −0.439\*\*\* |
|  | (−4.49) | (−4.88) |
| *CapEx* | −0.159 | −0.219 |
|  | (−1.49) | (−1.45) |
| *PPE* | 0.624\*\*\* | 0.786\*\*\* |
|  | (4.92) | (4.78) |
| *IO* | 0.287\*\*\* | 0.041 |
|  | (3.78) | (0.39) |
| *IO\_HHI* | −0.277 | 0.753 |
|  | (−0.40) | (0.87) |
| *TobinQ* | 0.019\*\*\* | 0.004 |
|  | (4.21) | (0.55) |
| *KZindex* | −0.000 | 0.001 |
|  | (−0.06) | (0.83) |
| *HHI* | 1.085\*\*\* | 2.301\*\*\* |
|  | (2.83) | (4.33) |
| *HHI\_ square* | −1.162\*\*\* | −2.611\*\*\* |
|  | (−2.71) | (−4.62) |
| *Analyst* | 0.007 | 0.016 |
|  | (0.41) | (0.76) |
| *Constant* | −0.377\*\*\* | −0.150 |
|  | (−2.64) | (−0.83) |
| FIRM FE | YES | YES |
| YEAR FE | YES | YES |
| Observations | 24,794 | 24,794 |
| Adj. R-squared | 0.764 | 0.520 |

*Notes*: This table presents the results of the ordinary least squares regression specified in equation (3). In column (1), the dependent variable is *LnPatentt+*3, defined as the natural logarithm of one plus the number of patents filed (and eventually granted) at year *t+*3. In column (2), the dependent variable is *LnCitePatt+*3, defined as the natural logarithm of one plus the average number of non-self citations received on each patent filed (and eventually granted) at year *t+*3. *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure, calculated as the product of –1 and the natural logarithm of one plus the weighted-average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by US institutionto the total ownership held by all US institutions in the firm in that quarter. All independent variables are measured at year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

## The role of different institutional investor types

The previous literature suggests that different types of shareholders may have different incentives and abilities to monitor corporate managers. Therefore, we investigate whether the relationship between shareholder coordination and innovation is stronger when the institutions involved have stronger monitoring incentives. Following Huang (**2014**), we classify institutional investors using two methods. We first categorize institutional investors as either independent or grey institutions as in Chen et al. (**2007**). Independent institutions, such as investment companies, independent investment advisers, and public pension funds, do not have business relationships with the companies that they hold, so they are more likely to engage in active monitoring. On the other hand, grey institutions, such as insurance companies, banks and private pension funds, are more likely to have business relationships with the companies in their portfolio, so their monitoring ability may be compromised due to their tendency to protect the business relationships. Therefore, we predict that the relationship between shareholder coordination and innovation productivity should be driven mainly by independent institutions. We also classify institutional investors as dedicated or transient institutions as in Bushee (**1998**). Dedicated institutional investors have large and long-term holdings which are concentrated in fewer firms, so they are more likely to take an active role in monitoring and focus on firms’ long-term performance. Transient institutions, by contrast, are more likely to have short-term investment horizons, high turnover, and engage in momentum trading strategies. These transient institutions may exacerbate managerial myopia due to their short-term focus. Accordingly, we anticipate that the relationship between shareholder coordination and innovation productivity should be driven mainly by dedicated institutions.

Table **3** reports results of the role of different institutional investors. Columns (1) and (3) display the results for independent and grey institutions. Consistent with our prediction, we find that shareholder coordination among independent institutions, but not grey institutions, is positively and significantly associated with patent grants and patent citations. Similarly, in columns (2) and (4) we find that coordination among dedicated institutions, but not transient institutions, is positively related to innovation productivity. These results provide further support to our hypothesis that greater coordination among institutional investors improves innovation outcomes due to more effective institutional monitoring.

**TABLE 3.**Measuring shareholder coordination with different types of institutional investors

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ***LnPatentt*+3** |  | ***LnCitePatt*+3** |  |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
| *COORD\_PROX\_Indep* | 0.014\*\* |  | 0.030\*\*\* |  |
|  | (2.02) |  | (3.24) |  |
| *COORD\_PROX\_Grey* | 0.006 |  | 0.003 |  |
|  | (0.98) |  | (0.40) |  |
| *COORD\_PROX\_Ded* |  | 0.020\*\*\* |  | 0.016\* |
|  |  | (2.96) |  | (1.90) |
| *COORD\_PROX\_Trans* |  | −0.001 |  | 0.004 |
|  |  | (−0.18) |  | (0.68) |
| *LnSale* | 0.049\*\*\* | 0.047\*\*\* | 0.034 | 0.030 |
|  | (2.64) | (2.58) | (1.49) | (1.35) |
| *R&D* | 0.486\*\*\* | 0.498\*\*\* | 0.421\*\* | 0.441\*\* |
|  | (3.06) | (3.14) | (2.14) | (2.25) |
| *LnAge* | 0.343\*\*\* | 0.366\*\*\* | 0.398\*\*\* | 0.427\*\*\* |
|  | (6.80) | (7.05) | (6.30) | (6.59) |
| *ROA* | 0.078\*\*\* | 0.076\*\*\* | 0.086\*\* | 0.082\*\* |
|  | (2.87) | (2.78) | (2.26) | (2.16) |
| *Leverage* | −0.314\*\*\* | −0.312\*\*\* | −0.437\*\*\* | −0.430\*\*\* |
|  | (−4.44) | (−4.41) | (−4.85) | (−4.77) |
| *CapEx* | −0.150 | −0.165 | −0.189 | −0.212 |
|  | (−1.39) | (−1.54) | (−1.25) | (−1.40) |
| *PPE* | 0.624\*\*\* | 0.636\*\*\* | 0.777\*\*\* | 0.798\*\*\* |
|  | (4.89) | (4.99) | (4.70) | (4.83) |
| *IO* | 0.283\*\*\* | 0.256\*\*\* | 0.040 | 0.002 |
|  | (3.71) | (3.36) | (0.38) | (0.01) |
| *IO\_HHI* | −0.313 | −0.208 | 0.695 | 0.827 |
|  | (−0.44) | (−0.30) | (0.80) | (0.95) |
| *TobinQ* | 0.019\*\*\* | 0.019\*\*\* | 0.005 | 0.004 |
|  | (4.26) | (4.16) | (0.69) | (0.59) |
| *KZindex* | −0.000 | −0.000 | 0.001 | 0.001 |
|  | (−0.07) | (−0.11) | (0.83) | (0.78) |
| *HHI* | 1.065\*\*\* | 1.042\*\*\* | 2.266\*\*\* | 2.229\*\*\* |
|  | (2.73) | (2.67) | (4.21) | (4.13) |
| *HHI \_square* | −1.150\*\*\* | −1.117\*\* | −2.590\*\*\* | −2.539\*\*\* |
|  | (−2.62) | (−2.55) | (−4.49) | (−4.38) |
| *Analyst* | −0.009 | −0.011 | −0.011 | −0.016 |
|  | (−0.49) | (−0.63) | (−0.48) | (−0.66) |
| *Constant* | −0.371\*\* | −0.639\*\*\* | −0.090 | −0.372\*\* |
|  | (−2.49) | (−4.15) | (−0.48) | (−2.03) |
| FIRM FE | YES | YES | YES | YES |
| YEAR FE | YES | YES | YES | YES |
| Observations | 24,607 | 24,607 | 24,607 | 24,607 |
| Adj. R-squared | 0.764 | 0.764 | 0.521 | 0.521 |

*Notes*: This table presents the results of the ordinary least squares regression specified in equation (3) which has been augmented to test the effect of differing measures of shareholder coordination. In columns (1) and (2), the dependent variable is *LnPatentt+*3, defined as the natural logarithm of one plus the number of patents filed (and eventually granted) at year *t+*3. In columns (3) and (4), the dependent variable is *LnCitePatt+*3, defined as the natural logarithm of one plus the average number of non-self citations received on each patent filed (and eventually granted) at year *t+*3. *COORD\_PROX\_Indep* is the geographic-proximity-based shareholder coordination measure (*COORD\_PROX*), calculated only among independent institutional investors, defined as mutual funds and independent investment advisers in year *t*. *COORD\_PROX\_Grey* is the geographic-proximity-based shareholder coordination measure (*COORD\_PROX*), calculated only among grey institutional investors, defined as bank trusts, insurance companies, and other institutions which are neither mutual funds nor independent investment advisers in year *t*. *COORD\_PROX\_Ded* is the geographic-proximity-based shareholder coordination measure (*COORD\_PROX*), calculated only among dedicated institutional investors, as defined in Bushee (1998) in year *t*. *COORD\_PROX\_Trans* is the geographic-proximity-based shareholder coordination measure (*COORD\_PROX*), calculated only among transient institutional investors, as defined in Bushee (1998) in year *t*. All independent variables are measured at year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

## Cross-sectional tests

We investigate cross-sectional differences in the relationship between shareholder coordination and innovation outputs to further validate our main findings. We begin by examining the role of concentrated ownership, as measured by the total ownership held by large blockholders who own more than 5% of the firm's shares (*Blockown*). Sapra et al. (**2014**) find that greater blockholder ownership improves innovation outcomes due to the enhanced monitoring from more concentrated ownership. We argue that more coordinated shareholders can form a coalition and monitor managers as a large blockholder even when they do not individually own a large stake in the firm's equity. We expect that the relationship between shareholder coordination and corporate innovation is stronger when the blockholder ownership is lower. As expected, we find that the interaction term between shareholder coordination (*COORD\_PROX*) and the high blockholder ownership dummy (*High Block IO*) is negative and statistically significant at the 5% level in both the patent counts and citations regressions in Table **4**. These results suggest that the positive relationship between shareholder coordination and innovation productivity is more pronounced in firms with a lower percentage of blockholder ownership.

**TABLE 4.**Cross-sectional results on blockholder monitoring

|  |  |  |
| --- | --- | --- |
|  | ***LnPatentt*+3** | ***LnCitePatt*+3** |
|  | **(1)** | **(2)** |
| *COORD\_PROX × High Block IO* | −0.010\*\* | −0.013\*\* |
|  | (−2.28) | (−2.04) |
| *COORD\_PROX* | 0.034\*\*\* | 0.034\*\*\* |
|  | (3.92) | (2.63) |
| *High Block IO* | −0.011 | −0.052 |
|  | (−0.14) | (−0.47) |
| *LnSale* | 0.068\*\*\* | 0.055\*\* |
|  | (3.64) | (2.53) |
| *R&D* | 0.446\*\*\* | 0.483\*\* |
|  | (2.84) | (2.41) |
| *LnAge* | 0.273\*\*\* | 0.312\*\*\* |
|  | (5.93) | (5.24) |
| *ROA* | 0.080\*\*\* | 0.103\*\*\* |
|  | (2.77) | (2.89) |
| *Leverage* | −0.349\*\*\* | −0.522\*\*\* |
|  | (−5.24) | (−6.10) |
| *CapEx* | −0.185\* | −0.265\* |
|  | (−1.81) | (−1.80) |
| *PPE* | 0.657\*\*\* | 0.884\*\*\* |
|  | (5.59) | (5.67) |
| *IO* | 0.231\*\*\* | −0.053 |
|  | (3.38) | (−0.55) |
| *IO\_HHI* | −0.248 | 0.831 |
|  | (−0.41) | (1.09) |
| *TobinQ* | 0.020\*\*\* | 0.005 |
|  | (4.38) | (0.78) |
| *KZindex* | −0.000 | −0.000 |
|  | (−0.51) | (−0.18) |
| *HHI* | 0.992\*\*\* | 2.191\*\*\* |
|  | (2.85) | (4.56) |
| *HHI\_square* | −1.085\*\*\* | −2.440\*\*\* |
|  | (−2.74) | (−4.66) |
| *Analyst* | −0.009 | 0.003 |
|  | (−0.57) | (0.14) |
| FIRM FE | YES | YES |
| YEAR FE | YES | YES |
| Observations | 21,348 | 21,348 |
| Adj. R-squared | 0.754 | 0.518 |

*Notes*: This table presents the results of the ordinary least squares regression specified in equation (3) which has been augmented to test the cross-sectional results on blockholder ownership. Blockholder ownership (*Blockown*) is defined as the total ownership of institutional investors that individually owns more than 5% of the firm's shares in year *t*. *High Block IO* is defined as a binary variable equal to one for firms with *Blockown* above the sample median, and zero otherwise in year *t*. *COORD\_PROX x High Block IO* is the interaction between *COORD\_PROX* and *High Block IO* in year *t*. In column (1), the dependent variable is *LnPatentt+*3, defined as the natural logarithm of one plus the number of patents filed (and eventually granted) at year *t+*3. In column (2), the dependent variable is *LnCitePatt+*3, defined as the natural logarithm of one plus the average number of non-self citations received on each patent filed (and eventually granted) at year *t+*3. *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure, calculated as the product of –1 and the natural logarithm of one plus the weighted-average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by US institutionto the total ownership held by all US institutions in the firm in that quarter. All independent variables are measured at year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

We also investigate the importance of information asymmetry to the relationship between shareholder coordination and innovation. Holmstrom (**1979**) suggests that information asymmetry leads to agency problems, which can be mitigated through greater monitoring effort. Therefore, we hypothesize that firms with more severe information asymmetry experience greater improvement in innovation productivity from the enhanced monitoring of coordinated shareholder. Following Chemmanur and Tian (**2018**), we use analyst earnings forecast dispersion (*AnalystDisp*), the standard deviation of analyst earnings forecasts in a year, to proxy for information asymmetry. Greater forecast dispersion is consistent with greater information asymmetry. Consistent with our expectation, the results in Table **5** show that the interaction term between *COORD\_PROX* and the high analyst forecast dispersion dummy (*High Information Asymmetry*) is positive and statistically significant at the 5% and 1% level in the patent counts and citations regressions, respectively. These results demonstrate that the effect of shareholder coordination on innovation output is stronger for firms with greater information asymmetry.

**TABLE 5.**Cross-sectional results on information asymmetry

|  |  |  |
| --- | --- | --- |
|  | ***LnPatentt*+3** | ***LnCitePatt*+3** |
|  | **(1)** | **(2)** |
| *COORD\_PROX × High Information Asymmetry* | 0.005\*\*\* | 0.004\*\* |
|  | (3.09) | (2.29) |
| *COORD\_PROX* | 0.014\*\* | 0.019\*\* |
|  | (2.27) | (2.19) |
| *High Information Asymmetry* | −0.110\*\* | −0.114 |
|  | (−2.30) | (−1.22) |
| *LnSale* | 0.047\* | 0.029 |
|  | (1.84) | (0.96) |
| *R&D* | 0.481\*\* | 0.441\*\* |
|  | (2.46) | (2.42) |
| *LnAge* | 0.325\*\* | 0.380\*\*\* |
|  | (3.03) | (5.69) |
| *ROA* | 0.086\*\* | 0.094\* |
|  | (2.27) | (1.95) |
| *Leverage* | −0.327\*\*\* | −0.449\*\*\* |
|  | (−3.48) | (−4.54) |
| *CapEx* | −0.138 | −0.198 |
|  | (−1.21) | (−1.37) |
| *PPE* | 0.611\*\*\* | 0.774\*\*\* |
|  | (3.29) | (4.18) |
| *IO* | 0.299\*\* | 0.052 |
|  | (2.38) | (0.35) |
| *IO\_HHI* | −0.324 | 0.709 |
|  | (−0.48) | (0.90) |
| *TobinQ* | 0.019\*\* | 0.004 |
|  | (2.57) | (0.38) |
| *KZindex* | −0.000 | 0.001 |
|  | (−0.07) | (1.12) |
| *HHI* | 1.082\*\* | 2.299\*\*\* |
|  | (2.86) | (4.50) |
| *HHI\_square* | −1.158\*\* | −2.607\*\*\* |
|  | (−2.87) | (−4.73) |
| *Analyst* | 0.009 | 0.018 |
|  | (0.39) | (0.85) |
| FIRM FE | YES | YES |
| YEAR FE | YES | YES |
| Observations | 24,794 | 24,794 |
| Adj. R-squared | 0.764 | 0.520 |

*Notes*: This table presents the results of the ordinary least squares regression specified in equation (3) which has been augmented to test the cross-sectional results on information asymmetry. Information asymmetry (*AnalystDisp*) is measured by analyst forecast dispersion, which is the average standard deviation of analyst earnings forecasts in year *t*. *High Information Asymmetry* is a binary variable equal to one for firms with *AnalystDisp* above the sample median, and zero otherwise in year *t*. *COORD\_PROX × High Information Asymmetry* is the interaction between *COORD\_PROX* and *High Information Asymmetry* in year *t*. In column (1), the dependent variable is *LnPatentt+*3, defined as the natural logarithm of one plus the number of patents filed (and eventually granted) at year *t+*3. In column (2), the dependent variable is *LnCitePatt+*3, defined as the natural logarithm of one plus the average number of non-self citations received on each patent filed (and eventually granted) at year *t+*3. *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure, calculated as the product of –1 and the natural logarithm of one plus the weighted-average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by US institutionto the total ownership held by all US institutions in the firm in that quarter. All independent variables are measured at year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

## Possible channels

In this subsection, we further examine the possible mechanisms that drive the positive relationship between shareholder coordination and innovation outcomes. First, we investigate whether coordinated institutional investors improve innovation through an increased tolerance for failure and reduced managerial career concerns. Manso (2011) argues that tolerance (or even reward) for early failure is important to motivating innovation. Coordinated institutional investors may improve managers’ incentive to innovate by monitoring the managers collectively and protecting them from being fired due to purely bad luck in innovation. To test this reduced career concern channel, we follow Aghion et al. (2013) in examining whether greater shareholder coordination reduces the sensitivity of CEO turnover to declines in profitability. In particular, our variable of interest is the interaction between changes in profitability and shareholder coordination. We anticipate that if more coordinated shareholders are better able to distinguish between bad luck and bad management, then CEO turnover will be less responsive to declines in profitability. We estimate the following logit regression model to test the reduced career concern hypothesis:

(4)

where the dependent variable, *Forced CEO Turnover*, is a binary variable equal to one if a CEO is fired, and zero otherwise. *F*(.) is the logit specification.  is change in profitability scaled by total assets and *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure specified in section 2.2. *Z* is a vector of control variables as in Aghion et al. (2013), including firm size (*LnSale*), R&D expenses (*R&D*), firm age (*LnAge*), return on assets (*ROA*), leverage (*Leverage*), capital expenditures (*CapEx*), property, plant, and equipment (*PPE*), institutional ownership (*IO*), the Herfindahl Index of institutional ownership concentration (*IO\_HHI*), market-to-book ratio (*TobinQ*), financial constraint (*KZindex*), the Herfindahl Index of industry concentration (*HHI*), the square of the Herfindahl Index of industry concentration (*HHI\_square*), and analyst coverage (*Analyst*).andindex firm and year, respectively. *di* denotes firm fixed effects and *dt* denotes year fixed effects.

Table **6** presents the results of the reduced career concern test described in equation (**4**). We show that CEOs are more likely to be fired when profits decline, as indicated by the negative and significant coefficient on Δ(*Profits/Assets*). However, the interaction effect between Δ(*Profits/Assets*) and *COORD\_PROX* cannot be evaluated using the standard reported coefficient on the interaction term, as it depends on the value of all independent variables. Therefore, both the magnitude and statistical significance of the interaction term can vary across different observations. We employ the suggested corrections in Ai and Norton (**2003**) and Norton, Wang, and Ai (**2004**) to estimate the corrected marginal effect and statistical significance of the interaction term between change in profitability and shareholder coordination (*COORD\_PROX*) across various predicted probability thresholds and values for independent variables. We find that the corrected interaction effect is overwhelmingly positive and statistically significant. The average interaction effect for results in Table **6** is 0.0475, with a standard error of 0.0147 and a z-statistic of 3.05, which is significant at the 1% level. In terms of economic significance, when profitability declines by one standard deviation (0.174), an increase in one standard deviation of shareholder coordination (0.907), on average, reduces the chance of the CEO being fired by 0.75% ( = 0.0475\*0.174\*0.907), or 8.3% of the unconditional mean of forced CEO turnover (9%), which is non-trivial. Overall, this test confirms that greater shareholder coordination reduces the likelihood of a CEO being fired due to a decline in profitability and lends support to the reduced career concerns hypothesis.

**TABLE 6.**Shareholder coordination and the sensitivity of forced CEO turnover to change in profitability

|  |  |
| --- | --- |
|  | **Forced CEO Turnover** |
| *Δ(Profits/Assets)* | −2.758\*\* |
|  | (−2.23) |
| *COORD\_PROX* | −0.278 |
|  | (−1.49) |
| *Δ(Profits/Assets) × COORD\_PROX* | 0.436\* |
|  | (1.89) |
| *LnSale* | 0.290\*\* |
|  | (2.11) |
| *R&D* | −2.171 |
|  | (−1.20) |
| *LnAge* | −0.262 |
|  | (−0.75) |
| *ROA* | 0.195 |
|  | (0.55) |
| *Leverage* | −0.033 |
|  | (−0.07) |
| *CapEx* | 0.248 |
|  | (0.20) |
| *PPE* | −0.807 |
|  | (−1.03) |
| *IO* | −1.757\*\*\* |
|  | (−3.31) |
| *IO\_HHI* | 12.169\*\* |
|  | (2.55) |
| *TobinQ* | −0.007 |
|  | (−0.20) |
| *KZindex* | 0.008\*\* |
|  | (1.99) |
| *HHI* | −1.605 |
|  | (−0.66) |
| *HHI \_square* | −0.371 |
|  | (−0.12) |
| *Analyst* | 0.064 |
|  | (0.47) |
| FIRM FE | YES |
| YEAR FE | YES |
| Observations | 6,020 |
| Pseudo R-squared | 0.072 |

*Notes*: This table presents the results of the logit regression specified in equation (4). The dependent variable is *Forced CEO Turnover*, measured as a binary variable equal to one if a CEO was fired, and zero otherwise in year *t+*1. CEO firing data are obtained from Eisfeldt and Kuhnen (2013) and cover the CEOs of 2,779 publicly traded companies in Execucomp during the period 1992–2006. *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure, calculated as the product of –1 and the natural logarithm of one plus the weighted-average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by US institutionto the total ownership held by all US institutions in the firm in that quarter. *Δ(Profits/Assets)* is change in profit scaled by assets in year *t*. All independent variables are measured at year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

We also investigate whether increased shareholder coordination may reduce other agency problems like managerial shirking and myopia and increase innovation productivity. Innovation is a difficult task with a high probability of failure and uncertain long-term benefits, which requires managers to exert costly effort to achieve. Self-interested managers may prefer to shirk their duties as they do not fully capture the benefits of their efforts due to the separation between ownership and control (Hart, 1983). In addition, managers may underinvest in long-term innovation projects due to a myopic preference for short-term earnings performance (Stein, 1989). Coordinated shareholders may force managers to exert costly effort to innovate and to value firm long-term performance over short-term stock prices through enhanced monitoring. Accordingly, both the reduced managerial shirking hypothesis and reduced managerial myopia hypothesis would predict greater managerial effort and commitment to innovation among firms with more coordinated shareholders.18 We use the amount of investment in innovation through R&D to estimate managerial effort and commitment to developing long-term innovation projects. We estimate the following regression model to examine the relationship between shareholder coordination and R&D expenditure:

(5)

where *R&D* is R&D expenditure scaled by total assets.19 *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure specified in section 2.2. *Z* is a vector of control variables, including firm size (*LnSale*), firm age (*LnAge*), return on assets (*ROA*), leverage (*Leverage*), capital expenditures (*CapEx*), property, plant, and equipment (*PPE*), institutional ownership (*IO*), the Herfindahl Index of institutional ownership concentration (*IO\_HHI*), market-to-book ratio (*TobinQ*), financial constraint (*KZindex*), the Herfindahl Index of industry concentration (*HHI*), the square of the Herfindahl Index of industry concentration (*HHI\_square*), and analyst coverage (*Analyst*).andindex firm and year, respectively. *di* and *dt* denote firm and year fixed effects. *ξ* is the error term. A positive β2 suggests that greater shareholder coordination is related to an increase in R&D expenditure.

As shown in Table **7**, the coefficient on *COORD\_PROX* is positive and statistically significant, indicating that an increase in shareholder coordination is associated with greater R&D expenditure. This finding is consistent with the notion that monitoring from coordinated institutional investors decreases agency problems, reducing the propensity for managers to shirk their innovation efforts for a quiet life and to forego valuable long-term investment projects in exchange for greater short-term earnings.**20**

**TABLE 7.**Shareholder coordination and R&D expenditure

|  |  |
| --- | --- |
|  | ***R&Dt*+1** |
| *COORD\_PROX* | 0.004\*\*\* |
|  | (2.73) |
| *LnSale* | −0.010\*\*\* |
|  | (-6.07) |
| *LnAge* | −0.000 |
|  | (−0.01) |
| *ROA* | −0.018\*\*\* |
|  | (−2.64) |
| *Leverage* | −0.007 |
|  | (−1.08) |
| *CapEx* | −0.059\*\*\* |
|  | (−4.94) |
| *PPE* | 0.036\*\*\* |
|  | (5.08) |
| *IO* | 0.001 |
|  | (0.14) |
| *IO\_HHI* | −0.073 |
|  | (−1.13) |
| *TobinQ* | 0.009\*\*\* |
|  | (8.58) |
| *KZindex* | −0.001\*\*\* |
|  | (−3.67) |
| *HHI* | −0.039 |
|  | (−1.02) |
| *HHI \_square* | 0.071 |
|  | (0.95) |
| *Analyst* | −0.007\*\*\* |
|  | (−4.79) |
| *Constant* | 0.119\*\*\* |
|  | (9.47) |
| FIRM FE | YES |
| YEAR FE | YES |
| Observations | 32,670 |
| Adj. R-squared | 0.848 |

*Notes*: This table presents the results of the ordinary least squares regression specified in equation (5). The dependent variable is *R&D*, defined as the R&D expenditure scaled by assets in year*+* 1. *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure, calculated as the product of –1 and the natural logarithm of one plus the weighted-average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by US institutionto the total ownership held by all US institutions in the firm in that quarter. All independent variables are measured at year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

## Endogeneity concerns

While measuring future innovation outcomes at year *t+*3 and controlling for firm fixed effects in our baseline regression reduces endogeneity issues including reverse causality and omitted time invariant firm characteristics, we perform a battery of further tests to address potential endogeneity concerns. We first address the potential concern that shareholder coordination may merely capture firm characteristics such as firm size, institutional ownerships and analyst coverage that can explain corporate innovation as documented in the literature (e.g., Aghion et al., 2013). To alleviate this concern, we estimate a prediction model for shareholder coordination, following Pantzalis and Wang (2017), and use the residual shareholder coordination as our new measure of interest, *COORD\_PROX\_RESID*. By construction, the predicted shareholder coordination is a linear combination of the firm characteristics used in the prediction model. If shareholder coordination is merely an aggregate proxy capturing those firm characteristics, then the residual shareholder coordination should not contribute to innovation productivity. However, if the residual shareholder coordination provides explanatory power for the variation in innovation outcomes, then shareholder coordination is more likely to be causally linked to corporate innovation. We estimate the following prediction model for shareholder coordination, as utilized in Pantzalis and Wang (2017):

(7)

where *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure specified in section 2.2. *U* is a vector of control variables, including firm size (*LnSale*), market-to-book ratio (*TobinQ*), firm beta (*Beta*), return on assets (*ROA*), leverage (*Leverage*), sales growth (*SaleGrowth*), firm age (*LnAge*), institutional ownership (*IO*), the Herfindahl Index of institutional ownership concentration (*IO\_HHI*), stock return (*BHRET12*), analyst coverage (*Analyst*), share turnover (*Turnover*), dividend yield dummy (*Dividend*), and the geographic distance between a firm's headquarters and its institutional investors (*InstHQDist*). Firm and year are indexed byand , respectively. , , and  denote industry, year, and metropolitan statistical area (MSA) fixed effects, respectively. φ is the error term, which is the measure of residual shareholder coordination, *COORD\_PROX\_RESID*.

In Table **8**, we report the regression results using residual shareholder coordination, *COORD\_PROX\_RESID* as the variable of interest. Consistent with the positive monitoring role of shareholder coordination in corporate innovation, we find that the unexplained shareholder coordination is positive and statistically significant in both patent counts and patent citations regressions. These results suggest that the shareholder coordination measure provides incremental explanatory power for the variation in innovation outcomes beyond the factors documented in the literature and is likely to be causally linked to corporate innovation.

**TABLE 8.**Residual shareholder coordination

|  |  |  |
| --- | --- | --- |
|  | ***LnPatentt*+3** | ***LnCitePatt*+3** |
|  | **(1)** | **(2)** |
| *RESID\_COORD\_PROX* | 0.016\*\* | 0.015\* |
|  | (2.32) | (1.74) |
| *LnSale* | 0.047\*\*\* | 0.031 |
|  | (2.59) | (1.36) |
| *R&D* | 0.490\*\*\* | 0.432\*\* |
|  | (3.09) | (2.20) |
| *LnAge* | 0.342\*\*\* | 0.405\*\*\* |
|  | (6.86) | (6.44) |
| *ROA* | 0.076\*\*\* | 0.083\*\* |
|  | (2.79) | (2.17) |
| *Leverage* | −0.312\*\*\* | −0.431\*\*\* |
|  | (−4.41) | (−4.78) |
| *CapEx* | −0.161 | −0.210 |
|  | (−1.50) | (−1.39) |
| *PPE* | 0.630\*\*\* | 0.792\*\*\* |
|  | (4.94) | (4.79) |
| *IO* | 0.269\*\*\* | 0.012 |
|  | (3.51) | (0.12) |
| *IO\_HHI* | −0.257 | 0.785 |
|  | (−0.36) | (0.90) |
| *TobinQ* | 0.019\*\*\* | 0.004 |
|  | (4.25) | (0.65) |
| *KZindex* | −0.000 | 0.001 |
|  | (−0.11) | (0.79) |
| *HHI* | 1.058\*\*\* | 2.245\*\*\* |
|  | (2.71) | (4.16) |
| *HHI \_square* | −1.138\*\*\* | −2.559\*\*\* |
|  | (−2.60) | (−4.41) |
| *Analyst* | −0.011 | −0.015 |
|  | (−0.59) | (−0.64) |
| *Constant* | −0.438\*\*\* | −0.237 |
|  | (−3.13) | (−1.36) |
| INDUSTRY FE | YES | YES |
| YEAR FE | YES | YES |
| Observations | 24,794 | 24,794 |
| Adj. R-squared | 0.764 | 0.521 |

*Notes*: This table presents the results of the ordinary least squares regression where the dependent variable is innovation outcome and the independent variable of interest is the residual shareholder coordination measure. In column (1), the dependent variable is *LnPatentt+*3, defined as the natural logarithm of one plus the number of patents filed (and eventually granted) at year *t+*3. In column (2), the dependent variable is *LnCitePatt+*3, defined as the natural logarithm of one plus the average number of non-self citations received on each patent filed (and eventually granted) at year *t+*3. *RESID\_COORD\_PROX* is the unobservable part of the geographic-proximity-based shareholder coordination measure, as specified in equation (7). All independent variables are measured at year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

An important concern is whether strong monitoring from shareholder coordination promotes innovation or firms that are more innovative attract institutional investors that cluster in certain areas. While this reverse causality is possible, our results in Table **3** show that only coordination among institutional investors with a strong monitoring incentive is associated with greater innovation productivity, and this therefore lessens the concern. To further address the possibility of reverse causality, we estimate a dynamic panel generalized method of moments (GMM) model. As observed in Wintoki, Linck, and Netter (**2012**), this estimation technique is robust to endogeneity problems caused by reverse causality, simultaneity and unobserved heterogeneity. The results of the GMM estimation are presented in Table **9**. We find that *COORD\_PROX* is a statistically significant predictor of patent counts and patent citations at the 10% and 5% level, respectively, using the GMM estimation technique. The magnitude of the coefficient increases as compared to the baseline findings in Table **2**, which may be driven by the reduced measurement error. We also verify that the assumptions of the GMM specification are valid by checking the first and second order serial correlation, AR(1) and AR(2), respectively. By construction, we expect AR(1) to be statistically significant, while we expect AR(2) to be insignificant if our specification is valid. We find that both results hold as expected. The specification also passes the Hansen overidentification test, which adds validity to the instruments.

**TABLE 9.**Generalized method of moments (GMM)

|  |  |  |
| --- | --- | --- |
|  | ***LnPatentt*+3** | ***LnCitePatt*+3** |
|  | **(1)** | **(2)** |
| *COORD\_PROX* | 0.242\* | 0.313\*\* |
|  | (1.79) | (2.29) |
| *LnSale* | 0.169 | 0.395\*\*\* |
|  | (1.10) | (2.83) |
| *R&D* | 6.610\*\* | 4.240 |
|  | (2.41) | (1.58) |
| *LnAge* | 0.058 | −0.070 |
|  | (0.48) | (−0.54) |
| *ROA* | 0.246 | −0.711 |
|  | (0.36) | (−1.15) |
| *Leverage* | −0.518 | −1.208\*\* |
|  | (−0.94) | (−2.21) |
| *CapEx* | −1.675 | −1.581 |
|  | (−0.97) | (−0.95) |
| *PPE* | 0.426 | 1.297 |
|  | (0.49) | (1.53) |
| *IO* | 1.202\* | 1.182\* |
|  | (1.78) | (1.74) |
| *IO\_HHI* | −1.747 | −1.849 |
|  | (−0.49) | (−0.54) |
| *TobinQ* | 0.158\* | 0.118 |
|  | (1.68) | (1.49) |
| *KZindex* | −0.004 | −0.015 |
|  | (−0.33) | (−1.18) |
| *HHI* | 2.210 | 2.138 |
|  | (1.09) | (1.03) |
| *HHI \_square* | −1.722 | −1.680 |
|  | (−0.82) | (−0.79) |
| *Analyst* | −0.097 | −0.112 |
|  | (−0.81) | (−0.96) |
| *Constant* | −16.818+ | −10.371 |
|  | (−1.81) | (−1.06) |
| INDUSTRY FE | YES | YES |
| YEAR FE | YES | YES |
| Observations | 24,794 | 24,794 |

*Notes*: This table reports estimation results from the dynamic panel generalized method of moments (GMM) estimation model. In column (1), the dependent variable is *LnPatentt+*3, defined as the natural logarithm of one plus the number of patents filed (and eventually granted) at year *t+*3. In column (2), the dependent variable is *LnCitePatt+*3, defined as the natural logarithm of one plus the average number of non-self citations received on each patent filed (and eventually granted) at year *t+*3. *COORD\_PROX* is the geographic-proximity-based shareholder coordination measure, calculated as the product of –1 and the natural logarithm of one plus the weighted-average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by US institutionto the total ownership held by all US institutions in the firm in that quarter. All independent variables are measured at year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

To further investigate the potential for reverse causality, we conduct a change-on-change analysis commonly used in the literature (e.g., Aggarwal, Erel, Ferreira, & Matos, **2011**). If monitoring from shareholder coordination indeed promotes future innovation, then changes in shareholder coordination should be positively associated with subsequent changes in innovation and not the other way around (i.e., changes in innovation should not be related with subsequent changes in our measure of shareholder coordination). Table **10** presents the results of the change-on-change analysis. As shown in column (1), changes in shareholder coordination (*ΔCOORD\_PROX*) are positively and significantly associated with subsequent changes in patent counts. In column (2), change in shareholder coordination is positively and insignificantly associated with patent count. This could be because the change-in-change model produces a less efficient estimate with panel data that has a large number of firms and a small number of years (Wooldridge, **2009**). Using the opposite specification (namely, regressing changes in shareholder coordination on lagged changes in patent counts and patent citations), we do not find such an effect in columns (3) and (4). The change-on-change analyses provide mixed results, but in tandem with the other results reported help to alleviate reverse causality concerns.

**TABLE 10.**Change-on-change regressions between shareholder coordination and innovation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **∆Ln*Patentt*+3** | **∆Ln*CitePatt*+3** | **∆*COORD\_PROXt*+3** | **∆*COORD\_PROXt*+3** |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
| *∆COORD\_PROX* | 0.011\*\* | 0.004 |  |  |
|  | (2.05) | (0.36) |  |  |
| *∆LnPatent* |  |  | −0.006 |  |
|  |  |  | (−0.82) |  |
| *∆LnCitePat* |  |  |  | −0.004 |
|  |  |  |  | (−0.76) |
| *∆LnSale* | 0.006 | −0.015 | 0.043\*\* | 0.043\*\* |
|  | (0.62) | (−1.02) | (2.30) | (2.29) |
| *∆R&D* | −0.060 | −0.001 | 0.235 | 0.235 |
|  | (−0.66) | (−0.00) | (1.55) | (1.54) |
| *∆LnAge* | 0.233\*\*\* | 0.316\*\*\* | −0.334\*\*\* | −0.334\*\*\* |
|  | (6.49) | (6.35) | (−4.32) | (−4.32) |
| *∆ROA* | −0.004 | −0.009 | 0.010 | 0.010 |
|  | (−0.29) | (−0.42) | (0.28) | (0.29) |
| *∆Leverage* | −0.025 | −0.107\* | −0.103\* | −0.103\* |
|  | (−0.63) | (−1.86) | (−1.84) | (−1.84) |
| *∆CapEx* | 0.064 | 0.094 | 0.127 | 0.126 |
|  | (1.15) | (1.00) | (0.84) | (0.84) |
| *∆PPE* | 0.131\*\* | 0.164\* | 0.044 | 0.044 |
|  | (2.08) | (1.69) | (0.43) | (0.43) |
| *∆IO* | 0.124\*\*\* | −0.065 | 0.077 | 0.077 |
|  | (2.89) | (−0.92) | (1.20) | (1.20) |
| *∆IO\_HHI* | −0.646 | 0.956\* | −0.675 | −0.673 |
|  | (−1.63) | (1.67) | (−1.44) | (−1.43) |
| *∆TobinQ* | 0.008\*\*\* | 0.004 | −0.001 | −0.001 |
|  | (2.79) | (0.79) | (−0.21) | (−0.20) |
| *∆KZindex* | −0.000 | −0.000 | −0.001 | −0.001 |
|  | (−0.58) | (−0.04) | (−1.10) | (−1.10) |
| *∆HHI* | −0.053 | 0.324 | 0.172 | 0.174 |
|  | (−0.25) | (0.92) | (0.50) | (0.50) |
| *∆HHI* | -0.113 | −0.412 | −0.321 | −0.323 |
|  | (−0.46) | (−1.00) | (−0.83) | (−0.84) |
| *∆Analyst* | 0.010 | 0.004 | 0.003 | 0.002 |
|  | (1.26) | (0.33) | (0.16) | (0.15) |
| *Constant* | −0.217\*\*\* | −0.225\*\*\* | 0.034\*\*\* | 0.035\*\*\* |
|  | (−19.00) | (−14.45) | (2.75) | (2.92) |
| INDUSTRY FE | YES | YES | YES | YES |
| YEAR FE | YES | YES | YES | YES |
| Observations | 19,862 | 19,862 | 16,149 | 16,149 |
| Adj. R-squared | 0.061 | 0.023 | 0.008 | 0.008 |

*Notes*: This table presents the results of the ordinary least squares regression where the dependent variable is the change in innovation outcome from year *t+*2 to year *t+*3 and the independent variables are measured as the difference from year *t–*1 to year *t*. Specifically, in column (1), the dependent variable is ∆*LnPatentt+*3, defined as the change in the natural logarithm of one plus the number of patents filed (and eventually granted) at year *t+*3. In column (2), the dependent variable is *∆LnCitePatt+*3, defined as the change in the natural logarithm of one plus the average number of non-self citations received on each patent filed (and eventually granted) at year *t+*3. The independent variable of interest, *∆COORD\_PROX*, is the change in the geographic-proximity-based shareholder coordination measure, which is calculated as the product of –1 and the natural logarithm of one plus the weighted-average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by US institutionto the total ownership held by all US institutions in the firm in that quarter. All independent variables are measured as the difference from year *t–*1 to year *t*. Detailed variable definitions are given in Appendix A. Standard errors are clustered by firm. T-statistics are reported in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Finally, we conduct additional tests to confirm the robustness of our baseline results.**21** First, we directly control for a number of other institutional ownership variables to assure that the results on our shareholder coordination measure are not driven by other institutional ownership features. For example, there may be a concern that local institutions are more likely to hold firms in close proximity because they have access to greater information about local firms (e.g., Baik, Kang, & Kim, **2010**; Park & Chung, **2007**) and our coordination measure merely captures clustered local institutional ownership that is informed about local firms’ innovation productivity. We find that the inclusion of local institutional ownership, dedicated institutional ownership, and independent institutional ownership in the regression model has no impact on either the statistical significance or magnitude of the coefficient on *COORD\_PROX*.**22** Second, we construct alternative measures of shareholder coordination to further address potential confounding effects. Specifically, we exclude local institutional investors located within a 150 mile radius of the firm's headquarters when calculating the shareholder coordination measure. Shareholder coordination retains its positive and statistically significant influence on patent count and citations when the shareholder coordination measure is limited to non-local institutional investors. In addition, we reconstruct the shareholder coordination measure to exclude institutions in the New York City and Boston metropolitan areas to address the potential concern that our results could be driven by a clustering of institutional investors in New York City and Boston. Shareholder coordination remains a significant predictor of innovation outcomes even absent the investors concentrated in the Boston and New York metropolitan areas. Lastly, we include the G-Index as defined in Gompers, Ishii, and Metrick (**2003**) as an additional control of firm-level corporate governance. Since the G-index primarily covers S&P 500 firms, including the G-index substantially reduces our sample size and the statistical power of our tests. After the inclusion of the G-index, shareholder coordination is positively related to future patent counts and patent citations at the 10% level.

# 4 CONCLUSIONS

While the previous literature shows that institutional and blockholder ownership increases innovation productivity (e.g., Aghion et al., **2013**; Choi, Lee, & Williams, **2011**; Edmans, **2009**), it largely overlooks the interactions between these institutions and its impact on innovation outputs. We hypothesize that, for a given level of institutional ownership, the effect of their monitoring effort on innovation outcomes is stronger when they have an increased ability to coordinate. We find evidence that increased shareholder coordination, as proxied by geographic proximity, is related to increased innovation outputs, measured by patent grants and patent citations. The results are robust to several specifications used to address potential endogeneity concerns, including the use of a residual coordination measure, a dynamic panel GMM model, and a change-on-change regression specification. Furthermore, the results are robust when we control for additional institutional characteristics, control for a measure of corporate governance, and exclude local investors or institutional investors concentrated in New York City and Boston when measuring shareholder coordination.

To substantiate our main results, we further investigate whether the effect of shareholder coordination is stronger among institutions with stronger monitoring incentives. We find supportive evidence that coordination has positive effects on innovation only for dedicated and independent institutions, who are more likely to engage in long-term investment strategies and monitoring (Bushee, **1998**; Porter, **1992**). Furthermore, we find that the effect of shareholder coordination is stronger when the firm can benefit more from coordinated monitoring, such as when it has a lower percentage of blockholder ownership and when there is more severe information asymmetry.

Finally, we investigate the channel through which shareholder coordination influences innovation outcomes. We show results consistent with the notion that shareholder coordination reduces managerial agency problems. Overall, our results support the hypothesis that shareholder coordination enables diffuse shareholders to mitigate agency problems and spur innovation.

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# APPENDIX A

## Variable Definitions

|  |  |
| --- | --- |
| **Variable** | **Definition** |
| Innovation Measures |  |
| *LnPatentt+*3 | Natural logarithm of one plus firms’ total number of patents filed (and eventually granted) in year *t+*3 |
| *LnCitePatt+*3 | Natural logarithm of one plus firms’ total number of non-self citations received on the firm's patents filed (and eventually granted), scaled by the number of the patents filed (and eventually granted) in year *t+*3 |
| Shareholder Coordination Measures |  |
| *COORD\_PROX* | Geographic-proximity-based shareholder coordination measure, calculated as the product of –1 and the natural logarithm of 1+weighted average geographic distance between US institutional shareholders of the firm in each firm-quarter in year *t*, where the weight is the ratio of ownership held by individual institution to the total ownership held by all US institutions in a firm at quarter *q* |
| *COORD\_PROX\_Indep* | Geographic-proximity-based shareholder coordination measured among independent institutional investors (mutual funds and independent investment advisers as in Ferreira and Matos (2008) |
| *COORD\_PROX\_Grey* | Geographic-proximity-based shareholder coordination measured among grey institutional investors (bank trusts, insurance companies, and other institutions as in Ferreira and Matos (2008) |
| *COORD\_PROX\_Ded* | Geographic-proximity-based shareholder coordination measured among dedicated institutional investors as defined in Bushee (1998) |
| *COORD\_PROX\_Trans* | Geographic-proximity-based shareholder coordination measured among transient institutional investors as defined in Bushee (1998) |
| Other Variables |  |
| *LnSale* | Book value of sales (#12) |
| *R&D* | R&D expenditure (#46) divided by book value of total assets (#6), set to 0 if missing |
| *LnAge* | Natural logarithm of the number of years since the stock was included in the Compustat database at the end of fiscal year *t* |
| *ROA* | Return-on-assets ratio defined as net income (#172) divided by book value of total assets (#6) |
| *Leverage* | Leverage ratio defined as the ratio of sum of current labilities (#5) and long-term debt (#10) to total assets (#6) |
| *CapEx* | Capital expenditure (#128) divided by book value of total assets (#6) |
| *PPE* | Net property, plant & equipment (#8) divided by book value of total assets (#6) |
| *IO* | The institutional holdings (%) for firmin a year, calculated as the average of the four quarterly institutional holdings reported through form 13F divided by total number of shares outstanding |
| *IO\_HHI* | Herfindahl index of institutional ownership concentration based on percentages of institutional holdings by all 13F institutions |
| *TobinQ* | Market-to-book ratio defined as market value of equity (#199 × #25) plus book value of assets (#6) minus book value of equity (#60) minus balance sheet deferred taxes (#74, set to 0 if missing), divided by book value of total assets (#6) |
| *KZindex* | KZ index defined as –1.002 × Cash Flow ((#18+#14)/#8) plus 0.283 × Q ((#6+#199 × #25–#60–#74)/#6) plus 3.139 × Leverage ((#9+#34)/(#9+#34+#216)) minus 39.368 × Dividends ((#21+#19)/#8) minus 1.315 × Cash holdings (#1/#8), where #8 is net value of property, plant and equipment |
| *HHI* | Herfindahl index of three-digit SIC industry *j* where firmbelongs |
| *HHI \_square* | The square of Herfindahl index |
| *Analyst* | Natural logarithm of the number of analysts covering a firm in year *t* |
| *Blockown* | Total ownership held by institutions whose ownership is above 5% from Thomson-Reuters Institutional Holdings (13F) in year *t* |
| *AnalystDisp* | Analyst forecast dispersion, measured as the average standard deviation of analyst earnings forecasts in year *t* |
| *Dividend* | Dividend dummy equals one if the firm pays dividends, and zero otherwise in year *t* |
| *Forced CEO Turnover* | Binary variable equal to one if a CEO was fired over fiscal year *t+*1 and zero otherwise |
| *Δ(Profits/Assets)* | Change in the ratio of net income (#172) to book value of total assets (#6), from year *t–*1 to year *t* |
| *BHRET12* | Compound gross return in the last 12 months |
| *Turnover* | Average monthly trading volume of a firm's shares scaled by the average number of shares outstanding in a year |
| *InstHQDist* | Geographic distance between a firm's headquarters and its institutional investors in year *t* |

# DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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# Notes

1 Studies show that investments in innovation have a failure rate between 50%-80% (Asplund & Sandin, 1999; Cozjinsen, Vrakking, & IJerzloo, 2000).

2 Anecdotal evidence suggests that institutional investors often engage in collaborative actions. For instance, the California State Teacher’s Retirement System (CALSTRS) partnered with California-based Relational Investors LLC to force Occidental Petroleum to improve its corporate governance practices and to push the Timken Company to spin off its steel division (CALSTRS, 2010, 2013). Research also shows that institutional investors can work together to initiate shareholder proposals to influence corporate decisions (e.g., Gillan & Starks, 2000).

3 Specifically, Hong et al. (2005) show that mutual fund managers are more likely to buy (or sell) a particular stock if other managers in the same city are buying (or selling) that same stock. Geographic proximity has also been shown to be an important determinant of friendship and marriage (Bossard, 1932), the formation of interlocked corporate boards (Kono, Palmer, Friedland, & Zafonte, 1998), the development of relationships among floor traders (Baker, 1984), and venture capital firms’ investment decisions (Sorenson & Stuart, 2001).

4 In, the inclusion of additional institutional ownership characteristics and a measure of firm corporate governance, the exclusion of local institutional investors in the creation of the shareholder coordination measure, and the exclusion of institutional investors headquartered in New York City or Boston in the construction of shareholder coordination measure.

5 Is from the reduced managerial myopia hypothesis.

6 Our conclusions are drawn based on US firms, which feature dispersed ownership (Huang, 2014). However, there are substantial variations in ownership structure between different countries. For instance, Pedersen and Thomsen (1997) show that in 1990, 61% of the largest 100 companies in Great Britain have dispersed ownership such that the largest owner holds less than 20% of the company’s vote. However, in Austria and Italy, ownership is much more concentrated; in none of the largest 100 companies does the largest owner hold less than 20% of the company’s vote. As the ownership structure in Great Britain most closely resembles that of the US, shareholder coordination may play a similar corporate governance role as in the US. However, in countries like Austria and Italy, the role of shareholder coordination is less clear. On the one hand, the dominant owners may have strong monitoring incentives that substitute for the role of shareholder coordination. On the other hand, the concentrated ownership may prompt minority shareholders to coordinate more to avoid being exploited by the dominant owner. It would be interesting to empirically examine the role of shareholder coordination in corporate governance in various international contexts.

7 Institutional investor data are based on Bushee (1998) and can be found at http://acct.wharton.upenn.edu/faculty/bushee/IIclass.html. We thank Dr. Bushee for generously providing these data. We also thank Andrea Eisfeldt for graciously providing these data on her website: https://sites.google.com/ site/andrealeisfeldt/. The CEO turnover data cover the CEOs of 2,779 publicly traded firms from 1992–2006.

8 Firms in our sample may have foreign institutional investors as well, but those investors are excluded when we calculate the shareholder coordination mea- sure. We apply the requirement of at least one US institutional investor on a quarterly basis and average the shareholder coordination measure across a year, so firms may enter or leave the sample if their institutional ownership changes. In footnote 8, we further discuss our rationale for excluding foreign institutional investors and the robustness of our main results when foreign institutional investors are included.

9 To gauge the representativeness of our sample, we examined the market capitalization of our sample firms as a percentage of the CRSP-Compustat Merged universe over our sample period. We find that, on average, our sample covers 61.9% of the market capitalization of the CRSP-Compustat Merged universe. The coverage is comparable to that reported in Table 1 Panel C of Mathers, Wang, and Wang (2017), which also examines patenting output.

10 While the NBER Patent Citation database covers patents filed up to 2006, the HBS patent database is only available for patents filed on and before 2005 and granted by 2010. Therefore, our patent data contain patents that are filed from 1994 to 2005 and granted eventually by 2010.

11 Foreign investors are excluded when we calculate the shareholder coordination measure for a number of reasons. First, the prior literature suggests that foreign institutions are less effective in monitoring managers than domestic institutions due to the geographical distance (e.g., Kang & Kim, 2008; Kim, Miller, Wan, & Wang, 2016). In addition, the average fraction of the total institutional equity holdings in the US managed by foreign institutions is less than 7% over our sample period. Therefore, foreign institutions are unlikely to play an influential role in corporate governance. Moreover, the presence of foreign institutions may dramatically decrease the measured weighted average geographic proximity among shareholders and add noise to our shareholder coordination measure. In unreported results, we also construct an alternative shareholder coordination variable that measures the weighted average geographical distance between institutional investors including foreign institutions. We continue to find a positive and significant relationship between this alternative measure of shareholder coordination and patent outputs.

12 While the formula presented in Equation (1) appears complicated, it is a standard measure of geographical distance between two places on the Earth and is commonly used in the literature. For example, Coval and Moskowitz (1999, 2001) use a similar formula to measure the geographical distance between an investment fund and a firm, and Goetschalckx (2011) applies the same formula to measure transportation distance in the operation of supply chains (p. 46).

13 *COORD\_PROX* is largely orthogonal to the fraction of total institutional ownership out of total shares outstanding because the ownership weight of each institutional investor is calculated as the number of shares owned by each institution scaled by total institutional ownership. A simple numeric example can illustrate this point. Assume that a firm has three institutional investors, A, B and C, each of whom hold 10 million shares of the firm. The ownership weight of each institutional investor is calculated as the number of shares owned by each institution scaled by all institutional shares, which is 1/3 (10 million/30 million). In this case, whether the firm has a total number of shares outstanding of 100 million or 500 million (i.e., the total fraction of institutional shares is 30% or 6% given the institutional holdings of 30 million shares), our calculated weighted average geographical distance between these institutional investors remains the same, as is the same. In all our regressions, we control for the total fraction of institutional ownership (*IO*), so the coefficient on *COORD\_PROX* should be interpreted as the incremental role of shareholder coordination in corporate innovation, holding total institutional ownership constant.

14 The use of this OLS model follows the literature and facilitates comparison of our results with the existing literature on patent outcomes. As the Poisson and negative binomial models deal with count data, we also rerun our baseline regression using these models. Our results remain qualitatively similar using these alternative regression models. In addition, since the median of both patent counts and citations is zero, we also examine the effect of transforming the dependent variables into binary variables and performing a logit regression. Our main results continue to hold.

15 The results are qualitatively similar when we measure patent activity at *t*+1 and *t+*2

16 If we define patents granted as the *y* variable and shareholder coordination (*COORD\_PROX*) as the *x* variable of interest, then the coefficient on *COORD\_PROX* of 0.019 represents dln(1 + *y*)/d*x*. To find the change in *y* (d*y*), we derive it as d*y* = [dln(1 + *y*)/d*x*]∗d*x*∗(1 + *y*). Assuming *x* changes from its 10th to its 90th percentile (1.516) and *y* is at its unconditional mean (9.522), d*y* = [dln (1 + *y*)/d*x*]∗d*x*∗(1 + *y*) = 0.019∗1.516∗(1+9.522) = 0.30308. This represents a 3.18% (0.30308/9.522) increase in the mean of patents granted. The economic significance of *COORD\_PROX* in column (2) when the dependent variable is non-self citations per patent is calculated similarly.

17 In comparison, on average, an increase in *R&D* from the 10th percentile to the 90th percentile is associated with a 9.31% increase in the number of patents granted according to the results in column (1) and a 10.1% increase in patent citations based on results in column (2). Given that *R&D* is an important input of innovation, the economic significance of *COORD\_PROX* is substantial.

18 While the managerial agency problem could also manifest as empire building and therefore overinvestment in R&D (Baumol, 1959), this effect would bias us against finding increased R&D expenditure among firms with more coordinated shareholders, controlling for total institutional ownership. In addition, contrary to the prediction of empire building, existing work finds that managerial entrenchment reduces R&D expenditure while greater managerial ownership increases it (e.g., Cho, 1992; Yang, 2018).

19 To allow for more recent data we extend the sample period in this test to 2014, which is the most recent institutional holdings data available through our subscription to Thomson Reuters.

20 We attempt to disentangle the reduced managerial shirking hypothesis from the reduced managerial myopia hypothesis. Specifically, we examine the relationship between R&D spending and the interaction term of managerial pay-for-performance sensitivity (*Delta*) and shareholder coordination (*COORD\_PROX*). The reduced managerial shirking hypothesis predicts a negative interaction term since greater pay-for-performance sensitivity gives managers more incentive to exert effort and lessens the role of shareholder coordination in reducing managerial shirking. On the other hand, the reduced managerial myopia hypothesis suggests a positive interaction term. Greater pay-for-performance sensitivity gives managers more financial incentive to behave myopically, especially given the short average managerial tenure, so we expect that shareholder coordination is more important in curbing managerial myopia when there is greater pay-for-performance sensitivity. We measure *Delta* as the dollar change (in $1,000s) in CEO’s wealth associated with a 1% change in the firm’s stock price. In untabulated results, we do not find a significant effect of the interaction term between *Delta* and *COORD\_PROX* on R&D spending. The insignificant interaction term may imply that the competing effects of shirking and myopia are both in place. However, the insignificant interaction term could also be driven by the decreased power of our tests as our sample size is substantially reduced by the inclusion of managerial compensation data from Execucomp, which covers only S&P 1500 firms.

21 To conserve space, we do not tabulate the results of these additional robustness tests, but the results are available upon request.

22 We define local institutional ownership as ownership by institutions located within a 150 mile radius of a firm’s headquarters. We define dedicated institutional ownership as in Bushee (2001) and define independent institutional ownership as in Chen, Harford, and Li (2007).