Institutional Investment Horizons and Corporate Innovation

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This version: November, 2015

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Abstract

This paper examines the impact of institutional investor's investment horizons on corporate innovation. We conjecture that the presence of long-term institutional investors mitigates managerial myopia since long-term oriented institutions have more incentives to monitor with informational advantages, and that this will lead firms to engage in more innovative corporate activities. Using data on patents and citations of the U.S. firms over the period of 1980-2004, we find that long-term institutional ownership is positively related to the number of patents, citations, and citations per patent. Our findings suggest that firms' innovative activities increase with the greater presence of long-term institutional investors.

JEL classification: G31; G32; G34

Key words: innovation; institutional investor; investment horizon

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1. Introduction

In a typical competitive market, innovation is a crucial element for firms to effectively compete and remain the long-run comparative advantage. Along with the importance of innovation, particular attention is given to factors that drive corporate innovation from both academia and practitioners. On the other hand, institutional ownership in U.S. firms has significantly increased over the last three decades.[1] With surging ownership of institutions, their influence on determining corporate policies has greatly risen. Specifically, institutional shareholders play a vital role in motivating firm's innovation. Only few studies document the role of institutional investors on corporate innovation (Lerner, Sorensen, and Stromberg, 2011; Aghion, Reenen, and Zingales, 2013), and they typically overlook the effect of institutional investors' heterogeneity. Most prior studies consider institutional investors as a homogenous group with similar goals and strategies, and focus on the influence of institutional ownership on innovation. However, since innovation is nurtured by a long-term investment in intangible assets, the variation of institutional shareholders for a long-term investment is likely to affect corporative innovation. Thus, the objective of this paper is to provide empirical evidence on the impact of institutional investment horizons on corporate innovation.

There exist a number of types of institutional investors including pension funds, mutual funds, hedge funds, insurance companies, and bank trusts, etc. They face different level of regulatory schemes and pursue different degree of activism for corporate governance

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[1] Institutional investors have become the largest owners of the U.S. firm with more than 50% ownership in most recent decades (Chen, Harford, and Li, 2007). In addition, ownership of institutional investors exceeds 70% of the equity in the 1,000 largest U.S. corporations (the Conference Board, 2010 Institutional Investment Report).

reform (e.g. Gillan and Starks, 2000; Almazan, Hartzell, and Starks, 2005; Lim, 2013). One of notable dimensions of heterogeneity is the investment horizon of institutions. For instance, hedge funds are oriented to short-term investment horizons while traditional pension funds are aimed at reaping benefits from long-term investment. Different client bases, demographics, and liquidity needs make institutional investors involved in strategies with different investment horizons (Gaspar, Massa, and Matos, 2005). This different level of investment horizon of institutions leads to their different monitoring incentive and information role. Institutions with short-term investment horizons have less incentives to spend resources in monitoring since they are less likely to remain shareholders on an ongoing basis (Gaspar et al., 2005). In contrary, institutions with long-term investment horizons may join a firm long enough as shareholders, thus engaging in more monitoring activities to facilitate the long-term value creation of the firm. Furthermore, institutions with long-term investment horizons have more time and resources to learn the firm, and also possess efficient process to collect information, which, in turn, generate more precise information and improve information quality (Attig, Cleary, El Ghoul, and Guedhami, 2012).

Motivating and nurturing innovation are a very challenging task for firms. For example, Holmstrom (1989) argues that innovative activities involve the risks such as unpredictability and a high probability of failure. Due to career concerns, managers may dislike high risks accompanied by innovation and prefer more routine projects with quicker but lower profits, exacerbating agency problems (Narayanan, 1985). Moreover, firms pursing further innovation are imposed to disclose only partial information and are subject to larger information asymmetry (Bhattacharya and Ritter, 1983). Firms with heavy investment in innovation may be undervalued in equity market and are likely to expose more frequently to threat of hostile takeover (Stein, 1988). Because managers of those firms want to avoid such expropriation, they tend to focus on short-term and certain profits rather than investing in innovation that is risky and long-term project, thereby resulted in managerial myopia problems (He and Tian, 2013). Those problems that are induced from pursuing innovation may be resolved by the presence of long-term institutional investors. Increased monitoring activities of institutions with long-term investment horizons insure the manager against the reputational risk from a poor revenue realization (Aghion et al. 2013) and thus, motivate the manager to accomplish policies aimed at boosting the innovative activity of the firm. The production of more precise information by long-term institutional investors will decrease informational asymmetry, which reduces undervaluation problem or the exposure to threat of hostile takeover stemming from pursuing innovative activities and, in turn, mitigates managerial myopia. In addition, less informational asymmetry induced from a longer institutional shareholder horizon leads to efficient prices, thus encouraging managers to forgo short-term profits to invest in long-term projects such as innovation (Fang, Tian, and Tice, 2014).

The heterogeneity of investment horizon of institutions suggests an asymmetric influence on innovative activities: better monitoring and informational advantages by long-term institutional investors are more likely to induce firms to engage more innovation, whereas institutions with short-term investment horizons may cause managerial short-termism and impede firm innovation. Our main hypothesis is that the presence of longer horizon institutional investors is likely to enhance corporate innovation.

To test our hypothesis, we focus on the relation between institutional investor's investment horizon and observable innovation outputs. Consistent with prior literature (Hirshleifer, Low, and Teoh, 2012; Chen, Podolski, Rhee, and Veeraraghavan, 2014), our innovation data is obtained from the National Bureau of Economic Research (NBER) and includes the number of patents granted to a firm, citations count, and the number of citations received by each patent. Following Gaspar et al. (2005), we measure institutional investors' investment horizons using turnover ratio, which is defined as weighted average of the total portfolio churn rates of a firm's institutional investors. We also construct two other proxies for institutional investment horizon, which measure a percentage ownership of the firm held by long-term and short-term investors. We define long-term (short-term) investors as investors whose turnover ratio is bottom (top) half. Our final sample represents 53,599 U.S. firm-year observations over the period between 1980 and 2004. We find that turnover ratios of institutional investors are negatively related to the number of patent, citation, and citations per patent. Our results also describe that in general, long-term institutional ownership is positively related to innovation output while short-term institutional ownership is negatively related to innovation output. Additionally, we find that firms with higher long-term institutional ownership engage in more innovative activities than firms with higher short-term institutional ownership. The results support our argument that longer horizon institutional investors tend to boost corporate innovation. Our baseline results are potentially subject to endogeneity concerns. To account for omitted variable bias, we use the institutional investment horizon measure lagged 3 and 5 years as an main explanatory variable in the regressions because more lagged variables are less likely to be correlated with current omitted firm characteristics. As well, Firm-fixed effects are included in the regressions to control for time-invariant omitted firm characteristics. In order to mitigate the reverse causality that goes from corporate innovation to institutional investment horizons, we also perform the simultaneous equation analysis using three-stage least squares (3SLS) procedure. Overall, our main results remain unaffected.

The main contribution of our paper is to shed light on how institutional investors as a heterogeneous group affect corporate innovation. We focus on institutional investment horizon because this differential characteristic of institutions is greatly associated with managerial agency cost and information asymmetry, which exerts a strong influence on the extent of innovation. Previous literature investigates the role of institutional investors on innovation. For instance, Aghion et al. (2013) show that institutional investors boost corporate innovation by reducing manager's career risks. While this study regards institutional investors as a homogeneous group, our analysis suggests the effect of the presence of institutions with different investment horizon on innovative activities. Our paper also adds to the literature examining the positive effect of a longer institutional investor horizon on corporate behavior. Elyasiani, Jia, and Mao (2010) find that stable institutional ownership is related with a lower cost of debt. Attig, Cleary, El Ghoul, and Guedhami. (2013) argue that the cost of equity reduces in the presence of institutional investors with longer investment horizons. We contribute to these studies by suggesting that the presence of long-term oriented institutions increases corporate innovation. Our paper also contributes to the research linking institutional investment horizon to long-term investment. Bushee (1998) argues that firms with shorter horizon decrease R&D to increase short-term earnings. Instead of analyzing R&D expenditures, we focus on direct outputs of long-term investment proxied by the number of patents, citations, and citations per patent, thus showing the direct link between institutions with different investment horizon and firm's long-term intangible investments such as innovation.

The rest of the paper is organized as follows. In section 2, we review related literature and develop the preceding arguments more fully. Section 3 describe the data, summary statistics, and the construction of key variables. We discuss our main empirical findings in Section 4. Section 5 summarizes our findings and draws conclusions.

2. Literature Review and Hypothesis Development

By investigating the impact of institutional investment horizon on corporate innovation, we bring together three strands of research.

First, this paper is linked with the literature that analyzes the role of institutional investors as proxy for institutional activism. Shleifer and Vishny (1986) model that large shareholders engage in monitoring activities to mitigate managerial agency problem. However, all institutional investors do not show active shareholders activism because they differ in their investment goal and style and incentives for managers, and are subject to regulatory and legal environments (Gillan and Starks, 2000, and Yan and Zhang, 2009). These differences may distinctly influence the governance role. For example, Almazan et al. (2005) find that there exists the difference in monitoring costs between active institutions such as investment companies and investment advisors and passive institutions such as banks and insurance companies. In a line of this research, our paper is also related to a growing literature that examines the divergent monitoring and informational role of institutional investors by their different investment horizon. Gaspar et al. (2005) conjecture that institutions with a shorter investment horizon may not remain shareholders long enough to reap the corresponding benefits and thus, have less incentives to monitor managers. Consistent with this expectation, they find that firms owned by short-term investors have a weaker bargaining position in acquisition. Attig et al. (2012) argue that institutional shareholders with long-term investment horizons are advantageous from the economics of scale in collecting and processing information, showing that the sensitivity of firms' investment outlays to internal cash flows reduces in the presence of institutions with long-term investment horizons. These different incentives of institutional investors affect a variety of corporate policies: the cost of equity capital (Attig et al., 2013), equity returns (Yan and Zhang, 2009), payout policy choices (Gaspar et al., 2012), corporate governance (Lee and Chung, 2014), seasoned equity offerings (Hao, 2014), and the cost of debt (Elyasiani et al., 2010; Kim, Mantecon, and Song, 2014) are strongly associated with the heterogeneity of institutions' investment horizons.

The second strand of literature focuses on corporate innovation. Manso (2011) argues that managerial contracts that provide tolerance for early failure and reward for long-term success are optimal in motivating innovation. Ferrieira, Manso, and Silva (2014) model that innovation is suited for private ownership rather than public ownership. Empirical studies suggest various factors that influence managerial incentives for innovation. Hishleifer et al. (2012) document that firms with overconfident CEOs invest more in innovation. Aghion et al. (2013) find that higher institutional ownership ensures CEO's job stability, which curtails, in turn, managerial myopia and promotes innovative activities. He and Tian (2013) show that analyst coverage is negatively related to firm innovation since analysts force managers to put more weight for short-term goals. Fang et al. (2014) suggest that high stock liquidity makes firms more exposed to hostile takeover and also attracts transient investors, thus causing managers to be pressured to decrease investment in innovation to boost short-term earnings. Furthermore, non-executive employee stock options (Chang, Fu, Low, and Zhang, 2013), corporate venture capital (Chemmanur, Loutskina, and Tian, 2012), investors' greater tolerance for failure (Tian and Wang, 2014), and local gambling preferences (Chen et al., 2014) alter managerial incentives and therefore, motivate managers to invest in innovative activities. On the other hand, antitakeover legislation (Atanassov, 2013) and accounting conservatism (Chang, Hilary, Kang, and Zhang, 2013) are negatively associated with corporate innovation. However, existing studies have largely overlooked the importance of heterogeneous institutions' characteristics and especially, the role of institutional investment horizon in driving innovation. Our paper complements this line of research by filling in this gap.

As the third strand, our study is directly related to the literature that examines the relation between institutional investor horizon and long-term investment. Bushee (1998) finds that transient investors exhibit strong preferences for near-term earnings over long-run value.

They use R&D expenditures as a proxy for long-run investment. However, R&D expenditures capture only one observable quantitative inputs (Aghion et al., 2013) and are sensitive to accounting practice (Acharya and Subramanian, 2009). In comparison, we concentrate on the number of patents, citations, and citations per patent, which reveal the extent to which all observable and unobservable innovative inputs are successfully used. Our data closely captures innovative activities, thus providing us a good setting to examine the direct impact of institutional investor's investment horizon on firm innovation.

Overall, the discussion above allows to propose a testable hypothesis. Innovative activities are likely to be motivated when institutional investors engage in more monitoring activities with informational advantages. This will prevent managerial myopia and promote managerial decisions focused on the long-term value of the firm. Long-term institutional investors are more likely to perform effective monitoring role to promote innovation since they have more time, resource, and efficient process to collect information about the firm. We propose the testable hypothesis that the presence of longer horizon institutional investors is likely to promote corporate innovation measured by the number of patent, citations, and citations per patent.

3. Data and Research Design

3.1. Sample Construction

Our sample is constructed from several database. Patent and citation-related data are obtained from 2006 edition of the NBER patent database. We obtain all accounting and financial information from Compustat. Analyst coverage data is obtained from the Institutional Brokers' Estimate System (I/B/E/S) database. Furthermore, we require that our sample covers institutional ownership data, which is from Thomson Reuters CDA/Spectrum database (form 13F). We exclude financial firms (SIC codes from 6000 to 6999) and utilities industries (SIC codes from 4900 to 4949) because financial decisions of these firms are heavily restricted by the government. The sample includes firms in the intersection of the NBER patent database, Compustat, I/B/E/S, and Thomson Reuters' 13F Holdings. Observations with missing data on control variables and dependent variables are excluded. Following extant literature, in order to make our sample representative, we include all firms in Compustat database with the same 4-digit SIC code as the firms in the patent database (Hirshleifer et al., 2012, and Chen et al., 2014).[2] Our final sample consists of 53,599 U.S. firm-year observations over the period of 1980-2004.

3.2. Measuring Innovation

We measure innovation activities as patent counts and patent citations. Patents counts and patent citations are constructed from the 2006 edition of the NBER patent database (Hall, Jaffe, and Trajtenberg, 2001). This database covers 3.2 million patent grants and 23.6 million patent citations from 1976 to 2006. The database contains information such as patent assignees, their Compustat-mated identifiers, the number of citations received by each patent, and the technology class of the patents, etc.

Patents are included in the database only if they are eventually granted. Moreover, on average, a 2-year lag between patent application and patent grant exists. Because the database ends in 2006, patents applied in 2005 and 2006 may not be contained in the database. Thus, consistent with previous literature, we restrict our sample period in 2004 and year-fixed effects are also included in our analysis to address potential time truncation issues.[3]

However, patent counts are unable to perfectly capture whether innovation is successful since patents vary widely in their technological and economic significance

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[2] Following the innovation literature, we assign a value of 0 to firms with missing patent and citation counts that are not covered from NBER database.

[3] See Hall et al. (2001) for the detailed explanation.

(Hirshleifer et al., 2012). In comparison, citations received by patents better reflect patents' quality. Thus, our second measure of innovation is the total number of citations received by the patents applied for during the given year. We also employ citations per patent to precisely capture the significance and quality of its innovation output.

Since the sample has the finite length of time, raw citation counts encounter a time truncation bias. As patents receive citations over many years, patents created in the later year have less time to accumulate citations. Following Hall et al. (2001, 2005), the truncation problems in citations can be mitigated in two ways. First, each patent's citation count is adjusted by multiplying with the weighting index of Hall et al. (2001, 2005) provided in NBER database. The weighting index is constructed from estimating the citation-lag distribution. Hence, a newly created variable, *Qcitations*, is the sum of the adjusted patent citations across all patents applied for during each firm-year (Hirshleifer et al., 2012). Furthermore, the second adjustment way is from the fixed-effects approach. Specifically, to address this issue, we scale each raw citation count by the average citation count of all patents in the same technology class and year. Following Hirshleifer et al. (2012), the variable is denoted as *TTcitations*, the sum of the adjusted citation count across all patents applied for by the firm during the year.

3.3. Measuring Institutional Investor's Investment Horizons

All institutional investors with more than $100 million in securities should file their holdings on a quarter basis to the Securities and Exchange Commission (SEC). Our institutional investors' portfolio information is obtained from the Thomson's CDA/Spectrum database (form 13F) that collect a quarter filings of institutional holdings. To investigate the effect of institutional investment horizon on corporate innovation, we measure institutional investor horizon. Short-term institutional investors frequently trade their shares, whereas long-term institutional investors keep their positions unchangeable over a considerable long time. To implement this idea empirically, following Gaspar et al. (2005), we compute each institutional investor i's churn rate at quarter t, which measure how frequently an institutional investor rotates his stocks as follows:

$$CR_{i,t} = \frac{\sum_{j\epsilon Q}\left|N_{j,i,t}P_{j,t} - N_{j,i,t-1}P_{j,t-1} - N_{j,i,t-1}\Delta P_{j,t}\right|}{\sum_{j\in Q}\frac{N_{j,i,t}P_{j,t} + N_{j,i,t}P_{j,t-1}}{2}}, \quad (1)$$

Where Q is the set of companies held by investor i, $P_{j,t}$ is firm j's share price at quarter t and $N_{j,i,t}$ is the price of shares and the number of shares of company j held by institutional investor i at quarter t. A higher churn rate indicates a shorter investment horizon while a lower churn rate means a longer investment horizon.

Then, we calculate the investor turnover of firm k as the weighted average of the total portfolio churn rates of its investors over four quarters as follows:

$$Investor\ Turnover_k = \sum_{i\in S} W_{k,i,t}\left(\frac{1}{4}\sum_{r=1}^{4} CR_{i,t-r+1}\right), \quad (2)$$

Where S is the set of shareholders in company k and $W_{k,i,t}$ is the fraction of investor i's ownership in the total ownership held by institutional investors at quarter t.

Furthermore, as two other proxies for institutional investor horizon, we measure the firm's percentage ownership held by long-term institutional investors and by short-term institutional investors, respectively. Long-term (short-term) institutional investors are defined as investors whose *Turnover* is bottom (top) half. In order to show whether firms are held by higher long-term institutional ownership than short-term institutional ownership, we also create dummy variable equal to one if institutional ownership by long-term investors is higher than institutional ownership by short-term investors, otherwise zero.

3.4. Other Explanatory Variables

To separate the impact of institutional investors' horizons on corporate innovation, we control for other determinants that have been identified as important factors in motivating innovation from previous literature. R&D expenditures scaled by total assets are controlled in our regression analysis because it serves as important inputs for innovations.[4] Following Hall and Ziedonis (2001), we include firm size and capital intensity as our control variables, which are captured as the natural logarithm of total assets and the natural logarithm of the ratio of net property, plant, and equipment to the number of employees, respectively. Return on assets (*ROA*) is included as a proxy for profitability, and leverage (the ratio of the sum of long-term debt and short-term debt to book assets) and *Tobin's Q* (the market-to-book ratio) are contained to reflect the impacts of capital structure and growth opportunities, respectively. We also control for the ratio of cash to assets to capture cash holdings. To control the effects of firm's life cycle on innovation, we add firm age, which is defined as the natural log of the number of years that the firm appears in Compustat database. Capital expenditures are included as a control variable. As well, we control for product market competition, which is measured by the Herfindahl index constructed at the three-digit SIC level. Aghion et al. (2013) document that institutional ownership is positively related to innovation, and thus, aggregate institutional ownership is included as a control variable in our regression. Lastly, He and Tian (2013) argue that firms covered by a larger number of analysts engage in fewer innovative activities. We control for analyst coverage, which is calculated by the average number of analysts who provide earnings forecasts in a given year. We provide detailed variable definitions in Appendix.

3.5. Descriptive Statistics

Table 1 provides summary statistics of all variables. Panel A describes 25 percentile,

[4] Following a large number of innovation literature, we set firm-years with missing R&D expenditure to a zero value.

median, mean, 75 percentile, and standard deviation of variables representing innovation. The mean patent and raw citation counts are 5.447 and 46.495, respectively, but their median values are zero. Patent and raw citation counts are distributed as right-skewed with a zero value of median. Thus, to overcome this issue, following extant innovation literature, these variables are winsorized at the 99^{th} percentile and then are taken by the natural logarithm. The average log-transformed patent and raw citation counts are 0.663 and 1.158, respectively. Furthermore, *Qcitations* and *TTcitations*, which are adjusted to address a time truncation bias, are also highly skewed. We take the natural logarithm for these variables with the winsorization at the 99^{th} percentile and on average, the firms generate 1.363 *Qcitations* and 0.621 *TTcitations* every year. Additionally, descriptive statistics report that the average log-transformed raw and adjusted citations per patent are 0.683, 0.857, and 0.226, respectively.

[Insert Table 1 here]

Panel B and C of table 1 present descriptive statistics of main explanatory variables and control variables, respectively. The mean (median) institutional investor' turnover ratio is 0.191 (0.189). On average, long-term institutional ownership is higher than short-term institutional ownership in 40% of the firm-year observations. The long-term institutional investors own on average 13.2%, whereas the short-term institutional investors have 18.1% ownership. The mean ratio of R&D expenditure to total assets is 4% and the mean total assets are $723,093 million. Average ratio of property, plant, and equipment to the number of employees is 123.807. Average *ROA* is 0.086, average leverage is 0.235, average *Tobin's Q* is 1.906, and average ratio of cash to assets is 0.161. Furthermore, the mean *HIndex* is 0.158, the mean firm age is 15.897, and the mean ratio of capital expenditures to total assets is 0.072. The mean (median) institutional ownership and analyst average is 31.8% (27.2%) and 4.715

(2.167), respectively.[5] To mitigate outlier effect, all independent variables are winsorized at the 1% level at both tails. All independent variables are also lagged by one period.

4. Empirical Findings

4.1. Baseline Results

We run multivariate regressions to examine the impact of institutional investor's horizon on firms' innovative activities after controlling for other determinants identified in extant innovation literature. As control variables, a variety of firm characteristics are contained in our analysis. Table 2, 3, and 4 report our main results.

Table 2 presents the regression results that test the effect of institutional investor horizon on the number of patents, which is the fruits of innovative activities. In the model (1), we introduce *Turnover*, which is weighted average of churn rate of institutional investors, as the first proxy for investor horizon. As expected, the coefficient on our main variable, *Turnover*, is significantly negative, which indicates that an increase in institutional investors' turnover leads to a decrease in patent counts. In the line with our main hypothesis, this finding shows that the existence of long-term institutional investors facilitates corporate innovations.

[Insert Table 2 here]

In the model (2) – (5), the aggregate institutional ownership is excluded, and instead long-term and short-term institutional ownership are considered. In model (2), we use a dummy variable that takes the value of one when long-term institutional ownership is higher than short-term institutional ownership (*D(LTIO > STIO)*). The coefficient on *D(LTIO >*

[5] Following extant literature (e.g. Chang, Dasgupta, and Hilary, 2006; Chang et al., 2013), we assume that firms not covered by I/B/E/S database have no analyst coverage. Untabulated results show that our findings stay unchanged after removing firms that are not covered by I/B/E/S.

STIO) is significantly positive at 1% confidence level, suggesting that firms held by higher long-term investors engage in generating more patents. In model (3), we use long-term institutional ownership (*LTIO*) as a main explanatory variable and find that the coefficient on the variable is positive, but not significant. The coefficient on short-term institutional ownership (*STIO*) in model (4) is significantly negative. Model (5) in which both long-term and short-term institutional investors are included reveals that higher long-term institutional ownership is related to an increase in innovation, whereas higher short-term institutional ownership is likely to impede innovative activities.

The coefficient's sign of most control variables is as expected. For example, firms with more R&D expenditures, larger size, higher profitability, and less leverage tend to generate more patents. In addition, firms with higher market-to-book ratios, more cash holdings, and higher capital expenditures are related to more innovative activities. However, unlike He and Tian (2013), we find that analyst coverage has a positive effect on the patent.[6] The coefficient on institutional ownership is significantly negative, and this result is not consistent with the argument of Aghion et al. (2013), who find that greater institutional ownership motivates innovation. This disparate result is likely to stem from the opposite effect of short-term and long-term institutional ownership on corporate innovation.[7]

[Insert Table 3 here]

In Table 3, we employ the number of citations that it receives from subsequent

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[6] He and Tian (2013) describe that analyst coverage is negatively related to innovative outputs, whereas we find a positive relation. Extant literature reports similar results as ours (e.g. Chen et al., 2014 and Chang et al., 2013). Our results can be reconciled with findings of He and Tian (2013). They use firm fixed effects in all regressions while our analysis is based on industry and year fixed effects. In regressions with excluding firm fixed effects, they also find a significantly positive relation between analyst coverage and innovative activities. Furthermore, in our models controlling for firm fixed effects, its positive relation disappears and a negative coefficient on analyst coverage is shown even if it is not significant. See table 6 for this result.

[7] Our sample indicates that short-term institutional ownership is higher than long-term institutional ownership and firm-year observations with higher short-term institutional investors are more than those with higher long-term institutional investors. Thus, aggregate institutional ownership may be more held by short-term institutional investors compared to long-term institutional investors, making the result inconsistent with previous literature. Hirshleifer et al. (2012) show similar results. See Table 1 for its descriptive statistics.

patents as another proxy of corporate innovation. Panel A reports the regression analysis of institutional investors' horizon on *Qcitation* counts, which are adjusted using weighting index of Hall et al. (2001, 2005) to mitigate truncation bias problems. The coefficient on *Turnover* is significantly negative in model (1) and *D(LTIO > STIO)* is positively related to *Qcitation* counts in model (2). In addition, the coefficients on *LTIO* are positive in model (3) and (5) and statistically significant in model (5). Overall, those results indicate that the presence of long-term institutional investors encourages firms to invest in innovative activities. In Panel B, we use *TTcitation* count, which is adjusted using time-technology class fixed effect, as a dependent variable. The results are almost identical to those of *Qcitations*.

[Insert Table 4 here]

To clearly capture the extent to which innovative outputs are influential, we use average citations per patent as the proxy for innovation. Table 4 shows the results from regressions of citations per patent on institutional investor horizon. The results are very similar in both Panel A and B. A negative coefficient of *Turnover* in model (1) and a positive coefficient of *D(LTIO > STIO)* in model (2) indicate that more citations per patent are likely to be driven by long-term oriented institutional investors. Furthermore, the coefficients on *LTIO* are significantly positive in model (3) and (5), thus providing additionally supportive evidence on the positive effect of long-term institutional investors in motivating corporate innovation.

Taken together, the results reported in Table 2, 3, and 4 indicate that the presence of institutional investors with long-term investment horizon results in enhancing firm innovation. These results support our argument that the presence of long-term institutional investors prevent managerial myopia, and thus, force managers to more engage in innovation because long-term oriented institutional investors have more monitoring incentives and better information quality.

4.2. Analysis for Endogeneity

Our baseline findings show a strong positive association between institutional investment horizon and corporate innovation. However, our results can be subject to two types of endogeneity concern, omitted variable bias and reverse causality. To mitigate the omitted variable concern, *Turnover* lagged three years and five years instead of one year lagged *Turnover* is included as the main explanatory variable in the regressions because more lagged values of institutions' investment horizon should be less correlated with current omitted firm characteristics.[8]

[Insert Table 5 here]

Panel A and B of Table 5 report that there still exists a significantly negative relation between more distantly lagged *Turnover* and innovation outcomes, thus corroborating our previous results.

[Insert Table 6 here]

In Table 6, we also run the regressions including firm fixed effects to address the issues related to time-invariant omitted firm characteristics. The coefficients on *Turnover* are negative in all models and significant in model (1), (3), and (5), suggesting that institutions with longer term investment horizon tend to promote firms' innovative activities. The results are generally consistent with our main findings represented in the previous section.

While we document the casual relation running from institutional investment horizons to corporate innovation, some of the observed association could be attributable to institutional investors with long-term investment horizon which prefer to invest in more innovative firms. To alleviate this reverse casualty concern, following Elyasiani et al. (2010), we introduce a simultaneous equation approach with institutional investment horizons and

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[8] As well, employing more lagged values might be useful since the presence of institutions with different investment horizon could affect innovation with a lag.

corporate innovation as two endogenous variables. The two equations which are estimated simultaneously using three-stage least squares (3SLS) technique are as follows:

$$Innovation_{i,t} = \alpha_0 + \alpha_1 Turnover_{i,t\text{-}1} + \alpha_2 Controls_{i,t\text{-}1} + Year\ Dummies_t + Industry\ Dummies_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$Turnover_{i,t} = \beta_0 + \beta_1 Innovation_{i,t\text{-}1} + \beta_2 Controls_{i,t\text{-}1} + Year\ Dummies_t + Industry\ Dummies_{i,t} + \omega_{i,t} \quad (4)$$

The control variables used in Eq. (3) are the same as those in our previous regressions. Following extant literature (e.g. Elyasiani et al., 2012; Kim et al., 2014), the control variables in Eq. (4) include R&D expenditure, ROA, Tobin's Q, firm age, institutional ownership, and trading volume, defined as the ratio of the total number of shares traded to the number of shares outstanding.[9]

[Insert Table 7 here]

The results of the 3SLS regressions are presented in Table 7. The effect of innovation on *Turnover* is statistically insignificant in model (2) and (6), while the negative effect of *Turnover* on innovation remains statistically significant in all models. In model (4), (8), and (10), the coefficients on innovation variables are significantly positive, but it is not more corporate innovation that attracts the long-term institutional investors. In other words, this result does not mean that there exists the reverse casualty. Overall, the findings in 3SLS analysis show that our main results still hold, indicating that the effect of institutional investment horizon on corporate innovation is robust and casual.

5. Conclusion

This paper examines the impact of institutional investor's investment horizon on

[9] A firm with large stock trading volume tends to attract institutional investors with short-term investment horizon (Elyasiani et al., 2010), while the extent of stock trading volume is likely to have no effect on firm innovation.

corporate innovation. We hypothesize that the presence of long-term institutional investors provides a crucial power in driving corporate innovation since they tend to mitigate managerial short-termism by engaging in monitoring activities and generating more precise information, compared to short-term institutional investors.

Consistent with our argument, our findings show that innovative activities proxied by the number of patents, citations, and citations per patent significantly increase in the existence of institutional investors with a long-term investment horizon. Specifically, we find that turnover ratios of institutional investors are negatively related to innovation output. Our results also show that firms with higher long-term institutional ownership engage in more innovative activities relative to firms with higher short-term institutional ownership.

Our study contributes to the extant literature by shedding light on how the presence of institutional investors as a heterogeneous group influences corporate innovation. While previous literature focuses on the role of institutional investors as a homogeneous group on driving innovation, we add to this literature by examining the effect of institutional investment horizon on innovative activities of the firm. Our paper also contributes to the research on the relation between institutional investment horizons and long-term intangible investments. Bushee (1998) documents that firms with shorter horizon decrease R&D expenditures to increase short-term earnings. Instead of R&D expenditures that capture only one particular input, we use innovation output variables, which reveal the successful usage of all innovation inputs. Thus, we provide direct evidence on how the presence of institutions with different investment horizon is linked to corporate innovation.

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Appendix: Variable Definitions

Variable	Definition
Innovation Variables:	
Patent Count	Number of patents applied for during the year.
Raw Citation Count	The sum of the adjusted citations across all patents applied for during the year.
Qcitation Count	The sum of the adjusted citations across all patents applied for during the year. Each patent's citation count is adjusted by multiplying with the weighting index of Hall et al. (2001, 2005).
TTcitation Count	The sum of the adjusted citations across all patents applied for during the year. Each patent's citation count is divided by the average citation count of all patents in the same technology class and year.
Raw Citations per Patent	The average number of citations per patent.
Qcitations per Patent	The average number of adjusted citations per patent.
TTcitations per Patent	The average number of adjusted citations per patent.
Investment Horizon Variables:	
Turnover	Weighted average of institutional investors' churn rates.
D(LTIO – STIO)	Dummy variable equal to one if institutional ownership by long-term investors is higher than institutional ownership by short-term investors, and zero otherwise.
LTIO	Institutional ownership by long-term investors whose turnover is bottom half.
STIO	Institutional ownership by short-term investors whose turnover is top half.
Firm Characteristic Variables:	
R&D Expenditure	Research and development expenditures scaled by total assets. Missing values are set to a zero value.
Firm Size	The natural logarithm of total assets.
Capital Intensity	Net property, plant, and equipment per employee in thousands of dollars.
ROA	Ratio of operating income before depreciation to total assets.
Leverage	Ratio of the sum of short-term debt and long-term debt to total assets.
Tobin's Q	Ratio of market value to book value.
Cash Holdings	Ratio of cash to total assets.
Herfindahl Index	The sum of the squared share of each firm in total industry sales. The Herfindahl index is constructed based on sales at the three-digit SIC level.
Firm Age	Age of firm based on the years listed on Compustat.
Capital Expenditures	Capital expenditures scaled by total assets.
Institutional Ownership	Total institutional holdings of the firm.
Analyst Coverage	Arithmetic average of the 12 monthly numbers of earnings forecasts for the firm over fiscal year.

Table1: Summary Statistics

This table presents distributional statistics for variables used in our analysis. Panel A presents 25th percentile, medians, means, 75th percentile, standard deviations, and number of observations of innovation measures. Panel B and C report descriptive statistics of institutional investment horizon measures and firm characteristics, respectively. The sample includes 53,599 firm-year observations from 1980 to 2004.

Panel A: Innovation Measures

Variables	25%	Median	Mean	75%	SD	N
Patent Count	0.000	0.000	5.447	2.000	20.055	53,599
ln(1+Patent Count)	0.000	0.000	0.663	1.099	1.333	53,599
Citation (raw) Count	0.000	0.000	46.495	8.000	184.628	53,599
ln(1+ Citation Count)	0.000	0.000	1.158	2.197	1.910	53,599
Qcitation Count	0.000	0.000	80.336	16.213	312.360	53,599
ln(1+ Qcitation Count)	0.000	0.000	1.363	2.846	2.153	53,599
TTcitation Count	0.000	0.000	5.290	1.000	19.981	53,599
ln(1+ TTcitation Count)	0.000	0.000	0.621	0.693	1.125	53,599
Citations per Patent	0.000	0.000	3.485	3.000	7.782	53,599
ln(1+ Citations per Patent)	0.000	0.000	0.683	1.386	1.102	53,599
Qcitations per Patent	0.000	0.000	5.636	6.771	11.888	53,599
ln(1+ Qcitations per Patent)	0.000	0.000	0.857	2.050	1.298	53,599
TTcitations per Patent	0.000	0.000	0.325	1.000	0.464	53,599
ln(1+ TTcitations per Patent)	0.000	0.000	0.226	0.693	0.322	53,599

Panel B: Institutional Investment Horizon Measures

Variables	25%	Median	Mean	75%	SD	N
Turnover (%)	0.154	0.189	0.191	0.227	0.054	53,599
D(LTIO – STIO)	0.000	0.000	0.400	1.000	0.490	53,599
LTIO (%)	0.034	0.104	0.132	0.209	0.112	53,599
STIO (%)	0.038	0.144	0.181	0.292	0.160	53,599

Panel C: Firm Characteristics

Variables	25%	Median	Mean	75%	SD	N
R&D / Assets (%)	0.000	0.000	0.040	0.043	0.080	53,599
Assets ($millions)	41.003	137.955	723.093	579.044	1372.626	53,599
PPE / #Emp. ($thousands)	13.058	26.086	123.807	64.070	342.869	53,599
ROA (%)	0.050	0.118	0.086	0.177	0.179	53,599
Leverage (%)	0.048	0.203	0.235	0.362	0.209	53,599
Tobin's Q	1.027	1.337	1.906	2.075	1.633	53,599
Cash / Assets (%)	0.021	0.074	0.161	0.224	0.201	53,599
Herfindahl Index	0.069	0.122	0.158	0.199	0.125	53,599
Firm Age (Years)	7.000	11.000	15.897	23.000	12.291	53,599
CapExp / Assets (%)	0.024	0.050	0.072	0.090	0.074	53,599
Institutional Ownership (%)	0.098	0.272	0.318	0.513	0.244	53,599
Analyst Coverage	0.000	2.167	4.715	6.333	6.332	53,599

Table 2. Institutional Investment Horizons and Patent Counts

This table presents the results of regressions of patent counts on institutional investor horizon. *Patent count* is the number of patents applied for during the year. *Turnover* is the weighted average of institutional investors' churn rates. *D(LTIO > STIO)* is a dummy variable equal to 1 if *LTIO* is higher than *STIO*, and 0 otherwise. *LTIO* is long-term institutional ownership and *STIO* is short-term institutional ownership. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. All regressions include year and industry fixed effects, defined based on three-digit SIC codes. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5%, and 1% is indicated by *, **, ***, respectively.

	Dependent variable = ln(1+Patent count)				
Variables	(1)	(2)	(3)	(4)	(5)
Turnover	-0.710***				
	(-5.16)				
D(LTIO > STIO)		0.104***			
		(6.20)			
LTIO			0.077		0.196*
			(0.66)		(1.72)
STIO				-0.482***	-0.504***
				(-5.31)	(-5.62)
R&D / Assets	2.404***	2.397***	2.389***	2.406***	2.399***
	(11.99)	(11.97)	(11.92)	(12.00)	(11.95)
ln(Assets)	0.282***	0.271***	0.265***	0.280***	0.277***
	(19.34)	(20.24)	(19.49)	(19.79)	(19.33)
ln(PPE / #Employees)	0.010	0.011	0.013	0.011	0.011
	(0.87)	(0.95)	(1.09)	(0.94)	(0.95)
ROA	0.228***	0.204***	0.179***	0.232***	0.229***
	(3.55)	(3.20)	(2.82)	(3.62)	(3.58)
Leverage	-0.226***	-0.208***	-0.205***	-0.224***	-0.216***
	(-4.44)	(-4.15)	(-4.05)	(-4.41)	(-4.24)
Tobin's Q	0.055***	0.053***	0.051***	0.055***	0.055***
	(8.97)	(8.69)	(8.46)	(8.90)	(8.97)
Cash / Assets	0.168***	0.159***	0.147**	0.163***	0.166***
	(2.93)	(2.76)	(2.53)	(2.83)	(2.88)
HIndex	0.088	0.085	0.075	0.084	0.082
	(0.91)	(0.88)	(0.78)	(0.87)	(0.85)
ln(1+Firm age)	0.189***	0.184***	0.195***	0.190***	0.184***
	(11.10)	(10.94)	(11.30)	(11.25)	(10.94)
Capex / Assets	0.224**	0.220**	0.199*	0.215**	0.217**
	(2.05)	(2.01)	(1.82)	(1.97)	(1.98)
ln(1+Analyst coverage)	0.123***	0.107***	0.099***	0.128***	0.123***
	(7.10)	(6.62)	(6.14)	(7.37)	(7.09)
Institutional Ownership	-0.238***				
	(-3.54)				
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Number of obs.	40,144	40,144	40,144	40,144	40,144
Adjusted R^2	0.597	0.597	0.596	0.598	0.598

Table 3. Institutional Investment Horizons and Patent Citations

This table reports the results of regressions of patent citations on institutional investor horizon. *Qcitation* (*TTcitation*) count is the total adjusted number of citations to all patents applied for over the year. *Qcitation* count is defined by the raw citation count number for each patent multiplied by the weighting index of Hall et al. (2001). *TTcitation* count is measured by the raw citation count number for each patent divided by the average citation count of all patents in the same technology class applied for in the same year. *Turnover* is the weighted average of institutional investors' churn rates. *D(LTIO > STIO)* is a dummy variable equal to 1 if *LTIO* is higher than *STIO*, and 0 otherwise. *LTIO* is long-term institutional ownership and *STIO* is short-term institutional ownership. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. All regressions include year and industry fixed effects, defined based on three-digit SIC codes. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5%, and 1% is indicated by *, **, ***, respectively.

	Panel A: Dependent variable = ln(1+Qcitation count)				
Variables	(1)	(2)	(3)	(4)	(5)
Turnover	-0.963***				
	(-3.98)				
D(LTIO > STIO)		0.170***			
		(6.14)			
LTIO			0.282		0.450**
			(1.43)		(2.33)
STIO				-0.661***	-0.710***
				(-4.40)	(-4.78)
R&D / Assets	4.852***	4.848***	4.829***	4.858***	4.843***
	(12.41)	(12.41)	(12.37)	(12.43)	(12.38)
ln(Assets)	0.435***	0.423***	0.411***	0.436***	0.429***
	(18.57)	(19.50)	(18.59)	(19.11)	(18.55)
ln(PPE / #Employees)	0.023	0.023	0.026	0.024	0.024
	(1.12)	(1.15)	(1.28)	(1.16)	(1.17)
ROA	0.402***	0.383***	0.338***	0.415***	0.410***
	(3.17)	(3.03)	(2.68)	(3.28)	(3.23)
Leverage	-0.436***	-0.415***	-0.404***	-0.436***	-0.419***
	(-4.80)	(-4.62)	(-4.47)	(-4.83)	(-4.62)
Tobin's Q	0.093***	0.091***	0.089***	0.093***	0.094***
	(7.91)	(7.80)	(7.62)	(7.90)	(8.00)
Cash / Assets	0.424***	0.417***	0.398***	0.419***	0.424***
	(4.01)	(3.95)	(3.76)	(3.96)	(4.02)
HIndex	0.059	0.060	0.042	0.056	0.050
	(0.35)	(0.36)	(0.25)	(0.33)	(0.30)
ln(1+Firm age)	0.308***	0.298***	0.312***	0.310***	0.297***
	(10.68)	(10.47)	(10.69)	(10.89)	(10.31)
Capex / Assets	0.480**	0.481**	0.447**	0.469**	0.473**
	(2.46)	(2.47)	(2.30)	(2.41)	(2.43)
ln(1+Analyst coverage)	0.230***	0.214***	0.197***	0.241***	0.230***
	(7.63)	(7.47)	(6.87)	(7.98)	(7.62)
Institutional Ownership	-0.275**				
	(-2.45)				

Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Number of obs.	40,144	40,144	40,144	40,144	40,144
Adjusted R^2	0.585	0.585	0.585	0.586	0.586

	Panel B: Dependent variable = ln(1+TTcitation count)				
Variables	(1)	(2)	(3)	(4)	(5)
Turnover	-0.714***				
	(-5.19)				
D(LTIO > STIO)		0.108***			
		(6.33)			
LTIO			0.005		0.136
			(0.04)		(1.19)
STIO				-0.540***	-0.555***
				(-5.89)	(-6.11)
R&D / Assets	2.279***	2.270***	2.265***	2.280***	2.275***
	(11.36)	(11.32)	(11.28)	(11.37)	(11.32)
ln(Assets)	0.275***	0.261***	0.257***	0.273***	0.271***
	(18.85)	(19.56)	(18.89)	(19.24)	(18.84)
ln(PPE / #Employees)	0.006	0.007	0.009	0.007	0.007
	(0.54)	(0.63)	(0.77)	(0.61)	(0.62)
ROA	0.249***	0.219***	0.195***	0.252***	0.251***
	(3.93)	(3.49)	(3.11)	(3.99)	(3.96)
Leverage	-0.241***	-0.219***	-0.219***	-0.237***	-0.232***
	(-4.73)	(-4.37)	(-4.33)	(-4.67)	(-4.54)
Tobin's Q	0.053***	0.051***	0.049***	0.053***	0.053***
	(8.61)	(8.28)	(8.02)	(8.56)	(8.60)
Cash / Assets	0.121**	0.111*	0.097*	0.116**	0.118**
	(2.11)	(1.93)	(1.68)	(2.03)	(2.06)
HIndex	0.094	0.091	0.081	0.090	0.088
	(0.99)	(0.95)	(0.85)	(0.95)	(0.93)
ln(1+Firm age)	0.187***	0.181***	0.194***	0.186***	0.182***
	(11.00)	(10.77)	(11.28)	(11.07)	(10.86)
Capex / Assets	0.234**	0.230**	0.208*	0.226**	0.227**
	(2.16)	(2.11)	(1.91)	(2.08)	(2.09)
ln(1+Analyst coverage)	0.133***	0.113***	0.107***	0.137***	0.133***
	(7.64)	(6.98)	(6.60)	(7.85)	(7.64)
Institutional Ownership	-0.287***				
	(-4.26)				
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Number of obs.	40,144	40,144	40,144	40,144	40,144
Adjusted R^2	0.567	0.566	0.564	0.567	0.567

Table 4. Institutional Investment Horizons and Citations per Patent

This table reports the results of regressions of average citations per patent on institutional investor horizon. *Qcitation* (*TTcitation*) count per patent is the adjusted number of citations per patent applied for over the year. *Turnover* is the weighted average of institutional investors' churn rates. *D(LTIO > STIO)* is a dummy variable equal to 1 if *LTIO* is higher than *STIO*, and 0 otherwise. *LTIO* is long-term institutional ownership and *STIO* is short-term institutional ownership. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. All regressions include year and industry fixed effects, defined based on three-digit SIC codes. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5%, and 1% is indicated by *, **, ***, respectively.

	Panel A: Dependent variable = ln(1+Qcitation count per patent)				
Variables	(1)	(2)	(3)	(4)	(5)
Turnover	-0.302**				
	(-2.19)				
D(LTIO > STIO)		0.064***			
		(4.54)			
LTIO			0.355***		0.391***
			(3.35)		(3.78)
STIO				-0.111	-0.154**
				(-1.47)	(-2.08)
R&D / Assets	2.810***	2.817***	2.800***	2.817***	2.803***
	(11.76)	(11.77)	(11.73)	(11.78)	(11.73)
ln(Assets)	0.167***	0.170***	0.161***	0.171***	0.165***
	(14.57)	(15.66)	(14.58)	(15.24)	(14.50)
ln(PPE / #Employees)	0.017	0.017	0.018	0.017	0.017
	(1.56)	(1.51)	(1.62)	(1.56)	(1.57)
ROA	0.141*	0.155**	0.132*	0.152*	0.147*
	(1.79)	(1.96)	(1.67)	(1.93)	(1.87)
Leverage	-0.216***	-0.219***	-0.205***	-0.223***	-0.208***
	(-4.21)	(-4.30)	(-4.00)	(-4.35)	(-4.05)
Tobin's Q	0.042***	0.042***	0.042***	0.042***	0.043***
	(5.76)	(5.84)	(5.82)	(5.77)	(5.93)
Cash / Assets	0.335***	0.338***	0.333***	0.334***	0.339***
	(5.26)	(5.33)	(5.25)	(5.24)	(5.33)
HIndex	-0.043	-0.038	-0.048	-0.041	-0.046
	(-0.44)	(-0.38)	(-0.49)	(-0.42)	(-0.47)
ln(1+Firm age)	0.134***	0.132***	0.130***	0.138***	0.127***
	(8.60)	(8.48)	(8.24)	(8.95)	(8.06)
Capex / Assets	0.210*	0.215*	0.203*	0.206*	0.209*
	(1.90)	(1.95)	(1.85)	(1.86)	(1.90)
ln(1+Analyst coverage)	0.097***	0.102***	0.089***	0.105***	0.096***
	(6.01)	(6.59)	(5.70)	(6.56)	(5.98)
Institutional Ownership	0.040				
	(0.68)				

Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Number of obs.	40,144	40,144	40,144	40,144	40,144
Adjusted R^2	0.525	0.525	0.525	0.525	0.525

	Panel B: Dependent variable = ln(1+TTcitation count per patent)				
Variables	(1)	(2)	(3)	(4)	(5)
Turnover	-0.121***				
	(-3.62)				
D(LTIO > STIO)		0.017***			
		(4.95)			
LTIO			0.114***		0.126***
			(4.22)		(4.78)
STIO				-0.036**	-0.050***
				(-2.00)	(-2.84)
R&D / Assets	0.675***	0.677***	0.672***	0.678***	0.673***
	(12.56)	(12.58)	(12.53)	(12.58)	(12.52)
ln(Assets)	0.047***	0.047***	0.045***	0.048***	0.046***
	(15.77)	(16.82)	(15.60)	(16.47)	(15.59)
ln(PPE / #Employees)	0.003	0.003	0.003	0.003	0.003
	(0.96)	(0.93)	(1.06)	(0.98)	(1.00)
ROA	0.020	0.022	0.016	0.022	0.021
	(1.11)	(1.28)	(0.90)	(1.28)	(1.19)
Leverage	-0.060***	-0.061***	-0.057***	-0.062***	-0.058***
	(-4.69)	(-4.80)	(-4.41)	(-4.87)	(-4.49)
Tobin's Q	0.011***	0.011***	0.011***	0.011***	0.011***
	(6.72)	(6.73)	(6.72)	(6.67)	(6.90)
Cash / Assets	0.075***	0.075***	0.074***	0.074***	0.076***
	(5.03)	(5.05)	(4.97)	(4.97)	(5.08)
HIndex	-0.023	-0.022	-0.025	-0.023	-0.024
	(-0.94)	(-0.90)	(-1.02)	(-0.94)	(-1.00)
ln(1+Firm age)	0.041***	0.040***	0.039***	0.042***	0.038***
	(10.25)	(10.30)	(9.87)	(10.80)	(9.65)
Capex / Assets	0.001	0.001	-0.002	-0.001	-0.000
	(0.03)	(0.04)	(-0.07)	(-0.04)	(-0.00)
ln(1+Analyst coverage)	0.019***	0.020***	0.016***	0.021***	0.019***
	(4.58)	(5.12)	(4.08)	(5.22)	(4.52)
Institutional Ownership	0.012				
	(0.79)				
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Number of obs.	40,144	40,144	40,144	40,144	40,144
Adjusted R^2	0.562	0.562	0.563	0.562	0.563

Table 5. Institutional Investment Horizons and Innovation Outcomes: Using the *Turnover* Variable Lagged 3 and 5 Years

This table reports the results of regressions of innovation outcomes on institutional investor horizon. *Patent* count is the number of patents applied for during the year. *Qcitation* (TTcitation) count is the total adjusted number of citations to all patents applied for over the year. *Qcitation* count is defined by the raw citation count number for each patent multiplied by the weighting index of Hall et al. (2001). *TTcitation* count is measured by the raw citation count number for each patent divided by the average citation count of all patents in the same technology class applied for in the same year. *Qcitation* (*TTcitation*) count per patent is the adjusted number of citations per patent applied for over the year. *Turnover* is the weighted average of institutional investors' churn rates. All independent variables are lagged by 3 years and 5 years. Variable definitions are provided in the Appendix. All regressions include year and industry fixed effects, defined based on three-digit SIC codes. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5%, and 1% is indicated by *, **, ***, respectively.

	ln(1+Patent count)	ln(1+Qcitation count)	ln(1+TTcitation count)	ln(1+Qcitation count per patent)	ln(1+TTcitation count per patent)
	Panel A: Three-year lagged				
Variables	(1)	(2)	(3)	(4)	(5)
Turnover	-0.775***	-1.211***	-0.807***	-0.465***	-0.161***
	(-4.42)	(-3.95)	(-4.56)	(-2.74)	(-3.85)
R&D / Assets	2.922***	5.362***	2.796***	2.793***	0.718***
	(10.54)	(10.35)	(9.98)	(9.26)	(10.45)
ln(Assets)	0.305***	0.449***	0.294***	0.159***	0.046***
	(17.04)	(15.66)	(16.41)	(11.57)	(12.98)
ln(PPE / #Employees)	0.009	0.012	0.005	0.007	0.001
	(0.60)	(0.44)	(0.33)	(0.47)	(0.37)
ROA	0.447***	0.532***	0.472***	0.028	0.016
	(5.06)	(3.16)	(5.37)	(0.27)	(0.70)
Leverage	-0.189***	-0.386***	-0.211***	-0.199***	-0.053***
	(-2.85)	(-3.31)	(-3.17)	(-3.08)	(-3.29)
Tobin's Q	0.051***	0.070***	0.043***	0.027***	0.008***
	(6.65)	(4.92)	(5.51)	(3.18)	(4.36)
Cash / Assets	0.199***	0.355***	0.137*	0.237***	0.058***
	(2.73)	(2.72)	(1.89)	(3.13)	(3.22)
HIndex	-0.028	-0.141	-0.034	-0.109	-0.046
	(-0.23)	(-0.69)	(-0.29)	(-0.93)	(-1.58)

ln(1+Firm age)	0.169***	0.270***	0.164***	0.117***	0.035***
	(8.81)	(8.26)	(8.56)	(6.56)	(7.90)
Capex / Assets	0.325**	0.733***	0.387***	0.312**	0.018
	(2.32)	(3.02)	(2.77)	(2.36)	(0.57)
ln(1+Analyst coverage)	0.132***	0.261***	0.149***	0.113***	0.022***
	(6.14)	(7.08)	(6.89)	(5.95)	(4.49)
Institutional Ownership	-0.208**	-0.186	-0.255***	0.096	0.018
	(-2.48)	(-1.33)	(-3.04)	(1.34)	(1.00)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Number of obs.	27,958	27,958	27,958	27,958	27,958
Adjusted R^2	0.624	0.609	0.590	0.549	0.586

	Panel B: Five-year lagged				
Variables	(1)	(2)	(3)	(4)	(5)
Turnover	-0.822***	-1.221***	-0.812***	-0.447**	-0.122**
	(-3.61)	(-3.17)	(-3.54)	(-2.18)	(-2.40)
R&D / Assets	3.419***	5.520***	3.116***	2.618***	0.682***
	(9.32)	(8.38)	(8.33)	(7.21)	(8.10)
ln(Assets)	0.332***	0.470***	0.320***	0.153***	0.046***
	(14.92)	(13.27)	(14.31)	(9.21)	(10.74)
ln(PPE / #Employees)	0.005	-0.011	-0.003	-0.012	-0.002
	(0.26)	(-0.33)	(-0.13)	(-0.69)	(-0.54)
ROA	0.560***	0.545**	0.577***	-0.080	-0.006
	(4.71)	(2.46)	(4.83)	(-0.63)	(-0.22)
Leverage	-0.169**	-0.310**	-0.191**	-0.143*	-0.047**
	(-2.03)	(-2.13)	(-2.28)	(-1.82)	(-2.37)
Tobin's Q	0.045***	0.049***	0.033***	0.016	0.007***
	(4.53)	(2.71)	(3.24)	(1.58)	(2.92)
Cash / Assets	0.202**	0.375**	0.155*	0.227**	0.048**
	(2.17)	(2.30)	(1.65)	(2.47)	(2.15)
HIndex	-0.112	-0.225	-0.092	-0.122	-0.051

	(-0.78)	(-0.92)	(-0.64)	(-0.86)	(-1.52)
ln(1+Firm age)	0.136***	0.208***	0.124***	0.092***	0.028***
	(6.22)	(5.52)	(5.67)	(4.49)	(5.50)
Capex / Assets	0.387**	0.889***	0.455**	0.386**	0.011
	(2.19)	(2.97)	(2.55)	(2.48)	(0.28)
ln(1+Analyst coverage)	0.138***	0.279***	0.159***	0.122***	0.023***
	(5.26)	(6.35)	(6.05)	(5.55)	(4.16)
Institutional Ownership	-0.178*	-0.109	-0.228**	0.143*	0.019
	(-1.69)	(-0.63)	(-2.15)	(1.65)	(0.87)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Number of obs.	19,754	19,754	19,754	19,754	19,754
Adjusted R^2	0.648	0.630	0.612	0.572	0.610

Table 6. Institutional Investment Horizons and Innovation Outcomes: Controlling for Firm Fixed Effects

This table reports the results of regressions of innovation outcomes on institutional investor horizon. *Patent* count is the number of patents applied for during the year. *Qcitation* (*TTcitation*) count is the total adjusted number of citations to all patents applied for over the year. *Qcitation* count is defined by the raw citation count number for each patent multiplied by the weighting index of Hall et al. (2001). *TTcitation* count is measured by the raw citation count number for each patent divided by the average citation count of all patents in the same technology class applied for in the same year. *Qcitation* (*TTcitation*) count per patent is the adjusted number of citations per patent applied for over the year. *Turnover* is the weighted average of institutional investors' churn rates. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. All regressions include year and firm fixed effects, defined based on three-digit SIC codes. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5%, and 1% is indicated by *, **, ***, respectively.

	ln(1+Patent count)	ln(1+Qcitation count)	ln(1+TTcitation count)	ln(1+Qcitation count per patent)	ln(1+TTcitation count per patent)
Variables	(1)	(2)	(3)	(4)	(5)
Turnover	-0.087*	-0.053	-0.114**	-0.050	-0.032**
	(-1.71)	(-0.50)	(-1.97)	(-0.70)	(-2.47)
R&D / Assets	0.490***	1.198***	0.601***	0.568***	0.095***
	(3.64)	(4.41)	(3.73)	(3.22)	(2.63)
ln(Assets)	0.148***	0.119***	0.147***	0.033**	0.002
	(9.29)	(5.48)	(8.63)	(2.45)	(0.89)
ln(PPE / #Employees)	0.022***	0.016	0.022**	-0.008	-0.001
	(2.70)	(1.03)	(2.32)	(-0.73)	(-0.44)
ROA	0.009	0.154**	0.025	0.126***	0.000
	(0.26)	(2.23)	(0.63)	(2.78)	(0.04)
Leverage	-0.116***	-0.265***	-0.166***	-0.094**	-0.027***
	(-3.74)	(-4.20)	(-4.44)	(-2.38)	(-3.39)
Tobin's Q	0.016***	0.021***	0.020***	-0.000	0.002**
	(4.57)	(2.86)	(4.89)	(-0.01)	(2.47)
Cash / Assets	0.019	0.082	0.040	0.054	0.014*
	(0.51)	(1.17)	(0.95)	(1.11)	(1.72)
HIndex	0.027	0.202*	0.065	0.174**	0.021
	(0.40)	(1.81)	(0.89)	(2.19)	(1.57)
ln(1+Firm age)	0.014	0.166***	0.072***	0.113***	0.022***
	(0.68)	(4.59)	(3.06)	(4.96)	(5.13)

Capex / Assets	-0.087*	-0.022	-0.111**	0.093*	-0.013
	(-1.94)	(-0.25)	(-2.18)	(1.69)	(-1.30)
ln(1+Analyst coverage)	-0.009	-0.011	-0.007	-0.004	0.001
	(-1.13)	(-0.70)	(-0.82)	(-0.39)	(0.45)
Institutional Ownership	-0.108***	-0.270***	-0.168***	-0.120***	-0.034***
	(-2.81)	(-4.03)	(-3.91)	(-2.83)	(-4.42)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Number of obs.	40,144	40,144	40,144	40,144	40,144
Adjusted R^2	0.921	0.897	0.881	0.873	0.913

Table 7. Three-Stage Least Squares (3SLS) Results

This table provides the results of simultaneous equation analysis using three-stage least squares (3SLS) procedure to address the effects of institutional investor horizons on corporate innovation. *Patent* count is the number of patents applied for during the year. *Qcitation* (*TTcitation*) count is the total adjusted number of citations to all patents applied for over the year. *Qcitation* count is defined by the raw citation count number for each patent multiplied by the weighting index of Hall et al. (2001). *TTcitation* count is measured by the raw citation count number for each patent divided by the average citation count of all patents in the same technology class applied for in the same year. *Qcitation* (*TTcitation*) count per patent is the adjusted number of citations per patent applied for over the year. *Turnover* is the weighted average of institutional investors' churn rates. *Trading Volume* is defined as the average monthly trading volume normalized by the number of shares outstanding. All independent variables are lagged by 1 year. Definitions for all other variables are provided in the Appendix. All regressions include year and industry fixed effects, defined based on three-digit SIC codes. *t*-statistics are in parentheses. Significance at the 10%, 5%, and 1% is indicated by *, **, ***, respectively.

Dependent Variable	ln(1+Patent)	Turnover	ln(1+Qcitation)	Turnover	ln(1+TTcitation)	Turnover	ln(1+Qcitation per patent)	Turnover	ln(1+TTcitation per patent)	Turnover
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(1+Patent)		0.000								
		(1.34)								
ln(1+Qcitation)				0.001***						
				(3.44)						
ln(1+TTcitation)						0.000				
						(0.92)				
ln(1+Qcitation per patent)								0.001***		
								(5.11)		
ln(1+TTcitation per patent)										0.003***
										(2.28)
Turnover	-0.679***		-0.888***		-0.686***		-0.246**		-0.112***	
	(-7.66)		(-5.40)		(-7.52)		(-2.49)		(-4.74)	
R&D / Assets	2.413***	0.028***	4.880***	0.026***	2.298***	0.028***	2.829***	0.025***	0.684***	0.026***
	(28.81)	(5.87)	(31.40)	(5.47)	(26.66)	(5.93)	(30.28)	(5.17)	(30.55)	(5.54)
ln(Assets)	0.293***		0.451***		0.286***		0.172***		0.048***	
	(61.00)		(50.54)		(57.78)		(32.12)		(37.12)	
ln(PPE/#Employees)	0.005		0.016*		0.002		0.015**		0.002	
	(0.99)		(1.67)		(0.39)		(2.55)		(1.43)	
ROA	0.227***	0.015***	0.397***	0.014***	0.249***	0.015***	0.133***	0.014***	0.018**	0.015***
	(6.95)	(8.02)	(6.55)	(7.91)	(7.42)	(8.05)	(3.66)	(7.95)	(2.08)	(8.04)
Leverage	-0.239***		-0.457***		-0.255***		-0.226***		-0.062***	
	(-9.37)		(-9.66)		(-9.70)		(-7.92)		(-9.07)	
Tobin's Q	0.054***	0.002***	0.091***	0.002***	0.052***	0.002***	0.040***	0.002***	0.010***	0.002***
	(17.32)	(10.22)	(15.64)	(10.05)	(16.18)	(10.25)	(11.55)	(9.93)	(12.09)	(10.12)
Cash / Assets	0.166***		0.434***		0.120***		0.347***		0.077***	
	(5.68)		(8.02)		(3.99)		(10.68)		(9.91)	

HIndex	0.092		0.080		0.100		-0.026		-0.020	
	(1.41)		(0.66)		(1.49)		(-0.36)		(-1.14)	
ln(1+Firm age)	0.192***	-0.010***	0.316***	-0.010***	0.189***	-0.010***	0.140***	-0.010***	0.042***	-0.010***
	(29.64)	(-26.66)	(26.21)	(-27.34)	(28.36)	(-26.59)	(19.32)	(-27.78)	(24.03)	(-27.33)
Capex / Assets	0.313***		0.615***		0.319***		0.265***		0.015	
	(4.32)		(4.57)		(4.27)		(3.27)		(0.77)	
ln(1+Analyst coverage)	0.115***		0.216***		0.126***		0.089***		0.017***	
	(15.94)		(16.06)		(16.87)		(10.97)		(8.74)	
Institutional Ownership	-0.268***	0.036***	-0.299***	0.035***	-0.314***	0.036***	0.044	0.035***	0.013*	0.035***
	(-10.14)	(29.03)	(-6.09)	(28.57)	(-11.54)	(29.21)	(1.48)	(28.69)	(1.79)	(28.99)
Trading Volume		0.004***		0.004***		0.004***		0.004***		0.004***
		(19.30)		(19.17)		(19.31)		(19.10)		(19.24)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	38,190	38,190	38,190	38,190	38,190	38,190	38,190	38,190	38,190	38,190
Adjusted R^2	0.603	0.234	0.591	0.234	0.573	0.234	0.531	0.234	0.568	0.234