The Effect of Institutional Ownership on Innovation: New Evidence

Chunlai Ye
Texas A&M University-Corpus Christi

Lin-Hui Yu
National Taiwan University

We follow Bushee (2001) and classify institutional investors into long-term and short-term investors. We find that that long-term institutional ownership is positively associated with innovative quality. However, we do not find such an association for short-term owners. Our results suggest that long investment horizons give institutional holders incentives to engage in monitoring activities and improve the subsequent performance in innovation. We also find that when firms have less growth potential, more years in operation, or financial constraints, long-term institutional owners are positively associated with innovative quality, suggesting that long-term investors exert a monitoring effort when direct monitoring becomes more important.

Keywords: Citation, Institutional Ownership, Innovation, Patent

INTRODUCTION

Innovation is the key element in firms' generating rents from their competitive advantages, and thus how to expand the scope and sustain the persistence of these advantages has always been of interest among capital market participants—including investors, financial institutions, and researchers (e.g., Raz, Shenhar, and Dvir 2002; Lawson, Samson, and Roden 2012; Hirshleifer, Hsu, and Li 2013). While Porter (1992) stresses the importance of continual investment in physical and intangible assets in order to sustain and upgrade competitive advantages, there has been a concern that US firms tend to underinvest in R&D because of a divergence of interests among managers and shareholders that impedes firms' allocation of resources to the projects with the highest payoff. Given the importance of innovation, we focus on one of the most important participants in the capital market—institutional owners, who control over 75% of outstanding equity in the US market (Aguilar 2013)—and provide evidence for the long debate on whether institutional owners enhance or impede innovation.

Institutional ownership may impede innovation because innovative projects, which aim to develop new technologies, find new business methods, or invent new products or services, are risky and challenging. The pressure of periodic financial reporting as requested by stock exchanges and the high uncertainty in innovation activities may induce managers to focus more on current earnings and engage in myopic behavior, hurting firms' long-term innovative abilities (Porter, 1992; Graves, 1988; Bushee, 2001; He & Tian, 2013; Aghion, Van Reenen, and Zingales 2013). Thus, institutional owners may have a negative causal effect on firm innovation.

On the other hand, institutional ownership may enhance innovation. Institutional owners' large holdings and the ability to process complex information give them incentives to monitor managers. Moral hazard models proposed by Grossman and Hart (1983) and Harris and Raviv (1991) predict that managers tend to invest sub-optimally if they are not properly monitored. Thus, if institutional investors monitor and exert influence over managers, institutional owners may have a positive effect on firm innovation.

Because of the two competing hypotheses, the question of whether institutional ownership enhances or impedes innovation has been an open debate, and the empirical evidence remains mixed. Specifically, while Hirshleifer, Low, and Teoh (2012) find that institutional ownership is negatively associated with innovation, He and Tian (2013) and Aghion et al. (2013) document a positive association. To add to the debate as to whether institutional ownership induces managerial short-termism or improves innovative activities, we propose that the types of institutional owners explain the differences in subsequent innovative performance.

We follow Bushee's (2001) classification and refer to "dedicated" investors as holding large investments in investee firms and having low-turnover trading behavior; "quasi-indexers" as having diversified portfolios and low turnover; and "transient" investors as having diversified portfolios and high turnover. Because dedicated institutional investors have a long investment horizon and sizable ownership, they are incentivized to monitor corporate behavior to ensure long-term profitability. Quasi-indexers are also active in monitoring activities, as their lack of the flexibility to "vote with their feet" motivates them to influence managerial actions (Carleton, Nelson, and Weisbach 1998; Appel, Gormley, and Keim 2016; Khan, Srinivasan, and Tan 2017). In other words, both dedicated and quasi-indexer institutional investors have long investment horizons, and thus are incentivized to engage in monitoring activities. On the other hand, transient investors are less interested in exerting monitoring effort as their diversified portfolios and short investment horizons make monitoring too costly and not feasible (e.g., Bushee, 2001; Dikolli, Kulp, & Sedatole, 2009). Consistent with the view that investment horizons of institutional owners are associated with the incentive to monitor, prior literature finds that different types of institutional investors are associated with heterogeneous effects on financial reporting and corporate behavior (e.g., Ajinkya, Bhojraj, & Sengupta, 2005; Ramalingegowda and Yu 2012). Following these studies, we predict that the various length of investment horizons of institutional owners are associated with heterogeneity in innovation outputs.

Our results are consist with prior literature suggesting that long-term investors (that is, dedicated investors and quasi-indexers) exert monitoring effort and improve governance and corporate performances (Appel, Gormley, and Keim 2016; Bird and Karolyi 2017; Khan, Srinivasan, and Tan 2017) and are consistent with the literature suggesting that transient investors are less interested in monitoring activities and their frequent buy-and-sell trading behavior encourages managers to focus more on near-term earnings at the expense of long-term value (Bushee 1998; Gaspar, Massa, and Matos 2005; Burns, Kedia, and Lipson 2010).

To investigate whether investment horizons play a role in institutional investors' monitoring effort and affect subsequent innovative performance, we examine 23,744 firm-year observations representing 3,599 US firms over 1981-2003 and use two proxies for innovative quality: (1) the number of patents granted and (2) the number of citations of the patents adjusted for peer performances in the same technological class (Luong et al. 2017; Sunder, Sunder, and Zhang 2017).

In support of our prediction, we find that long-term institutional ownership, including dedicated and quasi-indexing investors, is positively associated with innovative quality in investee companies. However, we do not find a positive association between transient institutional ownership and innovative quality. In fact, we find that transient investors are *negatively* associated with the number of patents granted and are not associated with the number of citations. Taken together, our results are consistent with the views that long investment horizons motivate long-term institutional owners to participate in monitoring activities and that firms under more scrutiny from long-term institutional holders perform better in innovative activities. We do not find evidence to suggest that transient investors improve innovation through active monitoring but provide some evidence that transient investors impede innovation.

Next, we examine whether firm fundamentals are associated with the extent of monitoring needed and subsequently affect the association between types of institutional ownership and innovation. We find that long-term investors are positively associated with innovative quality when firms have fewer growth options. However, we fail to document this association when firms have more growth opportunities. The results are consistent with the view that long-term institutional owners monitor managers closely when managers perceive the benefits of engaging in innovating activities to be low and are likely to slack off (Grossman and Hart 1983; Harris and Raviv 1991; Bertrand and Mullainathan 2003). We also examine whether firm age plays a role in the association between institutional ownership and innovation. Similar to the results examining growth option, we find that the monitoring role of long-term institutional investors become more important when firms have more years in operation. Such association disappears in young firms. The results support the view that long-term investors exert more monitoring effort when a company matures and grows in a slower rate. We repeat the same analysis for firms experiencing financial constraints and find that financially constrained firms exhibit a positive association between long-term institutional ownership and innovative quality; we do not find such evidence for unconstrained firms. The results are consistent with the view that managers need to more carefully allocate scarce resources when facing financial constraints and that long-term institutional holders, who have more ability and incentives to monitor, will seek to secure their long-term investment profits and influence managers' decisions. Taken together, the cross-sectional analyses suggest that when direct monitoring is more needed and more important, long-term institutional investors perform a monitoring role in investee firms' innovative activities.

Finally, we examine whether our results suggesting that long-term institutional investors serve a monitoring role and increase the quality of R&D projects are driven by selection issues. We perform a two-stage instrumental variable analysis using the inclusion of S&P 1500 as the instrumental variable, and find that our main inferences remain unchanged. We also examine whether our results are robust to an alternative classification of long- and short-term institutional investors based on Yan and Zhang (2007) and an alternative measure of innovative outputs in which we examine numbers of patents and citations two and three years ahead. We find that our inferences are robust to these alternative measures.

This study makes the following contributions. First, we provide new evidence for the debate on whether institutional ownership enhances or impedes innovation. We find that while long-term institutional owners serve a monitoring role and improve innovation, transient investors do not actively participate in monitoring activities and are negatively associated with the subsequent number of patents granted. Thus, the mixed evidence in prior literature (e.g., Hirshleifer et al. 2012; He and Tian 2013) documenting the association between institutional ownership and innovation is likely to be driven by the varying compositions of long-term *vis-a-vis* transient investors in the samples due to different sample selection procedures. Thus, we highlight the importance of controlling for heterogeneous effects of institutional owners in future research in order to draw reliable conclusions. Second, our evidence is likely to be of interest to governments and institutional investors, as innovation is the foundation of national-level competitiveness and institutional investors are often blamed for investees' underinvestment in R&D.

The remainder of the article is organized as follows: We discuss the literature and hypothesis development in the next section. Section 3 discusses the research design, sample construction, and descriptive statistics. Section 4 reports the empirical results. Section 5 presents sensitivity tests. Section 6 concludes the paper.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Institutional Ownership and R&D Investments

Whether firms should invest in projects with short-term profitability or long-term growth potential is an important but difficult strategic planning issue (Smit and Trigeorgis 2006; Xu and Yan 2014). This issue becomes even more complex if the differential investment horizon among institutional investors is considered. There is a large body of literature examining the association between institutional ownership

and R&D spending; however, the empirical evidence remains mixed. On one hand, institutional ownership may be negatively associated with R&D spending, because institutional money managers are compensated mainly by short-run performance measures and cannot afford to take a long-run view regarding investment decisions. This short-run pressure from institutional money managers encourages firms to engage in myopic investment behavior and to reduce R&D spending to meet institutional holders' earnings expectations (Porter 1992; Graves 1988) .

On the other hand, some argue that large holdings and the ability to process more complex information give institutions incentives to monitor firms and lead managers to choose investment projects that maximize long-run value rather than maintain short-run earnings growth. For example, Wahal and McConnell (2000) document a positive relation between R&D expenditures and institutional ownership. Kochhar and David (1996) find that institutional ownership is positively associated with firms' development of new products. In a related study, Francis and Smith (1995) find that concentrated firms are more innovative than diffusely held companies. Taken together, whether institutional ownership encourages and discourages R&D spending remains an open debate.

Types of Institutional Ownership and Innovative Quality

In this study, we examine the effects of institutional ownership on innovative quality, focusing on investment horizons of institutional owners. We are motivated by the mixed evidence regarding how institutional owners affect innovative outputs—the numbers of citations and patents. Specifically, while Hirshleifer et al. (2012) find that institutional ownership is *negatively* associated with the number of patents grants, He and Tian (2013) and Aghion et al. (2013) document a *positive* association between institutional ownership and the number of patents and citations.

Among institutional holders, investment horizons explain the incentives for active monitoring and trading for short-term trading profits. Specifically, while long-term investors specialize in monitoring and influencing the corporate behavior, short-term investors focus on information gathering and trading and prefer not to influence the management (Shleifer and Vishny 1986; Chen, Harford, and Li 2007). Related to this view, Bushee (1998) classifies institutions based on their past trading behavior and indicates that dedicated and large-holding institutional investors can monitor managers explicitly through governance activities and implicitly through information gathering activities, while transient investors focus more on short-term earnings and are less interested in monitoring activities. In support of this strand of literature, prior studies document that the institutional ownership type explains the differences in firms' financial reporting (Ajinkya, Bhojraj, and Sengupta 2005; Ramalingegowda and Yu 2012), earnings management behavior (Koh 2007), and CEO contracting (Dikolli, Kulp, and Sedatole 2009). Following these prior studies, we expect that institutional ownership types can disentangle the competing effects of institutional holders on innovation and explain the mixed evidence on innovative quality.

Manso (2011) and Tian and Wang (2014) find that tolerance (or even reward) for short-run innovation failure and reward for long-run success are crucial in motivating and nurturing innovation. We expect that the difference in investment horizons between long-term investors and transient investors is associated with the heterogeneity of subsequent innovation performance. Specifically, long-term investors, who have strong incentives to serve a monitoring role and look for long-term profitability, are likely to tolerate short-run innovation failure and to motivate innovative activities.

On the other hand, short-term investors, who have high turnover trading behavior may find monitoring costly and not feasible and thus be unlikely to serve an active monitoring role in firms' innovative activities. If short-term investors do not interfere with companies' innovation strategies, it is possible that managers are not affected by short-term institutional ownership. Following this argument, there may not be an association between short-term institutional ownership and innovative quality. It is also possible that in the absence of the monitoring mechanism of institutional owners, managers engage in value-destroying projects based on their own self-interest. Thus, short-term ownership may be negatively associated with innovative quality. Furthermore, short-term investors, who focus on maximizing short-run earnings and have high-turnover trading behavior, cannot wait for the final outcome of long-run investment projects and will simply interpret short-run failure as bad news. Their short investment

horizon adds pressure to managers, and firms may need to forgo R&D projects to meet short-run performance goals. This view is supported by Graham, Harvey, and Rajgopal (2005), who document that managers bypass positive net present value (NPV) projects and sacrifice long-term firm value to meet earnings benchmarks. Thus, following the latter argument, we predict that short-term institutional ownership is negatively associated with innovative quality. Overall, we expect that the types of institutional owners are associated with heterogeneous innovation performances.

Firm Characteristics, Types of Institutional Ownership, and Innovative Quality

Next, we examine whether firm characteristics—growth options, age, and financial constraints—are associated with direct monitoring and affect the association between institutional ownership and innovation. We first predict that the direct monitoring role becomes more important when firms have less growth potential and have more years in operation. Prior literature suggests that managers have a tendency to choose a quieter life by exerting less effort than shareholders desire (Hölmstrom 1979; Grossman and Hart 1983; Bertrand and Mullainathan 2003), leading to moral hazard problems. Managerial risk-aversion leads managers to forgo risk-taking, positive NPV projects and to take low-risk projects (Amihud and Lev 1981; May 1995; Gormley and Matsa 2016). When managers perceive that the benefits of engaging in effort-intensive activities (i.e., innovation) are not high and the outcome is uncertain, they may choose to avoid difficult decisions (Bushee 1998; Hirshleifer and Suh 1992). Thus, the monitoring role of long-term institutional ownership becomes more important when the market perceives that the firm has less growth potential and when the company reaches a more matured stage and grow at a slower rate (Mueller 1972; Dunne and Hughes 1994; Huergo and Jaumandreu 2004). Specifically, we predict that long-term institutional ownership is positively associated with innovative quality for firms having fewer growth options and being older. Our previous discussion indicates that transient investors have no incentive to be actively involved in monitoring activities; thus we predict there is no association between transient institutional ownership and innovative quality even when the monitoring mechanism becomes more important.

Next, we examine whether and how financial constraints affect the association between institutional ownership and innovation. The success of R&D projects depends on whether firms have the funds to sustain innovation activities. If firms do not have sufficient funds for all desired investments, managers are forced to forgo positive NPV projects, resulting in under-investment problems (Denis and Mihov 2003). Li (2011) also indicates that the likelihood that R&D projects will fail is higher for financially constrained firms than for unconstrained firms and that R&D-intensive firms' risk increases with a financially constrained status. Thus, the monitoring role of long-term investors becomes more important when firms experience financial constraints.

Facing financial constraints, managers need to more carefully allocate scarce resources between competing investment projects, as wrong decisions and value-destroying projects may put the company in a more difficult situation in the long-run. Because investment decisions are especially crucial for constrained firms, long-term institutional holders, who have more ability and incentives to monitor, will seek to secure their long-term investment profits and influence managers' decisions. Active monitoring by institutional owners improves corporate governance and mitigates agency problems, namely, the concern that managers invest in projects for their own self-interest. As a result, subsequent financial performance and the outcome of innovative activities should be enhanced (Core, Holthausen, and Larcker 1999; Gompers, Ishii, and Metrick 2003; Lin, Ma, and Xuan 2011). Furthermore, the long investment horizon of institutional investors puts less pressure on managers to meet short-term earnings targets, increasing the likelihood of financially constrained firms' allocating scarce resources to R&D projects and preventing them from forgoing positive NPV projects. We predict that transient investors do not have incentives to actively monitor financially constrained firms and thus expect there may be no association between transient institutional ownership and innovative quality.

RESEARCH DESIGN AND SAMPLE

Baseline Regression

To examine the baseline association between institutional ownership and innovative quality, we follow the literature (e.g., He & Tian 2013; Tian & Wang 2014; Chemmanur, Loutskina, & Tian, 2014; Luong et al. 2017; Sunder, Sunder, and Zhang 2017) and estimate the following regression:

$$INNOVATION_{it+1} = \beta_0 + \beta_1 LONGTERM_{it} + \beta_2 TRANSIENT_{it} + \sum \text{Controls} + \varepsilon_{it} \quad (1)$$

We alternatively define the dependent variable $INNOVATION_{it+1}$ as $PATENT_{it+1}$ and $CITATION_{it+1}$. When calculating the dependent variables, we keep firm-year observations with zero patent or patent citation to avoid losing firm-year observations (e.g., Tian and Wang 2014; Luong et al. 2017). *PATENT* is the natural logarithm of one plus the number of patents filed in year t+1 and eventually granted. *CITATION* is the natural logarithm of one plus the number of citations of each patent through 2006 scaled by the average number of citations of patents applied for in the same year and assigned to the same technological class (Luong et al. 2017; Sunder, Sunder, and Zhang 2017).

We include *LONGTERM* and *TRANSIENT* as the test variables. First, we follow Bushee (2001) and classify institutional investors into dedicated, quasi-indexer, and transient groups. Next, we follow Gong, Louis, and Sun (2008) and Koh (2007) and define long-term investors as "dedicated" and "quasi-indexer" institutional holders because they both exhibit low turnover and have a buy-and-hold strategy. This classification enables us to compare the differential effect of the investment behavior of institutional owners on innovative quality. Next, we define *LONGTERM* (*TRANSIENT*) as the number of shares held by long-term (transient) institutional investors divided by the total number of shares outstanding. A positive coefficient on *LONGTERM* (*TRANSIENT*) suggests that long-term (short-term) institutional holding is positively associated with innovative quality, while a negative coefficient on *LONGTERM* (*TRANSIENT*) indicates long-term (short-term) institutional holders have negative impact on innovation.

Equation (1) includes a series of firm-level control variables that are likely to affect innovative quality. *SIZE* is the natural logarithm of total assets. *SALEGROWTH* is the sales growth rate, measured as the change in sales in year *t* divided by lagged sales. *LEV* is the leverage ratio and is measured as total debt (the sum of total long-term debt and total debt in current liabilities) divided by the book value of assets. *RD* is measured as the R&D expense divided by the book value of assets. Consistent with Acharya, Baghai, and Subramanian (2013), we exclude firms with missing information for R&D expenses. *ln(K/L)* is the logarithm of total assets divided by the number of employees. *ROA,* return on assets, is measured as income before extraordinary items, divided by total assets. *COVERAGE* is analyst coverage, the mean of the 12 monthly numbers of earnings forecast from the summary file during year *t* in the I/B/E/S database. *MA* is managerial ability, measured as the decile rank, by industry and year, of the managerial ability score as in Demerjian, Lev, and McVay. (2012). *HH* is the Herfindahl index and is measured as the sum of squares of the percentage market shares held by the respective firms, for firm *i*'s four-digit SIC industry. *TOBINQ* is Tobin's Q ratio. *AGE* is a company's age. *KZ* is Kaplan and Zingales's (1997) index (*TOBINQ*, *AGE*, and *KZ* are defined below). All independent variables are measured in year *t*. Finally, we include industry and year fixed effects and cluster standard errors at the firm level.

Measures of Growth Opportunities, Age, and Financial Constraints

We calculate *TOBINQ*, *AGE*, and *KZ* to measure the extent direct monitoring is needed. *TOBINQ,* the Tobin's Q ratio, is measured as the market value of total assets scaled by the book value of total assets. The market value of total assets is calculated as the market value of equity (the number of common stock shares outstanding times the stock price at the fiscal year end) plus the book value of total assets minus the book value of total equity minus deferred taxes. *AGE* is the natural logarithm of the difference in the current year and the first year a firm appearing in COMPUSTAT.

KZ, Kaplan and Zingales' index (Kaplan and Zingales 1997), is calculated based on the following equation:

$$KZ = -1.002 \times CASHFLOW + 0.283 \times TOBINQ + 3.139 \times LEVERAGE - 39.368 \times DIVIDENDS - 1.315 \times CASH \quad (2)$$

where *CASHFLOW* is measured as the sum of income before extraordinary items and depreciation and amortization, divided by lagged net property, plant, and equipment (PP&E); *LEVERAGE* is measured as the book value of total debt (the sum of total long-term debt and total debt in current liabilities), divided by the sum of the book value of total debt and the book value of equity; *DIVIDENDS* is dividends for common and preferred stocks, divided by lagged net PP&E; and *CASH* is cash and short-term investments divided by lagged net PP&E.

We use *TOBINQ*, *AGE*, and *KZ* to partition firm-year observations into three subsamples and conduct subsample analyses. Firm-year observations in the subsamples with the lowest *TOBINQ*, the highest *AGE*, and the highest *KZ* are perceived to have fewer growth options, to be older, and to have financial constraints, respectively, and need more direct monitoring.

Sample Selection and Descriptive Statistics

We construct the sample using the following data sources: (1) financial statement information from Compustat; (2) analyst coverage data from I/B/E/S; (3) institutional holding information from Thomson Reuters (13f); and (4) patent data from the 2006 edition of the NBER database. We exclude firms in financial institutions (SIC 6000-6999) and regulated industries (SIC 4400-4999) because these industries have different reporting requirements. Our sample period starts in 1981, the first year for which we have Bushee's classification data. The NBER database covers patent information from 1976 to 2006; however, because it takes an average of two years for a patent application to be approved and thus patents applied for during 2005 and 2006 are less likely to be covered by the database, we exclude the last two years to reduce truncation bias (Hall, Jaffe, and Trajtenberg 2001). As our dependent variable *INNOVATION* is measured in year t+1, our sample period ends in 2003. Finally, we exclude firm-year observations without the data necessary to derive variables in Equation (1) and obtain 23,744 firm-year observations from 3,599 distinct firms over 1981-2003. Table 1 provides the details of the sample selection process.

Table 2 reports the descriptive statistics. The average ownership by long-term and transient institutional holders is 24.5%, and 7.7%, respectively. The mean of *SIZE* is 5.281, indicating that our sample firms have an average book value of assets of $197 million dollars. On average, firms spend 8.8% percent of total assets on R&D projects.

TABLE 1
SAMPLE SELECTION

	Number of firm–year observations
Initial sample retrieved from Compustat for the period 1981–2003	259,175
Less:	
Foreign firms	(34,385)
Firms in the financial and regulated industries	(81,557)
Firms with negative shareholders' equity	(26,857)
Firms missing data for calculating control variables	(68,214)
Firms missing information for R&D expenses	(24,685)
Final sample	23,477

TABLE 2
DESCRIPTIVE STATISTICS

Variable	Mean	25%	Median	75%	STD
PATENT	1.201	0.000	0.693	1.946	1.946
CITATION	1.185	0.000	0.248	2.090	2.090
INST_OWN	0.328	0.069	0.298	0.547	0.547
LONGTERM	0.245	0.046	0.217	0.406	0.406
TRANSIENT	0.077	0.000	0.044	0.115	0.115
SIZE	5.281	3.914	4.984	6.464	6.464
SALEGRWOTH	0.237	–0.006	0.108	0.287	0.287
LEV	0.158	0.015	0.125	0.260	0.260
RD	0.088	0.021	0.056	0.118	0.118
ln(K/L)	5.040	4.453	4.990	5.554	5.554
ROA	–0.008	–0.021	0.047	0.089	0.089
COVERAGE	6.825	1.857	3.833	8.917	8.917
MA	0.553	0.300	0.600	0.800	0.800
HH	0.261	0.126	0.198	0.351	0.351
TOBINQ	2.236	1.160	1.614	2.569	2.569
AGE	2.500	1.792	2.485	3.219	3.219
KZ	–5.802	–5.916	–1.868	0.117	0.117

EMPIRICAL RESULTS

Innovative Quality and Institutional Ownership Composition

Table 3 presents the results from examining the association between innovative quality and institutional ownership type. Panel A reports the regression results when the dependent variable is *PATENT*, measured as the natural logarithm of one plus the number of patents filed in year t+1 and eventually granted. Column (1) reports results for the base regression, in which we include the total percentage of institutional ownership, *INST_OWN*. The coefficient on *INST_OWN* is significantly positive (0.176, t-statistic = 1.85). Column (2) examines whether long-term and transient institutional ownership have differential effects on the number of patents granted. The test variables are *LONGTERM* and *TRANSIENT*. We find that the coefficient on *LONGTERM* loads positively (0.360, t-statistic = 2.74), while the coefficient on *TRANSIENT* loads negatively (–0.341, t-statistic = –1.82), suggesting that the investment horizon of institutional owners has differential effects on innovative quality. Specifically, while long-term institutional investors serve a monitoring role and improve innovative quality, transient investors impede innovation.

Next, we alternatively define the dependent variable as *CITATION* and report the results in Panels B. We find the coefficient on *INST_OWN* is significantly positive (0.248, t-statistic = 2.43), indicating that on average, institutional ownership is positively associated with innovative quality. When we add *LONGTERM* and *TRANSIENT* to Equation (1) and examine the differential effects of long-term versus short-term investors on citations, we continue to find the coefficient on *LONGTERM* to be significantly positive (0.343, t-statistic = 2.46), but fail to find the coefficient on *TRANSIENT* to be significant (–0.018, t-statistic = –0.08).

Taken together, Table 3 supports our prediction that the types of institutional owners are associated with heterogeneous innovation performances. Specifically, the positive association between institutional ownership and innovation is driven by long-term investors, who have a long investment horizon and have more incentives to monitor companies. Transient investors are either not associated with the number of citations or negatively associated with the number of patents granted. The lack of association or negative association between transient investors and innovation is consistent with the view that the short investment horizon and high diversification of holdings of transient investors make monitoring activities

too costly and decrease their willingness to actively monitor managers. In addition, the length of investment horizon of long-term institutional investors is more aligned with the investment horizon of innovative activities and thus long-term institutional investors improve the subsequent innovative performance.

Because of the differential effects of long-term versus transient investors on innovative quality, we highlight the importance of controlling for the different types of institutional investors in future research. Our findings also shed light on the mixed evidence in the literature examining institutional ownership and innovation. The mixed evidence may be attributed to the varying compositions of long-term *vis-a-vis* transient investors across samples in prior studies due to different sample selection procedures.

TABLE 3
INNOVATIVE QUALITY AND INSTITUTIONAL OWNERSHIP COMPOSITION

Panel A: Dependent variable: *PATENT*				
	(1)		(2)	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	–1.978	(–4.69)***	–2.018	(–4.76)***
Test variables:				
INST_OWN	0.176	(1.85)*		
LONGTERM			0.360	(2.74)***
TRANSIENT			–0.341	(–1.82)*
Control variables:				
SIZE	0.433	(17.93)***	0.434	(17.98)***
SALEGRWOTH	–0.005	(–0.37)	–0.001	(–0.08)
LEV	–0.335	(–3.05)***	–0.333	(–3.04)***
RD	2.606	(12.99)***	2.615	(13.07)***
ln(K/L)	–0.011	(–0.30)	–0.003	(–0.09)
ROA	0.042	(0.54)	0.055	(0.71)
COVERAGE	0.038	(7.85)***	0.038	(7.77)***
MA	–0.099	(–1.63)	–0.099	(–1.63)
HH	0.205	(1.70)*	0.193	(1.60)
TOBINQ	0.050	(6.98)***	0.055	(7.32)***
AGE	0.130	(4.60)***	0.122	(4.32)***
KZ	0.000	(0.14)	0.000	(0.06)
Fixed effects	Industry/Year		Industry/Year	
n	23,744		23,744	
Adj. R^2	52.81%		52.88%	

Panel B: Dependent variable: *CITATION*				
	(1)		(2)	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	–2.084	(–4.53)***	–2.104	(–4.57)***
Test variables:				
INST_OWN	0.248	(2.43)**		
LONGTERM			0.343	(2.46)**
TRANSIENT			–0.018	(–0.08)
Control variables:				
SIZE	0.419	(16.06)***	0.419	(16.09)***
SALEGRWOTH	0.009	(0.61)	0.012	(0.75)
LEV	–0.342	(–2.80)***	–0.341	(–2.80)***
RD	2.429	(10.90)***	2.434	(10.95)***
ln(K/L)	–0.013	(–0.32)	–0.009	(–0.22)
ROA	0.036	(0.41)	0.042	(0.49)
COVERAGE	0.045	(8.54)***	0.045	(8.48)***
MA	–0.112	(–1.67)*	–0.112	(–1.68)*
HH	0.164	(1.25)	0.158	(1.20)
TOBINQ	0.053	(6.54)***	0.056	(6.48)***
AGE	0.094	(3.15)***	0.090	(3.01)***
KZ	0.001	(0.72)	0.001	(0.68)
Fixed effects	Industry/Year		Industry/Year	
n	23,744		23,744	
Adj. R^2	47.60%		47.61%	

Growth Opportunities, Types of Institutional Ownership, and Innovative Quality

Table 4 presents the results examining whether institutional holders exert differential effort in monitoring when the firms have less growth potential and need more direct monitoring. We first sort firm-year observations into three groups based on *TOBINQ* and re-estimate Equation (1) using subsamples. Panel A presents the results when the dependent variable is *PATENT*. Column (1) reports the results using firm-year observations with the lowest *TOBINQ* and shows that the coefficients on *LONGTERM* is significantly positive (0.460, *t*-statistic = 2.85), We also find similar results in the middle tertile. However, we find that such behavior disappears in Column (3) in which we include firms having the most growth options. These results support the argument that the monitoring role of long-term investors is positively associated with innovative quality when firms have fewer growth opportunities. The coefficients on *LONGTERM* is insignificant (0.100, *t*-statistic = 0.50). With respect to transient institutional investors, the coefficient on *TRANSIENT* is insignificant (–0.339, *t*-statistic = –1.02) for firms having the lowest *TOBINQ* in Column (1) and significantly negative (–0.731, t-statistic = –3.01) for firms having highest *TOBINQ* in Column (3). These results are consistent with the view that transient investors do not serve a strong monitoring role and are not associated with better innovative quality.

Next, we repeat the analysis using *CITATION* and report the results in Panels B. The results are similar to those in Panel A. As shown in Column (1), the coefficient on *LONGTERM* continues to load significantly positive in (0.426, *t*-statistic = 2.51) but is not significant in Column (3) (0.086, *t*-statistic = 0.41), corroborating our previous results that monitoring role of long-term investors is important for companies needed monitoring the most. With respect to transient investors, *TRANSIENT* is insignificant in both Columns (1) and (3). In other words, we again do not find evidence to support the argument that transient auditors serve a monitoring role and enhance innovation, as the coefficient on *TRANSIENT* is not significantly positive.

Overall, the results in Table 4 are consistent with the findings in Bertrand and Mullainathan (2003), who suggest that when managers perceive that the benefits of engaging in effort-intensive activities are

not high, managers choose to avoid such activities and prefer a quiet life and may slack off. Thus, the monitoring role of long-term institutional ownership becomes more important when the market perceives that the firm has less growth potential. Such a problem becomes less severe if managers face more growth opportunities and can obtain more benefits from engaging in more complex activities (Bushee 1998).

TABLE 4
GROWTH OPPORTUNITIES, TYPES OF INSTITUTIONAL OWNERSHIP, AND INNOVATIVE QUALITY

Panel A: Dependent variable: *PATENT*

	(1) Low *TOBINQ*		(2) Medium *TOBINQ*		(3) High *TOBINQ*	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	–1.837	(–3.40)***	–1.871	(–3.35)***	–2.608	(–7.22)***
Test variables:						
LONGTERM	0.460	(2.85)***	14.00	(2.85)***	0.100	(0.50)
TRANSIENT	–0.339	(–1.02)	–0.43	(–0.05)	–0.731	(–3.01)***
Control variables:						
SIZE	0.416	(13.11)***	0.410	(12.45)***	0.482	(14.00)***
SALEGRWOTH	–0.015	(–0.52)	–0.022	(–0.76)	–0.007	(–0.43)
LEV	–0.493	(–3.22)***	–0.126	(–0.88)	0.059	(0.36)
RD	3.135	(10.22)***	2.590	(9.19)***	2.236	(9.18)***
ln(K/L)	–0.071	(–1.41)	0.002	(0.03)	0.032	(0.68)
ROA	0.106	(0.92)	0.021	(0.18)	0.094	(0.83)
COVERAGE	0.045	(5.37)***	0.043	(6.39)***	0.029	(4.43)***
MA	–0.104	(–1.27)	–0.072	(–0.79)	–0.178	(–2.14)**
HH	0.302	(2.19)**	0.154	(0.87)	–0.013	(–0.10)
TOBINQ	0.198	(2.31)**	0.168	(2.78)***	0.038	(4.80)***
AGE	0.154	(4.25)***	0.132	(3.19)***	0.078	(1.92)*
KZ	–0.001	(–0.48)	0.000	(–0.19)	0.001	(0.77)
Fixed effects	Industry/Year		Industry/Year		Industry/Year	
n	7,908		7,921		7,915	
Adj. R^2	53.75%		53.10%		56.38%	

Panel B: Dependent variable: *CITATION*						
	(1) Low *TOBINQ*		(2) Medium *TOBINQ*		(3) High *TOBINQ*	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	–1.710	(–2.95)***	–2.065	(–3.40)***	–2.929	(–7.65)***
Test variables:						
LONGTERM	0.426	(2.51)**	0.509	(2.79)***	0.086	(0.41)
TRANSIENT	–0.206	(–0.59)	0.227	(0.71)	–0.330	(–1.21)
Control variables:						
SIZE	0.398	(12.22)***	0.409	(11.48)***	0.470	(12.13)***
SALEGRWOTH	–0.009	(–0.28)	–0.023	(–0.67)	0.011	(0.56)
LEV	–0.458	(–2.81)***	–0.104	(–0.67)	0.098	(0.52)
RD	3.243	(9.47)***	2.624	(8.24)***	1.842	(6.91)***
ln(K/L)	–0.091	(–1.67)*	–0.013	(–0.25)	0.047	(0.89)
ROA	0.154	(1.26)	0.055	(0.43)	–0.031	(–0.24)
COVERAGE	0.052	(6.02)***	0.049	(6.66)***	0.036	(4.89)***
MA	–0.113	(–1.29)	–0.093	(–0.95)	–0.213	(–2.21)**
HH	0.308	(2.11)**	0.073	(0.38)	–0.097	(–0.62)
TOBINQ	0.176	(1.95)*	0.185	(2.72)***	0.042	(4.54)***
AGE	0.119	(3.12)***	0.104	(2.36)**	0.058	(1.36)
KZ	–0.001	(–0.35)	0.000	(–0.22)	0.002	(1.52)
Fixed effects	Industry/Year		Industry/Year		Industry/Year	
n	7,908		7,921		7,915	
Adj. R^2	49.73%		48.68%		49.40%	

Age, Types of Institutional Ownership, and Innovative Quality

Next, we examine whether age of a company plays a role in the association between types of institutional ownership and innovative quality. Table 5, Panel A provides the empirical results when the dependent variable is *PATENT*. We sort firm-year observations into three groups based on firm age and categorize them as "young," "middle-aged," and "old" groups. Column (3) reports that the coefficient on *LONGTERM* is significant positive when we include old firms (0.594, *t*-statistic = 2.65) and Column (2) when we include the middle-aged firms (0.304, *t*-statistic = 2.13). However, we find that such behavior disappears in Column (1) in which we include young firms (0.204, *t*-statistic = 1.51). With respect to transient investors, *TRANSIENT* is insignificant in Columns (1), (2), and (3).

We repeat the analysis using *CITATION* and report the results in Table 5, Panel B. The results are similar to those in Panel A, in which we document a positive association between long-term investors and the number of citations for middle-aged and old firms but fail to document such an association for young firms. Taken together, the results in Table 5 are consistent with the view that age is associated with direct monitoring needed and thus affect the monitoring effort exerted by long-term investors.

TABLE 5
AGE, TYPES OF INSTITUTIONAL OWNERSHIP, AND INNOVATIVE QUALITY

Panel A: Dependent variable: *PATENT*						
	(1) Young Firms		(2) Middle-aged Firms		(3) Old Firms	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	–2.027	(–7.50)***	–2.877	(–7.72)***	–2.303	(–3.30)***
Test variables:						
LONGTERM	0.204	(1.51)	0.304	(2.13)**	0.594	(2.65)***
TRANSIENT	–0.022	(–0.11)	–0.091	(–0.36)	0.239	(0.60)
Control variables:						
SIZE	0.301	(10.30)***	0.280	(9.26)***	0.577	(13.62)***
SALEGRWOTH	–0.022	(–1.56)	0.002	(0.07)	–0.004	(–0.06)
LEV	–0.096	(–0.78)	–0.311	(–2.35)**	–0.279	(–1.21)
RD	1.828	(9.65)***	2.421	(8.95)	5.894	(7.87)***
ln(K/L)	0.089	(2.67)***	0.078	(1.66)*	–0.092	(–1.16)
ROA	0.126	(1.65)*	0.393	(3.53)***	0.157	(0.60)
COVERAGE	0.017	(2.82)***	0.041	(5.98)***	0.030	(4.13)***
MA	0.023	(0.41)	0.016	(0.20)	–0.261	(–1.99)**
HH	–0.223	(–2.22)**	0.014	(0.11)	0.252	(1.12)
TOBINQ	0.048	(6.21)***	0.051	(4.07)***	0.041	(1.71)*
AGE	–0.090	(–2.61)***	0.296	(4.77)***	0.244	(1.77)*
KZ	0.003	(2.82)***	0.004	(2.71)***	0.002	(0.54)
Fixed effects	Industry/Year		Industry/Year		Industry/Year	
n	7,946		7,886		7,912	
Adj. R^2	32.41%		37.58%		59.74%	

Panel B: Dependent variable: *CITATION*						
	(1) Young Firms		(2) Middle-aged Firms		(3) Old Firms	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	–2.395	(–8.23)***	–3.060	–7.70)***	–2.026	(–2.72)***
Test variables:						
LONGTERM	0.426	(1.41)	0.318	(2.05)**	0.535	(2.24)**
TRANSIENT	–0.206	(1.16)	0.264	(0.92)	0.369	(0.83)
Control variables:						
SIZE	0.295	(9.41)***	0.255	(7.71)***	0.571	(12.44)***
SALEGRWOTH	–0.009	(–0.50)	0.012	(0.42)	0.055	(0.77)
LEV	–0.187	(–1.36)	–0.202	(–1.36)	–0.400	(–1.57)
RD	1.601	(7.43)***	2.317	(7.45)***	5.605	(7.07)***
ln(K/L)	0.100	(2.68)***	0.082	(1.60)	–0.125	(–1.45)
ROA	0.078	(0.89)	0.380	(2.93)***	–0.011	(–0.04)
COVERAGE	0.021	(3.00)***	0.054	(6.87)***	0.036	(4.59)***
MA	0.040	(0.62)	0.016	(0.19)	–0.305	(–2.15)**
HH	–0.295	(–2.66)***	–0.070	(–0.50)	0.277	(1.13)
TOBINQ	0.052	(5.77)***	0.051	(3.75)***	0.032	(1.19)
AGE	–0.075	(–1.92)*	0.256	(3.73)***	0.178	(1.20)
KZ	0.003	(2.55)**	0.006	(3.47)***	0.005	(1.01)
Fixed effects	Industry/Year		Industry/Year		Industry/Year	
n	7,946		7,886		7,912	
Adj. R^2	26.39%		34.59%		56.30%	

Financial Constraints, Types of Institutional Ownership, and Innovative Quality

Finally, we examine whether institutional holders exert differential efforts in monitoring when the firms have financial constraints and need more direct monitoring. Table 6, Panel A, provides the empirical results when the dependent variable is *PATENT*. We construct three subsamples based on *KZ*. Column (3) reports the results for firms having the highest *KZ*, which are perceived to have the most difficult financial position in our sample, and Column (1) for firms having the lowest *KZ*, which are the least likely to have financial problems. Column (2) are for firms whose *KZ* is in the middle tertile. We find that *LONGTERM* is significantly positive in both Columns (2) and (3) but is insignificant in Column (1), indicating that long-term institutional investors monitor firms to allocate scarce resources into R&D projects and improve innovative quality when firms have middle or high degree of financial constraints. However, we fail to find such monitoring role of long-term investors for financial healthy firms, as *LONGTERM* is insignificant in Column (1). Furthermore, different from significantly positive coefficients on *LONGTERM* in Columns (2) and (3), *TRANSIENT* is significantly negative in Column (2) and insignificant in Column (3), indicating that unlike long-term institutional investors, transient institutional investors do not serve a monitoring role and improve subsequent innovative quality. Taken together, these results are consistent with the view that the incentives of long-term investors to influence managerial behavior are stronger when firms experience middle degree and high degree of financial constraints.

Next, we repeat the analysis using *CITATION* and report the results in Panel B. Similar to the findings in Panel A, long-term institutional ownership is positively associated with innovative quality for firms having high and middle degrees of financial constraints and there is no such association for firms without financial constraints. The coefficient on *TRANSIENT* is insignificant in all three columns.

Overall, the results in Tables 4, 5 and 6 suggest that firm characteristics are associated with the extent of direct monitoring needed and affect the association between institutional ownership and innovation. Specifically, we find that when firms have less growth potential, more years in operation, or financial constraints, long-term investors are positively associated with innovative quality. However, such an

association disappears when firms have more growth options, fewer years in operation, or do not have financial constraints. These results support the argument that long-term institutional investors play a monitoring role in firms' innovative activities when the need for direct monitoring becomes more important.

TABLE 6
FINANCIAL CONSTRAINTS, TYPES OF INSTITUTIONAL OWNERSHIP, AND INNOVATIVE QUALITY

Panel A: Dependent variable: *PATENT*						
	(1) Low *KZ*		(2) Medium *KZ*		(3) High *KZ*	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	–2.173	(–4.98)***	–2.006	(–3.92)***	–2.148	(–5.55)***
Test variables:						
LONGTERM	0.169	(0.85)	0.370	(2.01)**	0.468	(2.73)***
TRANSIENT	–0.503	(–2.07)**	–0.528	(–1.84)*	0.242	(0.74)
Control variables:						
SIZE	0.417	(13.10)***	0.530	(14.52)***	0.352	(11.51)***
SALEGRWOTH	–0.011	(–0.60)	0.016	(0.46)	–0.018	(–0.80)
LEV	–0.078	(–0.41)	–0.346	(–1.67)*	–0.168	(–1.05)
RD	2.312	(8.02)***	2.935	(8.76)***	2.396	(9.33)***
ln(K/L)	0.021	(0.47)	0.005	(0.10)	–0.007	(–0.15)
ROA	0.149	(1.04)	–0.117	(–0.71)	–0.004	(–0.03)
COVERAGE	0.040	(6.32)***	0.029	(4.45)***	0.040	(4.65)***
MA	–0.091	(–1.07)	–0.077	(–0.72)	–0.062	(–0.77)
HH	0.157	(0.97)	0.129	(0.62)	0.100	(0.76)
TOBINQ	0.044	(5.02)***	0.071	(4.55)***	0.078	(6.43)***
AGE	0.022	(0.56)	0.149	(3.13)***	0.153	(3.85)***
KZ	0.001	(1.05)	0.034	(1.65)*	–0.064	(–3.25)***
Fixed effects	Industry/Year		Industry/Year		Industry/Year	
n	7,908		7,920		7,916	
Adj. R^2	54.01%		58.55%		46.97%	

Panel B: Dependent variable: *CITATION*						
	(1) Low *KZ*		(2) Medium *KZ*		(3) High *KZ*	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	–2.325	(–5.00)***	–2.007	(–3.64)***	–2.288	(–5.46)***
Test variables:						
LONGTERM	0.129	(0.62)	0.367	(1.89)*	0.462	(2.58)**
TRANSIENT	–0.166	(–0.62)	–0.260	(–0.80)	0.556	(1.48)
Control variables:						
SIZE	0.411	(11.81)***	0.510	(13.14)***	0.335	(10.27)***
SALEGRWOTH	0.014	(0.63)	0.023	(0.60)	–0.025	(–1.05)
LEV	–0.144	(–0.73)	–0.391	(–1.75)*	–0.096	(–0.53)
RD	1.972	(6.40)***	2.882	(7.89)***	2.283	(7.68)***
ln(K/L)	0.025	(0.51)	0.006	(0.09)	–0.027	(–0.48)
ROA	0.058	(0.37)	–0.013	(–0.07)	–0.011	(–0.07)
COVERAGE	0.044	(6.35)***	0.039	(5.47)***	0.048	(5.13)***
MA	–0.130	(–1.39)	–0.046	(–0.40)	–0.088	(–0.96)
HH	0.047	(0.28)	0.088	(0.40)	0.080	(0.55)
TOBINQ	0.046	(4.55)***	0.072	(4.05)***	0.078	(5.23)***
AGE	–0.011	(–0.28)	0.111	(2.30)**	0.130	(2.94)***
KZ	0.002	(1.83)*	0.033	(1.46)	–0.063	(–2.87)***
Fixed effects	Industry/Year		Industry/Year		Industry/Year	
n	7,908		7,920		7,916	
Adj. R^2	47.40%		54.73%		41.79%	

SENSITIVITY TESTS

Reassessment of Findings – Two-Stage Instrumental Variable Approach

To mitigate the concern that our inference suggesting that long-term institutional investors serve a monitoring role and improve the subsequent performance in innovation is driven by selection issues, we perform a two-stage instrumental variable analysis. In the first stage, we use the inclusion of S&P 1500 as the instrumental variable. Specifically, we regress *LONGTERM* on *S&P1500*, which is an indicator variable that equals one if a firm is included in S&P 1500 index and zero otherwise. We expect that the inclusion in the S&P 1500 is associated with the institutional ownership as fund managers may adjust their holdings based on this index. We also expect that the instrument variable satisfies the exclusion restriction requirement as stocks are included in the index because they enhance the representativeness of the index, not because of expected innovative performances. Table 7, Panel A, Column (1) reports the first-stage results and shows that the coefficient on *S&P1500* is significantly positive, consistent with our prediction that long-term investors own more shares of a firm if it is an S&P 1500 constituent.

In the second stage, we use the predicted value of *LONGTERM* (*PREDICT_LONGTERM*) from the first stage and then replace *LONGTERM* with *PREDICT_LONGTERM* in Equation (1). Columns (2) and (3) report the second-stage results when the dependent variable is *PATENT* and *CITATION*, respectively, and show that the coefficient on *PREDICT_LONGTERM* is significantly positive and *TRANSIENT* significantly negative for both dependent variables.

Next, we regress *TRANSIENT* on the instrumental variable, *S&P1500*, along with other explanatory variables. We repeat the procedures above and report the results in Panel B. The findings are similar to those in Panel A. We again find that the coefficient on *LONGTERM* to be significantly positive and *PREDICT_TRANSIENT* to be significantly negative for both dependent variables.

Overall, these results are consistent with those reported in the previous tables, providing additional evidence for our main inferences. The results preclude the concern that our results suffer from omitted variables and endogeneity issues.

TABLE 7
REASSESSMENT OF FINDINGS – TWO-STAGE INSTRUMENTAL VARIABLE APPROACH

Panel A:

	(1) First stage Dependent variable: *LONGTERM*		(2) Second stage Dependent variable: *PATENT*		(3) Second stage Dependent variable: *CITATION*	
Variable	Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat
Intercept	0.117	(6.51)***	–2.103	(–4.99)***	–2.200	(–4.80)***
Test variables:						
S&P1500	0.083	(26.15)***				
PREDICT_LONGTERM			1.420	(2.35)**	1.546	(2.44)**
TRANSIENT	0.914	(76.28)***	–1.329	(–2.32)**	–1.138	(–1.86)*
Control variables:						
SIZE	0.016	(13.54)***	0.407	(14.59)***	0.388	(13.17)***
SALEGRWOTH	–0.009	(–4.70)***	0.011	(0.76)	0.026	(1.56)
LEV	–0.042	(–5.44)***	–0.277	(–2.46)**	–0.279	(–2.23)**
RD	0.038	(2.57)**	2.574	(12.78)***	2.387	(10.66)***
ln(K/L)	–0.019	(–9.93)***	0.019	(0.52)	0.016	(0.40)
ROA	0.078	(10.82)***	–0.029	(–0.32)	–0.052	(–0.53)
COVERAGE	0.000	(1.80)*	0.036	(7.21)***	0.043	(7.88)***
MA	0.006	(1.42)	–0.109	(–1.79)*	–0.123	(–1.84)*
HH	0.037	(6.54)***	0.151	(1.23)	0.111	(0.82)
TOBINQ	–0.011	(–16.03)***	0.066	(6.64)***	0.068	(6.17)***
AGE	0.025	(15.45)***	0.088	(2.74)***	0.052	(1.50)
KZ	0.000	(3.80)***	0.000	(–0.39)	0.000	(0.19)
Fixed effects	Industry/Year		Industry/Year		Industry/Year	
n	23,744		23,744		23,744	
Adj. R^2	47.16%		52.80%		47.57%	

Panel B:

Variable	(1) First stage Dependent variable: *LONGTERM* Coeff.	*t*-stat	(2) Second stage Dependent variable: *PATENT* Coeff.	*t*-stat	(3) Second stage Dependent variable: *CITATION* Coeff.	*t*-stat
Intercept	–0.075	(–8.58)***	–3.189	(–4.04)***	–3.433	(–4.11)***
Test variables:						
S&P1500	–0.006	(–3.57)***				
LONGTERM	0.216	(76.28)***	3.829	(1.96)*	4.277	(2.09)**
PREDICT_TRANSIENT			–16.535	(–1.81)*	–18.379	(–1.92)*
Control variables:						
SIZE	0.007	(12.22)***	0.542	(8.10)***	0.541	(7.64)***
SALEGRWOTH	0.006	(6.73)***	0.101	(1.73)*	0.127	(2.09)**
LEV	–0.004	(–1.03)	–0.387	(–3.36)***	–0.403	(–3.15)***
RD	0.028	(3.92)***	3.072	(9.33)***	2.952	(8.45)***
ln(K/L)	0.013	(13.91)***	0.207	(1.69)*	0.230	(1.78)*
ROA	0.046	(13.01)***	0.799	(1.86)*	0.886	(1.97)**
COVERAGE	0.000	(–4.17)***	0.028	(3.90)***	0.035	(4.39)***
MA	0.003	(1.57)	–0.054	(–0.81)	–0.061	(–0.84)
HH	–0.019	(–6.94)***	–0.119	(–0.56)	–0.196	(–0.86)
TOBINQ	0.011	(32.81)***	0.225	(2.33)***	0.248	(2.45)**
AGE	–0.011	(–13.64)***	–0.060	(–0.58)	–0.116	(–1.06)
KZ	0.000	(–1.18)	–0.001	(–0.77)	0.000	(–0.25)
Fixed effects	Industry/Year		Industry/Year		Industry/Year	
n	23,744		23,744		23,744	
Adj. R^2	38.45%		52.88%		47.65%	

Untabulated Sensitivity Tests

We examine whether our results are sensitive to an alternative measure of long- and short-term institutional investors classification. We follow Yan and Zhang (2007) and construct an investment horizon measure based on portfolio turnover of institutions over the past four quarters. First, we calculate the churn rate for each institutional on a quarter-basis and calculate the average churn rate of each institutional over the past four quarters. Next, we sort all institutions based on the average churn rate into three tertiles for each quarter. Those in the top (bottom) tertile are classified into short-term (long-term) institutional investors. Finally, we define *LONG* (*SHORT*) as the percentage of ownership owned by long-term (*SHORT*) institutional investors. *OTHER* is the percentage of ownership owned by the middle tertile institutional investors. We find that the results are similar to those reported in Table 3. While long-term institutional ownership (*LONG*) is positively associated with the number of patents and the number of citations, short-term ownership (*SHORT*) does not exhibit such an association. *SHORT* is insignificant for both dependent variables. Taken together, our main inferences that long-term institutional investors serve a monitoring role in innovation activities and improve the innovative quality and that the length of investment horizons is associated with the heterogeneous effects of institutional owners, remain unchanged.

We also examine whether our results are sensitive to the time at which we measure the quality of innovation. Since the innovation process generally takes a long time, we examine whether our inferences hold if we measure innovation two and three years ahead. We replace our dependent variable $INNOVATION_{it+1}$ with $INNOVATION_{it+2}$ and $INNOVATION_{it+3}$. The results are similar to those in Table 3. The coefficient on long-term institutional ownership, *LONGTERM*, is significantly positive for both innovative quality proxies. The coefficient on transient institutional ownership, *TRANSIENT*, is

insignificant in both panels. Overall, our main inferences that long-term institutional investors serve a monitoring role in innovation activities and improve the innovative quality and that investment horizons of institutional investors affect the monitoring effort, remains unchanged.

CONCLUSIONS

This paper examines the association between institutional ownership and innovative quality, focusing on the heterogeneous effects of institutional owners. This study contrasts long-term institutional owners, who have strong incentives to monitor corporate behavior, with transient institutional owners, who do not possess such an incentive.

Our findings are based on 23,744 firm-year observations over 1981 to 2003 and can be summarized as follows. First, we find that while a higher level of ownership by long-term institutional investors is *positively* associated with innovative quality, a higher level of ownership by transient investors is *negatively* associated with the number of patents granted and is *not* associated with the number of citations. Our results are consistent with prior literature documenting the heterogeneous effects of institutional owners on financial reporting and corporate behavior, and are also consistent with the view that the long investment horizons give institutional investors more incentive to monitor companies and thus enhance governance and performance.

The study also examines whether institutional holders exert differential effort in monitoring when firms need more direct monitoring. We find that when firms have less growth potential, more years in operation, or financial constraints, long-term investors are positively associated with innovative quality. However, such an association disappears for firms having more growth potential, have fewer years in operation or not facing financial constraints. These results suggest that long-term institutional investors play a monitoring role in corporate innovative activities when direct monitoring is more needed and more important.

Overall, our findings suggest that long-term institutional holders serve a monitoring role in firms' innovative activities and enhance subsequent performances. We also provide some evidence to suggest that transient investors impede innovative performances. Our results provide an explanation for the mixed evidence on the association between institutional ownership and innovation (e.g., Hirshleifer et al. 2012; He and Tian 2013). The mixed evidence in prior literature may be attributed to the varying combinations of long-term and transient investors across samples in prior studies due to different sample selection procedures. Thus, future studies should separately consider the different types of institutional investors to disentangle the differential effects.

REFERENCES

Acharya, V. V., Baghai, R. P., & Subramanian, K. V. (2013). Wrongful discharge laws and innovation. *The Review of Financial Studies*, 27(1), 301–346.

Aghion, P., Van Reenen, J., & Zingales, L. (2013). Innovation and institutional ownership. *American Economic Review*, 103(1), 277–304.

Aguilar, L. A. (2013). *Institutional investors: Power and responsibility*. Washington, D.C. Retrieved from https://www.sec.gov/news/speech/2013-spch041913laahtm

Ajinkya, B., Bhojraj, S., & Sengupta, P. (2005). The association between outside directors, institutional investors and the properties of management earnings forecasts. *Journal of Accounting Research*, 43(3), 343–376.

Amihud, Y., & Lev, B. (1981). Risk reduction as a managerial motive for conglomerate mergers. *The Bell Journal of Economics*, 12(2), 605–617.

Appel, I. R., Gormley, T. A., & Keim, D. B. (2016). Passive investors, not passive owners. *Journal of Financial Economics*, 121(1), 111–141.

Bertrand, M., & Mullainathan, S. (2003). Enjoying the quiet life? Corporate governance and managerial preferences. *Journal of Political Economy*, 111(5), 1043–1075.

Bird, A., & Karolyi, S. A. (2017). Governance and taxes: Evidence from regression discontinuity. *The Accounting Review*, 92(1), 29–50.

Burns, N., Kedia, S., & Lipson, M. (2010). Institutional ownership and monitoring: Evidence from financial misreporting. *Journal of Corporate Finance*, 16(4), 443–455.

Bushee, B. J. (1998). The influence of institutional investors on myopic R&D investment behavior. *The Accounting Review*, 73(3), 305–333.

Bushee, B. J. (2001). Do institutional investors prefer near-term earnings over long-run value? *Contemporary Accounting Research*, 18(2), 207–246.

Carleton, W. T., Nelson, J. M., & Weisbach, M. S. (1998). The influence of institutions on corporate governance through private negotiations: Evidence from TIAA-CREF. *The Journal of Finance*, 53(4), 1335–1362.

Chemmanur, T. J., Loutskina, E., & Tian, X. (2014). Corporateventure capital, value creation, and innovation. *The Review of Financial Studies*, 27(8), 2434–2473.

Chen, X., Harford, J., & Li, K. (2007). Monitoring: Which institutions matter? *Journal of Financial Economics*, 86(2), 279–305.

Core, J. E., Holthausen, R. W., & Larcker, D. F. (1999). Corporate governance, chief executive officer compensation, and firm performance. *Journal of Financial Economics*, 51(3), 371–406.

Demerjian, P., Lev, B., & McVay, S. (2012). Quantifying managerial ability: A new measure and validity tests. *Management Science*, 58(7), 1229–1248.

Denis, D. J., & Mihov, V. T. (2003). The choice among bank debt, non-bank private debt, and public debt: evidence from new corporate borrowings. *Journal of Financial Economics*, 70(1), 3–28.

Dikolli, S. S., Kulp, S. L., & Sedatole, K. L. (2009). Transient institutional ownership and CEO contracting. *The Accounting Review*, 84(3), 737–770.

Dunne, P., & Hughes, A. (1994). Age, size, growth and survival: UK companies in the 1980s. *The Journal of Industrial Economics*, 42(2), 115–140.

Francis, J., & Smith, A. (1995). Agency costs and innovation some empirical evidence. *Journal of Accounting and Economics*, 19(2), 383–409.

Gaspar, J.-M., Massa, M., & Matos, P. (2005). Shareholder investment horizons and the market for corporate control. *Journal of Financial Economics*, 76(1), 135–165.

Gompers, P., Ishii, J., & Metrick, A. (2003). Corporate governance and equity prices. *The Quarterly Journal of Economics*, 118(1), 107–156.

Gong, G., Louis, H., & Sun, A. (2008). Earnings management and firm performance following open-market repurchases. *The Journal of Finance*, 63(2), 947–986.

Gormley, T. A., & Matsa, D. A. (2016). Playing it safe? Managerial preferences, risk, and agency conflicts. *Journal of Financial Economics*, 122(3), 431–455.
Graham, J. R., Harvey, C. R., & Rajgopal, S. (2005). The economic implications of corporate financial reporting. *Journal of Accounting and Economics*, 40(1–3), 3–73.
Graves, S. B. (1988). Institutional ownership and corporate R&D in the computer industry. *The Academy of Management Journal*, 31(2), 417–428.
Grossman, S. J., & Hart, O. D. (1983). An analysis of the principal-agent problem. *Econometrica*, 51(1), 7–45.
Hall, B., Jaffe, A., & Trajtenberg, M. (2001). *The NBER patent citations data file: Lessons, insights and methodological tools.*
Harris, M., & Raviv, A. (1991). The theory of capital structure. *The Journal of Finance*, 46(1), 297–355.
He, J. (Jack), & Tian, X. (2013). The dark side of analyst coverage: The case of innovation. *Journal of Financial Economics*, 109(3), 856–878.
Hirshleifer, D., Hsu, P.-H., & Li, D. (2013). Innovative efficiency and stock returns. *Journal of Financial Economics*, 107(3), 632–654.
Hirshleifer, D., Low, A., & Teoh, S. H. (2012). Are overconfident CEOs better innovators? *The Journal of Finance*, 67(4), 1457–1498.
Hirshleifer, D., & Suh, Y. (1992). Risk, managerial effort, and project choice. *Journal of Financial Intermediation*, 2(3), 308–345.
Hölmstrom, B. (1979). Moral hazard and observability. *The Bell Journal of Economics*, 10(1), 74–91.
Huergo, E., & Jaumandreu, J. (2004). Firms' age, process innovation and productivity growth. *International Journal of Industrial Organization*, 22(4), 541–559.
Kaplan, S. N., & Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints? *The Quarterly Journal of Economics*, 112(1), 169–215.
Khan, M., Srinivasan, S., & Tan, L. (2017). Institutional ownership and corporate tax avoidance: New evidence. *The Accounting Review*, 92(2), 101–122.
Kochhar, R., & David, P. (1996). Institutional investors and firm innovation: A test of competing hypotheses. *Strategic Management Journal*, 17(1), 73–84.
Koh, P.-S. (2007). Institutional investor type, earnings management and benchmark beaters. *Journal of Accounting and Public Policy*, 26(3), 267–299.
Lawson, B., Samson, D., & Roden, S. (2012). Appropriating the value from innovation: Inimitability and the effectiveness of isolating mechanisms. *R&D Management*, 42(5), 420–434.
Li, D. (2011). Financial constraints, R&D investment, and stock returns. *The Review of Financial Studies*, 24(9), 2974–3007.
Lin, C., Ma, Y., & Xuan, Y. (2011). Ownership structure and financial constraints: Evidence from a structural estimation. *Journal of Financial Economics*, 102(2), 416–431.
Luong, H., Moshirian, F., Nguyen, L., Tian, X., & Zhang, B. (2017). How do foreign institutional investors enhance firm innovation? *Journal of Financial and Quantitative Analysis*, 52(4), 1449–1490.
Manso, G. (2011). Motivating innovation. *The Journal of Finance*, 66(5), 1823–1860.
May, D. (1995). Do managerial motives influence firm risk reduction strategies? *The Journal of Finance*, 50(4), 1291–1308.
Mueller, D. C. (1972). A life cycle theory of the firm. *The Journal of Industrial Economics*, 20(3), 199–219.
Porter, M. (1992a). Capital choices: Changing the way America invests in industry. *Journal of Applied Corporate Finance*, 5(2), 4–16.
Porter, M. (1992b). Capital disadvantage: America's failing capital investment system. *Harvard Business Review*.
Ramalingegowda, S., & Yu, Y. (2012). Institutional ownership and conservatism. *Journal of Accounting and Economics*, 53(1–2), 98–114.

Raz, T., Shenhar, A. J., & Dvir, D. (2002). Risk management, project success, and technological uncertainty. *R&D Management*, 32(2), 101–109.
Shleifer, A., & Vishny, R. W. (1986). Large shareholders and corporate control. *Journal of Political Economy*, 94(3), 461–488.
Smit, H. T. J., & Trigeorgis, L. (2006). Strategic planning: Valuing and managing portfolios of real options. *R&D Management*, 36(4), 403–419.
Sunder, J., Sunder, S. V, & Zhang, J. (2017). Pilot CEOs and corporate innovation. *Journal of Financial Economics*, 123(1), 209–224.
Tian, X., & Wang, T. Y. (2014). Tolerance for failure and corporate innovation. *The Review of Financial Studies*, 27(1), 211–255.
Wahal, S., & McConnell, J. J. (2000). Do institutional investors exacerbate managerial myopia? *Journal of Corporate Finance*, 6(3), 307–329.
Xu, C., & Yan, M. (2014). Radical or incremental innovations: R&D investment around CEO retirement. *Journal of Accounting, Auditing & Finance*, 29(4), 547–576.
Yan, X. (Sterling), & Zhang, Z. (2007). Institutional investors and equity returns: Are short-term institutions better informed? *The Review of Financial Studies*, 22(2), 893–924.