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INSTITUTIONAL INVESTOR HETEROGENEITY AND INNOVATION

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ABSTRACT

According to investment horizons and portfolio concentration, this paper divides institutional investors into short-concentrated, short-diversified, long-concentrated, and long-diversified investors, and analyse the impact of different types of institutional investors on the innovation intensity of listed companies. Based on the data of non-financial listed companies in China's A-share stock market, the empirical results show that short diversified and long concentrated investors can promote the innovation intensity of listed companies, and this effect is more significant after the encouragement of regulatory policies.

Keywords: Innovation, Institutional investor, Investment horizons, Portfolio concentration

1. Introduction

In recent years, institutional investors play an increasingly important role in China'sstock market. Especially after the outbreak of the financial crisis in 2008, encouraged by regulatory policies, most institutional investors actively participate in the governance of listed companies and support enterprises to carry out long-term investment activities. Financial literature generally believes that institutional investors can influence the innovation investment decisions of listed companies and encourage management to make long-term innovation investment (Aghion et al., 2013; Sakaki and Jory, 2019; Chang et al., 2019). However, institutional investors show strong heterogeneity, and their trading behavior and impact on listed companies depend on their respective characteristics. Literature finds that short-term horizon institutional investors use information advantage to trade, and their information advantage is measured by the predictability of transactions. Long-termhorizon institutional investors understand the company's information through active supervision and actively participate in value-added activities. In addition, in order to supervise listed companies, institutional investors must hold enough shares to influence management's investment decisions. Institutional investors with different horizons and portfolio concentration have different trading models, and their impact on the innovative activities of

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listed companies is also different (Bushee, 1999; Nofsinger&Sias, 1999; Bushee, 2001; Yan and Zhang, 2009; Cremerset al., 2016; Kim et al., 2020).

Therefore, following Yan and Zhang (2009), Kim et al. (2020), we construct a simple two-way investor classification based on investment horizon and portfolio concentration. And we examine the impact of short-concentrated, short-diversified, long-concentrated, and long-diversified investors on the innovation intensity of listed companies. In addition, after the outbreak of the financial crisis in 2008, China's stock market regulators actively encourage institutional investors to participate in market transactions, and cultivate qualified institutional investors as one of the important ways to supervise the management of listed companies and improve the quality of the market. We further examine the differences in the impact of different types of institutional investors on the innovation activities of listed companies around 2008.

The empirical results show that short-diversified and long-concentrated institutional investors can enhance the innovation intensity of listed companies, and this effect is more significant after 2008. This letter helps to understand the differences of the influence of different types of institutional investors on listed companies, and also provides important empirical evidence for regulators to make policies to improve the quality of the market by using the field data from China.

2. Data and Methods

2.1 Data Source

Our samples cover all Chinese companies listed on the China's A-share stock market from 1990 to 2019, and the following samples are excluded: (1) financial companies; (2) companies with delisting risk warning in the sample interval; (3) companies with missing variables. After screening, our final sample consists of 44,071 firm-year observations over the 31-year sample period.

Annual institutional ownership data, trading information and accounting information are collected from the China Stock Market and Accounting Research Databases (CSMAR). Patent application data of listed companies come from Chinese Research Data Service (CNRDS).

2.2 Variables

Similar to Yan and Zhang (2009), Kim et al. (2020), we classify institutional investors into four groups as follows. Firstly, we divide institutional investors into short-term horizon and long-term horizon according to investment turnover (IT). We calculate the churn rate (CR) of each institutional investor i in each year t:

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$$CR_{i,t} = \frac{\min(CR\_buy_{i,t},\ CR\_sell_{i,t})}{\sum_{s=1}^{s_i} \frac{N_{i,s,t} * P_{s,t} + N_{i,s,t-1} * P_{s,t-1}}{2}} \quad (1)$$

where

$$CR\_buy_{i,t} = \sum_{s=1}^{s_i} |N_{i,s,t} * P_{s,t} - N_{i,s,t-1} * P_{s,t-1} - N_{i,s,t-1} * \Delta P_{s,t}| \quad when\ N_{i,s,t} > N_{i,s,t-1} \quad (2)$$

$$CR\_sell_{i,t} = \sum_{s=1}^{s_i} |N_{i,s,t} * P_{s,t} - N_{i,s,t-1} * P_{s,t-1} - N_{i,s,t-1} * \Delta P_{s,t}| \quad when\ N_{i,s,t} \leq N_{i,s,t-1} \quad (3)$$

Here,$N_{i,s,t}$ is the number of shares of stock s held by investor i at the end of year t, and $P_{s,t}$ is the price of stock s at the end of year t. Then, investor i's investment turnover (IT) measured at the end of year t is defined as the latest two-year rolling average of the churn rate (CR). As a final step, if the investment turnover (IT) of institutional investor i is greater than the median of the sample, it is divided into short-term horizon, otherwise it is divided into long-term horizon.

Then, we further divide short-term horizon and long-term horizon into two sub-groups: high and low portfolio concentration. At the end of the year t, the investor portfolio concentration of institutional investor i is measured by Herfindahl-Hirschman Index (HHI):

$$HHI_{i,t} = \sum_{s=1}^{s_i} \left(\frac{N_{i,s,t} * P_{s,t}}{\sum_{s=1}^{s_i} N_{i,s,t} * P_{s,t}}\right)^2 \quad (4)$$

When the Herfindahl-Hirschman Index (HHI) is higher than the sample median, it is divided into high concentration sub-groups, otherwise it is divided into low concentration sub-groups.

According to the above criteria, institutional investors are divided into four groups: short-concentrated, short-diversified, long-concentrated, and long-diversified investors. At the firm level, the percentage ownership of each investor group is calculated as the number of shares held by each investor group divided by the total number of shares outstanding, denoted by $SIOCon_{s,t}$,$SIODiv_{s,t}$,$LIOCon_{s,t}$and $LIODiv_{s,t}$ for short-concentrated, short-diversified, long-concentrated, and long-diversified institutions, respectively.

The annual total number of patent applications measures the output of R & D activities of listed companies, which can directly measure the innovation intensity of listed companies. It is also a widely used proxy variable of innovation intensity in literature. Following the literature (Fang et al., 2014; Cornaggia et al., 2015), we use the total number of patent applications in the year $t + 1$ to construct the first index (INV) to capture the innovation intensity of listed companies. It is worth noting that the total number of patent applications is right-skewed, and the 75th percentile

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equal to 0. Therefore, we use the logarithm of 1 plus the total number of patent applications in the year $t+1$, INV as our first variable to measure the innovation intensity of listed companies:

$$INV_{i,T} = \ln(1 + NumPat_{s,t+1}) \quad (5)$$

Where $NumPat_{s,t+1}$is the total number of patent applications of listed company s in the year $t+1$.

According to the classification of patents, there are great differences in the degree of innovation among invention patents, utility model patents and design patents. Among them, invention patents are mainly for products, methods or corresponding improvements to propose new designs, which have higher technical requirements and more difficult research and development, and can better reflect the innovation intensity of listed companies. Therefore, we use the logarithm of 1 plus the total number of invention patent applications in the year $t+1$, $INVIA$ as our second variable to measure the innovation intensity of listed companies:

$$INVIA_{i,T} = \ln(1 + NumPatC_{i,t+1}) \quad (6)$$

Where $NumPatC_{i,t+1}$is the total number of invention patent applications of listed company s in the year $t+1$.

In addition, following Fang et al. (2014), Blanco and Wehrheim(2017), we select control variables, including illiquidity (AMIHUD), firm size (MV), return on assets (ROA), investment in innovation (RDTA), asset tangibility (PPETA), leverage (LEV), investment in fixed assets (CAPEXTA), Tobinq's Q (TOBINQ), stock return volatility (SIGMA).

3. Empirical Results

3.1Descriptive statistics

The descriptive statistics of the main variables in this paper are given in Table 1. Column (1) is the variable name, and columns (2) - (9) are the number of observations, mean, standard deviation, minimum, 25th percentile, median, 75th percentile and maximum respectively. The statistical results show that the mean values of $SIOCon$, $SIODiv$, $LIOCon$ and $LIODiv$, which represent short-concentrated, short-diversified, long-concentrated, and long-diversified investors' ownership, are 0.057%, 4.504%, 17.479% and 5.474% respectively. It shows that in China's stock market, short-term horizon institutional investors tend to diversify, while long-term horizon institutional investors tend to concentrate.

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Table 1.Descriptive statistics

variable	N	mean	sd	min	p25	p50	p75	max
LnInv	44,071	1.311	1.497	0.000	0.000	0.693	2.398	8.993
LnInvIa	44,071	0.797	1.173	0.000	0.000	0.000	1.386	8.467
SIOCon(%)	44,071	0.057	0.951	0.000	0.000	0.000	0.000	36.470
SIODiv(%)	44,071	4.504	8.577	0.000	0.000	0.490	5.058	40.003
LIOCon(%)	44,071	17.479	20.175	0.000	0.000	5.980	36.470	69.230
LIODiv(%)	44,071	5.474	11.516	0.000	0.000	0.180	3.440	44.921
AMIHUD	44,071	-0.000	0.002	-0.007	-0.001	-0.000	0.000	0.004
ROA	44,071	0.032	0.074	-0.371	0.013	0.037	0.066	0.193
PPETA	44,071	0.940	0.080	0.556	0.929	0.966	0.987	1.000
LEV	44,071	0.450	0.215	0.054	0.286	0.444	0.600	1.088
TOBINQ	44,071	1.909	1.220	0.899	1.204	1.514	2.106	8.466
SIGMA	44,071	0.035	0.026	0.014	0.023	0.028	0.036	0.213

3.2 The impact of institutional ownership on innovation

Full-length papers generally, for example, consist of introduction, nomenclature, if any, main parts of the body, conclusions. The font sizes of the section headings are bold 12 pts and those of the subsection headings bold 12 pts, respectively.

Existing literature analyzes the relationship between institutional investors and the intensity of innovation activities of listed companies, and finds that the higher the proportion of institutional investors, the greater the intensity of innovation activities of listed companies (Sakaki and Jory, 2019; Chang et al., 2019). However, when explaining the impact of institutional investors, this kind of research does not examine the impact of different horizons and portfolio concentration. Different types of institutional investors face different investment constraints, and their trading strategies are not the same (Bushee, 1999; Nofsinger and Sias, 1999; Bushee, 2001; Yan and Zhang, 2009; Cremerset al., 2016). Therefore, we expect that different types of institutional investors have different effects on the innovation intensity of listed companies. Using the model (7) to examine the impact of different types of institutional investors on the innovation activities of listed companies:

$$Innovation_{s,t} = \beta_0 + \beta_1 * IO_{s,t} + \beta_2 * Control_{s,t} + YearFe + IndustryFe \qquad (7)$$

Of which, $Innovation_{s,t}$is the proxy variable to measure the innovation intensity of listed companies, $IO_{s,t}$is the proxy variable to measure the proportion of different types of institutional investors, $Control_{s,t}$is control variables, $YearFe$and $IndustryFe$ are year fixed effect and industry fixed effect respectively. The results of the above estimations are shown in Table 2.

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The results show that, at the 1% significance level, the coefficients of $SIODiv$ and $LIOCon$are significantly positive, that is, the higher the ownership of short-diversified and long-concentrated institutional investors, the greater the innovation intensity of listed companies. On average, the INV ($INVIA$), which measures the intensity of innovation activities of listed companies, increases 1.1% (1.0%) every 1% increase in the ownership of short-diversified institutional investors; the INV ($INVIA$) increases 0.1% (0.2%) every 1% increase in the ownership of long-concentrated institutional investors. However, the results also show that short-concentrated institutional investors and long-diversified institutional investors have no significant impact on the innovation activities of listed companies.

Table 2.The impact of institutional ownership on innovation

	(1)	(2)
VARIABLES	INV	INVIA
SIOCon	0.003	0.002
	(0.006)	(0.005)
SIODiv	0.011***	0.010***
	(0.001)	(0.001)
LIOCon	0.001**	0.002***
	(0.000)	(0.000)
LIODiv	0.001	0.001
	(0.001)	(0.001)
Control Variables	YES	YES
Observations	44,071	44,071
R-squared	0.417	0.344

3.3 Before and after the 2008

This subsection investigates how the effect of institutional investors on the innovation intensity changes over time. For the following reasons, we divide the sample interval into two sample intervals “before 2008” and “after 2008”. In 2008, the financial crisis broke out, the stock market experienced extreme volatility, investors suffered huge losses in the volatile market. Institutional investors have a professional analysis team, have more information advantages than individual investors, and shoulder the social expectation of curbing market violations and improving market quality. Therefore, the cultivation of qualified institutional investors is considered to be one of the important ways to supervise the management of listed companies and improve the quality of the market. As the chairman of China Securities Regulatory Commission (CSRC), Shang Fulin is one of the previous chairmen of CSRC who attaches the most attention to the cultivation of institutional investors. In 2008, Shang Fulin repeatedly advocated and encouraged the increase of institutional ownership in the stock market in the form of speeches, discussions and signed

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articles. Under the influence of regulatory policies, the proportion of institutional ownership in China's stock market has increased significantly since 2008.

Table 3 reports the effects of different types of institutional ownership on the innovation intensity of listed companies before and after 2008. The empirical results show that the impact of short-diversified and long-concentrated institutional investors on innovation intensity of listed companies is only significant in the "after 2008" sample interval. This result shows that after the outbreak of the financial crisis in 2008, the short-diversified and long-concentrated institutional investors in China's stock market have a stronger role in promoting the innovation intensity of listed companies.

Table 3.Before and after the 2008 financial crisis

	Before 2008		After 2008	
	(1)	(2)	(3)	(4)
VARIABLES	LnInv	LnInvIa	LnInv	LnInvIa
SIOCon	0.011	0.001	0.000	0.003
	(0.010)	(0.006)	(0.007)	(0.006)
SIODiv	0.005	0.001	0.010***	0.009***
	(0.007)	(0.001)	(0.001)	(0.001)
LIOCon	0.001	0.001*	0.001**	0.001***
	(0.001)	(0.001)	(0.000)	(0.000)
LIODiv	0.004**	0.004***	-0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables	YES	YES	YES	YES
Observations	15,278	15,278	28,793	28,793
R-squared	0.236	0.167	0.358	0.301

4. Robustness Test

In order to increase the reliability of the conclusion, a series of robustness analysis are carried out:

First, difference-in-differences (DID). In order to control the choice preference of institutional investors and the influence of time trend, this paper uses the difference-in-differences method to repeat the main test of this paper. The test results are listed in columns (1) - (2) of Table 4. In the regression results, the estimated coefficients of $SIODiv$ and $LIOCon$ were positive at 1% significance level.

Second, two stage least squares (TSLS). In order to reduce the impact of potential endogeneity, this paper takes the average shareholding ratio of the same type of institutional investors in the same industry in the same year as an instrumental variable, and uses two-stage least squares

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estimation to further test the robustness of the conclusion. The test results are listed in columns (3) - (4) of Table 4. The results of the two-stage least squares are the same as above mentioned.

Third, exclude minority shareholders. Large shareholders have more voting rights, which can put more pressure on management. Therefore, when classifying institutional investors, we further exclude the institutional investors whose shareholding ratio is less than 5%. The test results are listed in in columns (5) - (6) of Table 4. The empirical results show that the above findings are still valid.

Table 4.Robustness Test

	DID		TSLS		Sample screening	
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	DiffINV	DiffINVIA	INV	INVIA	INV	INVIA
SIOCon	0.001	0.000	0.003	0.002	-0.000	-0.000
	(0.001)	(0.001)	(0.006)	(0.005)	(0.005)	(0.003)
SIODiv	0.012*	0.010*	0.011***	0.010***	0.006***	0.007***
	(0.006)	(0.006)	(0.001)	(0.001)	(0.001)	(0.001)
LIOCon	0.002***	0.002***	0.001**	0.001*	0.001**	0.001**
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
LIODiv	0.001	0.001**	0.000	0.002***	0.001	0.002***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Control Variables	YES	YES	YES	YES	YES	YES
Observations	43,752	44,071	44,071	44,071	44,071	44,071
R-squared	0.101	0.079	0.417	0.344	0.415	0.342

5. Conclusion

This paper empirically tests the impact of different types of institutional investors on the intensity of innovation activities of listed companies by using non-financial listed companies in China's A-share stock market from 1990 to 2019 as research samples. The empirical results show that short diversified and long concentrated investors can enhance the innovation intensity of listed companies. The higher their ownership, the greater the total number of patent applications and invention patent applications of listed companies. In addition, we findthat the positive relationship between short diversified and long concentrated investors and innovation activity intensity of listed companies is more significant after 2008.

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