

# **How Do Institutional Investors Swell Firm Innovation: Evidence from China's High-tech Companies**

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## **Abstract**

By using the panel data of China's high-tech listed companies in 2013-2018, this paper shows common funds as active institutional investors significantly promotes firms' R&D investment. For every 10 percentage point increase of common fund ownership rate, high-tech firms' R & D expense ratio and R & D staff ratio would increase respectively by 0.1 and 2.3 percentage points. The impact is greater in more technology-intensive companies. But institutional investors have no influence on firms' innovation productivity measured by the number of patents gained per million R & D expenses. Further research suggests institutional investors affect high-tech firms' innovation through two channels. In the corporate governance channel, institutional investors raise firms' capitalisation ratio of R&D expenses to balance R & D investment and short-term earnings pressure and also increase management monetary compensation with stronger incentive for firm innovation. In the capital funding capacity channel, institutional investor shareholding as a signal for firm quality increases the chance of firms' equity refinancing. Every 10 percentage point increase of common fund ownership rate raises the likelihood of firms' seasoned equity offerings in the following three years by nearly 1 percentage point.

**JEL classification numbers:** G32, G23, G14

**Keywords:** institutional investors, firm innovation, corporate governance, capital funding capacity.

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## 1. Introduction

The Institutional investors, as professional investors with information advantages, are key players in the market for capital allocation, value discovery and promotion of innovation. Kyle (1985), Black (1986), Grinblatt and Keloharju (2001) suggest institutional investors are informed traders, while individual investors are noise traders. Ekkehart et al. (2009) use U.S. stock data from 1983 to 2004 to find the higher the institutional investor's shareholding, the more effective the stock pricing is. Studies from Bushee (1998), Eng and Shackell (2001) and Aghion et al. (2013) support a positive relationship between institutional investor ownership and firm innovation in the US.

China has continued to support institutional investors especially common funds to play a key role in the A share market since 2000s. The Chinese policymakers believe they can help improve corporate governance and stabilise the market (Yuan et al., 2008; Firth et al., 2016). Most studies show institutional investors improve firms' corporate governance, performance and innovation (Firth et al., 2010, 2016). But a few research points out institutional investors in the A-share market have short-sighted behaviours and because of the principal-agent problem, and play a passive role in corporate innovation (Yuan et al., 2009).

In July 2019, China officially launched its Sci-Tech innovation board (STAR board) dominated by institutional investors, hoping to strengthen support to technology innovation and industrial upgrading. According to Shanghai Stock Exchange, the STAR board targets high-tech companies especially in high-end equipment, new materials, new energy, environmental protection, biomedicine, internet, artificial intelligence and other strategic emerging industries.

To find out institutional investors' role in high-tech innovation, we select the A-share listed companies in six technology-intensive industries<sup>3</sup> as sample companies. Using the panel data from 2013 to 2018, we study the impact of common fund ownership on high-tech firm innovation and its specific working channels.

Our research shows institutional investors significantly promote the R & D expenses of China's high-tech companies, but has no impact on the innovation productivity. The impact on the R & D expenses is greater for more tech-intensive companies with higher R & D to revenue ratios. We find institutional investors influence the innovation spending through the channels of corporate governance and capital funding capacity. In the corporate governance channel, institutional investors increase high-tech firms' capitalization ratio of R & D expenses to balance R & D investment and short-term earnings pressure. And institutional investors also boost the management monetary compensation, supporting firms' innovation. In the capital funding capacity channel, institutional investor shareholding as a signal for firm quality increases the success rate of its equity refinancing in the market.

Our paper enriches the existing literature in two ways. First, we select listed

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<sup>3</sup> The six technology-intensive industries include aerospace, machinery, electrical equipment, automotive, medical equipment and information technology, which are consistent with the targets of the STAR board.

companies in some representative high-tech industries that are consistent with the targets of the STAR board as sample companies. Previous research mainly focuses on all companies. But high-tech companies and other companies are so different that we may get some new findings. Second, there is much literature on institutional investors' impact on firm innovation, but the specific impact channels receive less attention. This paper focuses on how institutional investors influence firms' innovation and identifies the specific channels.

The article advances as follows. Section 2 presents the literature. Section 3 proposes the research hypotheses. Section 4 includes model design and data. Section 5 shows empirical results with discussion on the endogeneity. Section 6 provides the conclusion.

## **2. Literature**

### **2.1 Institutional investors' role in firm innovation**

Institutional investors become increasingly important players in the stock market (Davis and Thompson, 1994). But there is much controversy about what roles institutional investors play in firms' innovation.

Some research suggests institutional investors have a positive impact on firm innovation. Corporate R & D investment is positively related to the institutional investor ownership as institutional investors can help corporate realize its long-term business strategies and goals (Baysinger, 1989). Institutional investors have information advantage and can help firms to make good decisions on R & D projects (Black, 1992). Institutional investors can exert pressure on the management to adjust firms' R & D investment to improve firm performance (Hansen and Hill, 1991). Hoskisson et al. (2002) find pension funds have positive effects on the technological innovation of listed companies as they care about long-term benefits. Suk Bong Choi et al. (2012) show institutional investors and overseas shareholders have a positive impact on technological innovation of the company. Luong et al. (2017) also find a positive correlation between institutional investor ownership and corporate technological innovation. Kochhar and David (1996) point out different types of institutional investors have different effects on corporate innovation as pressure-resistant boycotted institutional investors are more likely to promote the company's innovation activity. Bushee et al. (1998) and Zhang et al. (2018) suggest that long-term institutional investors can promote R & D investment and innovation achievement compared with short-term institutional investors.

Other studies mark negative or no significant impact of institutional investors on firm innovation. Froot et al. (1992) argue institutional investors also face information asymmetry so that they cannot effectively oversee the R & D projects to boost firm innovation. Samuel (1996) finds institutional investor ownership has a negative impact on companies' R & D and advertising expenses. Chung et al. (2003) believe institutional investors have no obvious promotion effect on corporate R & D investment.

## **2.2 How institutional investors influence firm innovation**

Most research focuses on corporate governance as the main channel for institutional investors to affect firm innovation. From a positive perspective, institutional investors are pro-active and have both incentive and capacity to monitor firms' innovation behaviour. As innovation is good for firm value, institutional investors will use their voting right to boost firm innovation. Aghion et al. (2009) argue that institutional investors are positively correlated with technology innovations in listed companies because they increase the effectiveness of corporate governance. Stock market reports positive returns to R & D expenses and patents (Griliches, 1981; Erickson and Jacobson, 1992) as the innovation activity will increase firms' profits and value (Paul, 1991; Sorescu and Spanjol, 2008). Institutional investors are proactive in monitoring firm managers (Jensen, 1991). Holderness & Sheehan (1988) argue higher proportion of institutional investor ownership leads to more benefits of voting as institutional investors can influence firms' important strategy including the R & D investment.

The passive view of institutional investors is based on the assumption that institutional investors are short-sighted. Because of information asymmetry or principal-agent problem, institutional investors only care about their performance in the near term and dislike uncertainty or risk in the future. Firms face challenges of high costs, uncertain payoffs and risk of failure in innovation investment (Sood and Tellis, 2009). The payback period of R & D investment is long and uncertain and institutional investors may force the management to cut R & D projects with long-term benefits. David et al. (2006) find short-term institutional investors may lead managers to chase short-term interests. Tian and Wang (2011) find tolerance for failure spurs firm innovation as IPO firms backed by more failure-tolerant VC investors are significantly more innovative.

Some other channels may also work. Institutional investors may impact firm innovation by influencing the management compensation (Khan et al., 2005), firms' earnings management behaviour (Koh, 2003) and dividend policy (Jensen, 1987; Grinstein, 2005). Higher stock liquidity may impede firm innovation as it increases exposure to hostile takeovers and presence of institutional investors who do not actively gather information or monitor (Fang et al., 2014).

The existing literature provides important reference for the research on institutional investors' role in China's high-tech companies. But there are still some defects: First, previous research has mostly focused on the entire share market as little literature has specifically referred to high-tech companies. But high-tech companies are so different from other companies that we may get contrary conclusions. Second, the previous research has mainly focused on the effects without in-depth analysis on the specific channels. Some studies have explored the impact of institutional investors on corporate governance, but lacked of further analysis on how the channel works.

### **3. Research hypotheses**

**Hypothesis 1:** Institutional investor ownership remarkably promotes the R&D expenses and productivity of China's high-tech companies.

The "Myopia Theory" suggests that institutional investors' pursuit of short-term benefits will prompt companies to lessen their R & D investment. But this paper holds that institutional investors care more about the future value growth in investing high-tech companies and the current innovation spending decides companies' value growth in future. The research by Lev and Sougiannis (1996) show a positive relationship between R & D and economic growth, future results and gains in business productivity. Therefore, institutional investors have incentive to influence and monitor managers' decision on R&D projects. Institutional investors also have the ability to impact management's actions directly throughout their ownership and indirectly by trading their stocks (Gillan and Stark, 2003). A few studies suggest managers generally limit R&D spending to realize a positive short-term result (Baber et al, 1992; Thurow, 1993; Perry and Grinaker, 1994). By voting by hand, institutional investors can promote high-tech companies' R&D expenses and innovation productivity.

In addition, high-tech companies have higher degree of asymmetric information than ordinary ones. As professional investors, institutional investors have an information advantage. Institutional investor ownership can boost firm value by passing a signal for firm quality to the market. This will in turn supports firms' innovation expenses by raising their capital funding capacity.

**Hypothesis 2:** Institutional investor ownership plays a greater role in promoting the innovation of those high-tech companies with higher R&D intensity.

Industries with high R&D spending intensity need more R&D investment, which will also cause more R&D cost. Lev (1999) suggests that R & D is the main assets of the high technology and biotechnology, which contributes significantly to the productivity and value creation of high-tech companies.

Therefore, institutional investor ownership should have a more significant impact on the innovation activity of those high-tech companies with higher R&D intensity.

**Hypothesis 3:** Institutional investor ownership promotes high-tech companies' innovation expenses by increasing the earnings management behaviours in term of R&D expense capitalisation.

Institutional investors care about both the R&D investment for future value growth and short-term results. Capitalisation of R&D expenses allows companies to better balance between increasing R&D investment and relieving short-term result pressure. Iskandar Rebai (2010) shows the involvement of institutional investors in the firms' capitals aggravates earnings management behaviours.

High-tech companies feature high R&D investment and asymmetric information. Capitalisation of R&D cost is the earnings management behaviour of high-tech companies directly related to innovation investment. The new accounting standards carried out in 2006 allow companies in China to capitalise part of R&D expenses during the development stage. In reality, technology companies have much freedom

in choosing whether to capitalise their R&D cost. Capitalisation will amortise the R&D expenses gradually over a longer period, mitigating the impact of large-scale innovation cost on short-term profits.

Institutional investors in China A-shares market share the characteristics of both short-term investors and long-term investors, that is, they focus on not only the long-term value growth of enterprises, but also their short-term profitability. Institutional investors encourage high-tech companies to increase the capitalisation ratio of R&D expenses, by it boosting the long-term value growth while relieving the pressure on short-term profitability. Research by Jia Mingqi et al. (2010) reveals that capitalisation of R&D cost is conducive to reinforcing corporate R&D investment. Nevertheless, capitalisation of R&D is merely an accounting treatment, and will not affect innovation efficiency. In view of the above analysis, the paper propose hypothesis 3 that institutional investor ownership will promote companies' innovation expenses by increasing the capitalisation ratio of R&D cost in high-tech companies.

**Hypothesis 4:** Institutional investor ownership promotes high-tech companies' innovation expenses and productivity by raising management compensation incentives (monetary compensation or equity incentives).

Compensation incentives mainly refer to the perspectives of monetary compensation, equity incentives or other performance-based payment. Most scholars find institutional investor ownership will increase monetary compensation to the management (Feng et al., 2010), and improve the sensitivity of management compensation to the performance (Almazan, 2005). A few research suggests monetary compensation and equity incentives to the management are positive to corporate innovation, but the performance-based payment is in negative correlation to corporate innovation (Bryan and Hwang, 2000; Wu and Tu, 2007).

On account of the existing research, this paper propose hypothesis 4 that institutional investor ownership promotes the innovation expenses and productivity by raising compensation incentives (monetary compensation or equity incentives) to the management.

**Hypothesis 5:** Institutional investor ownership increases high-tech companies' R&D investment by raising their capital funding capacity.

Serious asymmetric information exists in the A-shares market (Chakravarty et al., 1998). The management and institutional investors have firm quality information, but ordinary investors do not have that information, and herd by following institutional investors' transactions (Lin Tan et al, 2008). Because of higher asset specificity, high-tech companies have more severe information asymmetry. Institutional investors' shareholding passes the signal on firm quality to the market, boosting firm valuation. This in turn raises the high-tech companies' capital funding capacity and supports their R&D expenses.

Based on analysis, this paper propose hypothesis 5 that institutional investor ownership increases high-tech companies' R&D investment by raising their capital funding capacity.

## 4. Method

### 4.1 Variable

#### Explained variable

The explained variable for the empirical study is high-tech companies' innovation. There are a few variables, such as R&D expenses, R&D staff number and the number of patents, to measure firm innovation. But all these variables are closely related to firm size, while institutional investors prefer large firms because of the liquidity issue. This may cause the endogeneity problem. Based on the experience of Luong et al. (2017), this paper normalises the innovation variables by dividing them by other variables related to firm size.

We use three variables to measure high-tech companies' innovation.

- 1) R&D expense to income ratio (named "rdex") reflects the innovation cost or expense intensity.
- 2) R&D staff number to total staff number ratio (named "rdem") measures the R&D human capital and innovation personnel input.
- 3) The number of patents per million R&D expenses (named "patent") shows the innovation productivity. We set up three models with "rdex", "rdem" and "productivity" as the corresponding explained variables.

#### Explanatory variable

We have two categories of explanatory variables.

One is the institutional investor ownership rate, which is the focus of this paper. China has a few kinds of institutional investors, including common funds, private funds, security companies, insurance companies, and social security funds. The data is incomplete on the shareholdings of private funds and security companies in listed companies. Insurance companies and social security funds are passive institutional investors mainly investing in index products. Only common funds are transparent and active institutional investors in the market with available data. Therefore, we use common fund ownership rate (named "inst"), measured by common fund shareholdings as % of total free float shares, to represent institutional investor ownership.

The other is control variables. By excluding the effects of control variables, we can estimate the "net impact" of institutional investor ownership on firm innovation. Drawing on the existing literature's experience, we generate three control variables in this paper.

- 1) The natural logarithm of annual sales (named "sales") reflects the firm scale.
- 2) The dummy variable (named "soe") refers to the nature of the company's controller. When the controller is governments, public institutions, or state-owned enterprises, soe = 1, otherwise soe = 0.
- 3) The largest shareholder's ownership rate (named "larshratio") represents the equity concentration.

To analyse the specific impact channels, this paper also sets up extended models with some other explanatory variables.

First, we generate the interaction term (named "instrdamort") between the common

fund ownership rate and the capitalisation ratio of R&D expenses to analyse whether institutional investors influence firm innovation through the channel of earnings management.

Second, we use two interaction items to analyse whether institutional investors exert influence on firm innovation through the channel of management compensation incentives. One is the interaction between common fund ownership rate and management ownership rate. The other is the interaction between common fund ownership rate and top three managers' average annual salary.

Third, we set up a logit model for regression to verify the channel of capital funding capacity in the institutional investors' impact on firm innovation. We create a dummy variable (named "financing") according to whether high-tech companies provide seasoned equity offerings within three years after institutional investors hold shares. The dummy variable is the explained variable for the Logit model while the explanatory variables include the number of years companies have been listed for and the common fund ownership rate.



**Table 1: Variable description**

Variable		Description
Explained variables	rdex	R&D expenses to sales revenue ratio
	rdem	R&D staff number to total staff number ratio
	patent	Number of patents gained per million R&D expenses
	financing	Dummy variable: if firm saw equity refinancing in following three years after common fund shareholdings, financing=1, otherwise financing=0
Explanatory variables	inst	Common fund shareholdings as % of total free float shares
	sales	The natural logarithm of annual sales revenue
	soe	Dummy variable: when the actual controller is the government, public institution, or state-owned enterprises, soe = 1, otherwise soe = 0
	larshratio	The shareholding ratio of the largest shareholder
	instrdamort	The interaction term between the institutional investor ownership ratio and the capitalisation ratio of R&D expenses
	instmanagshare	The interaction between institutional investor ownership ratio (inst) and management ownership ratio
	instmanagwage	The interaction between institutional investor ownership ratio (inst) and top three managers' average annual salary
	year	The number of years companies have been listed for by end-2018

## 4.2 Basic models

To examine Hypothesis 1, this paper erects the model (1) by drawing on lessons from the research method of Luong et al. (2017).

$$Innovation_{it} = \alpha + \beta \cdot inst_{it} + \gamma \cdot X_{it} + \varepsilon_{it} \quad (1)$$

$Innovation_{it}$  is the explained variables described in Table 1. We conduct three regressions with R&D expense to income ratio (“rdex”), R&D staff number to total staff number ratio (“rdem”) and the number of patents gained per million R&D expenses (“patent”) as the respective explained variables.  $inst_{it}$  is the common fund ownership rate.  $X_{it}$  is the vector of control variables, including the natural logarithm of annual sales (“sales”), the nature of firm controller (“soe”), and the largest shareholder’s ownership rate (“larshratio”).

To examine Hypothesis 2, this paper divides sample companies into two groups by sorting their R&D expense to income ratios and performs grouped regressions using the model (1).

To examine Hypothesis 3, this paper builds model (2).

$$Innovation_{it} = \alpha + \beta \cdot inst_{it} + \gamma \cdot X_{it} + \delta \cdot instrdamort_{it} + \varepsilon_{it} \quad (2)$$

$instrdamort_{it}$  is the interaction item between common fund ownership rate and the capitalisation ratio of R&D expenses. Other variables are the same as those in model (1).

To examine Hypothesis 4, we set up model (3).

$$Innovation_{it} = \alpha + \beta \cdot inst_{it} + \gamma \cdot X_{it} + \delta \cdot instmanagshare_{it} + \theta \cdot instmanagwage_{it} + \varepsilon_{it} \quad (3)$$

$instmanagshare_{it}$  is the interaction item between the common fund ownership rate and the management shareholding ratio.  $instmanagwage_{it}$  is the interaction item between common fund ownership rate and top three managers' average annual salary. Other variables are the same as those in model (1).

To examine Hypothesis 5, we build model (4).

$$financing_i = \alpha + \beta \cdot inst_i + \gamma \cdot year_i + \varepsilon_i \quad (4)$$

$financing_i$  is the dummy variable related to companies' equity refinancing events. In case high-tech companies refinanced with seasoned equity offerings in the three years following common fund shareholdings, the value is 1, otherwise the value is 0.  $year_i$  is the number of years high-tech companies have been listed for at the end of 2018.  $inst_i$  is the common fund ownership rate.

### 4.3 Data source

Based on the accessibility of data, this paper selects 890 A-shares companies whose main business is part of the six high-tech industries, and which were listed before the end of 2017. We take the panel data of those companies ranging from 2013-2018 as the sample data. Some companies which got listed late are lack of data for some years. But we keep those companies' existing data for the rest of years to expand the sample size with more information. We remove the special treated shares ("St" shares) to ensure the accuracy of the empirical study. We gather all data from Wind database and GTA database. Table 2 offers the descriptive statistics of the variables.

**Table 2: Descriptive Statistics**

Variable		Mean	Std. Dev.	Min	Max	Observations
rdex	overall	7.145	6.2	0.0	76.4	N=4728
	between		5.7	0.1	49.0	n=888
	within		2.5	-19.7	56.0	T-bar=5.3
rdem	overall	4.4	7.4	0.0	56.9	N=5340
	between		5.0	0.0	33.6	n=890
	within		5.5	-26.1	43.6	T=6
patent	overall	0.70	6.49	0.000	360.0	N=4407
	between		6.37	0.002	187.4	n=889
	within		4.14	-186.0	173.3	T=5.0
inst	overall	4.3	7.9	0.0	62.4	N=5340
	between		9.6	-65.1	50.0	n=890
	within		11.7	-202.8	92.9	T=6
larshratio	overall	26.0	18.7	0.0	93.9	N=5340
	between		13.4	0.0	80.1	n=890
	within		13.1	-38.0	74.4	T=6
sales	overall	18.5	6.8	0.0	27.5	N=5340
	between		3.5	0.0	27.3	n=890
	within		5.8	-1.2	38.1	T=6
soe	overall	0.1	0.3	0.0	1.0	N=5340
	between		0.3	0.0	1.0	n=890
	within		0.1	-0.7	1.0	T=6

## 5. Main Results

### 5.1 Basic regressions

To test Hypothesis 1, we use the model (1) to conduct three regressions with “rdex”, “rdem” and “patent” as the respective explained variables. To avoid missing out other important explanatory variables, we generate the first-order lag terms of the explained variables as proxy variables for other important explanatory variables.

Table 3 shows the regression results. Common funds as important institutional investors have a significant impact on high-tech companies’ R&D expenses and personnel input. Every 10 percentage point increase in the common fund ownership rate boosts the R&D expenses to revenue ratio and R&D staff to total staff ratio by 0.1 and 2.3 percentage points, respectively. But the common fund ownership has no marked impact on the innovation productivity or number of patents gained per million R&D expenses.

For other explanatory variables, the ownership concentration has no significant influence on high-tech companies’ R&D expenses and personnel input, but it has a slight positive impact on the innovation productivity. Each 10 percentage point increase in the largest shareholder’s ownership ratio improves the number of patents

gained per million R&D expenses by 0.05. The intuition is higher ownership gives the largest shareholder stronger motivation and capacity to oversee firm innovation activity, which boosts the innovation productivity.

The firm scale measured by sales income has a significant negative impact on the R & D expenses and innovation productivity, yet a positive influence on the R&D personnel input. Each 10% increase of sales income lowers the R&D expense to income ratio and the number of patents gained per million R&D expenses by 2.8 percentage points and 0.3, respectively. But it increases the R&D staff number to total staff number ratio by 2.7 percentage points. Sales income has a negative impact on the R&D expense to income ratio, probably because the former is the denominator for the latter. The negative effect of sales revenue on the innovation productivity may reflect the law of diminishing marginal return. Large companies with more R&D investment may have to face lower marginal return and innovation productivity. Because large companies can afford more personnel cost with higher ratio of R&D staffs, sales income has a positive impact on the R&D personnel input. The state ownership increases high-tech companies' R&D expenses and staffs, yet has no impact on the innovation productivity. The R&D expense to income ratio of the state-owned high-tech companies is 0.28 percentage point higher than that of the non-state-owned companies.

**Table 3: Basic Regressions**

	(1) rdex	(2) rdem	(3) patent
L.#	0.86 <sup>***</sup>	0.791 <sup>***</sup>	0.404 <sup>***</sup>
	(108.26)	(20.43)	(84.95)
inst	0.011 <sup>*</sup>	0.23 <sup>**</sup>	-0.002
	(1.69)	(2.75)	(-0.51)
larshratio	-0.004	0.023	0.005 <sup>***</sup>
	(-1.42)	(0.59)	(2.64)
sales	-0.282 <sup>***</sup>	0.272 <sup>*</sup>	-0.031 <sup>***</sup>
	(-6.98)	(1.85)	(-3.88)
soe	0.275 <sup>*</sup>	-1.319	-0.094
	(1.84)	(-0.72)	(-0.91)
_cons	7.092 <sup>***</sup>	0.863	0.712 <sup>***</sup>
	(8.38)	(0.32)	(4.8)
N	3826	4450	3514
Groups	887	890	889
R-sq: within	0.079	0.047	0.51
R-sq: between	0.948	0.296	0.952
R-sq: overall	0.781	0.095	0.676
Note: The t-test values are shown inside parentheses. ***, **, and * indicate the significance at 1%, 5%, and 10% of significant levels respectively. L.# represents the first-order lag term of the explained variable.			

## 5.2 Grouped regressions

To verify Hypothesis 2, we divide sample companies into two groups and use grouped regressions for comparison. We sort sample companies by their R&D expense to income ratios and divide the sample into two groups with basically the same number of companies. Group one has high R&D expense to income ratios above 5.1%, and Group two has low R&D expense to income ratios below 5.1%. We use the two groups to conduct two regressions separately based on the model (1).

The empirical results in Table 4 support our Hypothesis 2. Institutional investors have a more significant impact on the R&D expenses and personnel input of group one companies with high R&D intensity. But the impact on the innovation productivity is not significant for both group one and group two companies. Every 10 percentage point increase in the common fund ownership rate lifts the R&D expense to income ratio by 0.1 percentage point for group one companies, yet has no influence on the ratio for group two companies. For each 10 percentage point rise in common fund ownership rate, the R&D staff ratio for group one and group two companies respectively increases by 2.3 and 1 percentage points. But common fund ownership has a slight negative impact on the innovation productivity on group one companies, yet no influence on that of group two companies.

**Table 4: Grouped Regressions**

	<b>Group one: high R&amp;D intensity</b>			<b>Group two: low R&amp;D intensity</b>		
	(1) rdex	(2) rdem	(3) patent	(1) rdex	(2) rdem	(3) patent
L.#	0.8***	0.74***	0.238***	0.662***	0.7***	0.237***
	(62.5)	(11.8)	(14.6)	(42.6)	(45.6)	(40.2)
Inst	0.01*	0.23*	-0.006*	-0.003	0.103***	0.003
	(1.75)	(1.7)	(-1.89)	(-1.02)	(4.85)	(0.46)
Larshratio	-0.01	0.031	0.005***	-0.001	0.045***	0.002
	(-1.3)	(0.46)	(2.84)	(-0.79)	(5.46)	(1.01)
Sales	-0.45***	0.529	-0.013**	-0.033*	0.176***	-0.018**
	(-5.6)	(1.59)	(-2.03)	(-1.9)	(5.61)	(-2.31)
Soe	0.622*	-1.70	-0.165*	-0.02	0.281	-0.246**
	(-0.47)	(-0.47)	(-1.77)	(-0.34)	(0.74)	(-1.97)
_cons	11.67***	-0.61	0.577***	2.049***	0.002	0.763***
	(6.98)	(-0.10)	(4.7)	(5.44)	(0.01)	(5.41)
N	1950	2220	1736	1883	2225	1712
Groups	443	444	441	445	445	440
R-sq: within	0.082	0.041	0.004	0.125	0.419	0.000
R-sq: between	0.923	0.189	0.685	0.838	0.864	0.920
R-sq: overall	0.702	0.067	0.188	0.514	0.541	0.543

Note: The t-test values are shown inside parentheses. \*\*\*, \*\*, and \* indicate the significance at 1%, 5%, and 10% of significant levels respectively. L.# represents the first-order lag term of the explained variable.

### 5.3 Endogeneity and robustness

The empirical tests in the previous parts may face the endogeneity problem. Common funds may pay attention to company innovation indicators in making investment decision. Therefore, it is not common fund ownership impacts company innovation, but the later influences the former.

The premise of the endogeneity problem is high-tech companies' innovation indicators contain information of future stock returns and common funds rely on the innovation indicators to make investment decisions. To improve the robustness of this paper, we draw on the processing approach of Appel et al. (2016) and apply the quasi-natural experiment method to justify the relationship between the common fund ownership and firm innovation. Capital Asset Pricing Model (CAPM) provides an important implication that investors' optimal asset allocation is a combination of the risk-free return and stock market portfolio. The investment weight of a stock in the investors' portfolio is just equal to its market capitalization weight in the market portfolio. Active common funds often use the popular market index to evaluate fund managers' performance. The common fund ownership rate of a shock is strongly correlated with the weight of the stock in the popular market index. The popular market index is different from the market portfolio in the CAPM as the index does not include all stocks in the market. Whether a stock is included in the popular market index can be regarded as a quasi-natural experiment. We can set up a dummy variable based on whether a shock is included in the market index as an instrument variable for common fund ownership rate.

In the A-shares market, the CSI 300 Index is the most representative and popular benchmark to evaluate common fund managers' performance. But only less than 50 of our sample companies belong to the constituent stocks of CSI 300 Index. Therefore, we select the CSI 800 Index as a broader index with more constituent stocks to represent the market index. About 150 of the sample companies are included in CSI 800 Index<sup>4</sup>. We set up a dummy variable (index) based on whether the stock is a constituent shock of the CSI 800 Index. If the sample company is a constituent stock of the CSI 800 Index, its dummy variable value is 1, otherwise the dummy variable value is 0. The dummy variable (index) is an instrumental variable for common fund ownership (inst).

We use the instrument variable to replace common fund ownership rate to conduct the regressions in the model (1). The empirical results are in the left part of Table 5. The results show the inclusion to the CSI 800 index has a remarkably positive impact on the R&D expenses of high-tech companies. On average, the inclusion to the CSI800 index lifts high-tech companies' R&D expense to income ratio by 1 percentage. But it has no significant impact on the R&D personnel input and innovation productivity.

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<sup>4</sup> The constituent stocks of the CSI 800 Index are adjusted annually. From 2013 to 2018, on average, 150 of the 890 sample companies belong to the constituent stocks of the CSI 800 Index.

**Table 5: Instrumental Variable Regressions**

	<b>(1) rdex</b>	<b>(2) rdem</b>	<b>(3) patent</b>
L.#	0.857***	0.789***	0.404***
	(107.9)	(20.5)	(84.96)
index	1.05***	0.292	-0.071
	(7.17)	(0.17)	(-0.72)
report			
larshratio	-0.005	0.024	0.005***
	(-1.6)	(0.63)	(2.67)
sales	-0.339***	0.294**	-0.031***
	(-7.81)	(2.0)	(-3.87)
soe	0.266*	-1.922	-0.083
	(1.79)	(-1.05)	(-0.8)
_cons	8.28***	0.991	0.708***
	(9.1)	(0.36)	(4.77)
N	3826	4450	3514
Groups	887	890	889
R-sq: within	0.08	0.047	0.51
R-sq: between	0.948	0.297	0.952
R-sq: overall	0.781	0.094	0.676
Note: The t-test values are shown inside parentheses. ***, **, and * indicate the significance at 1%, 5%, and 10% of significant levels respectively. L.# represents the first-order lag term of the explained variable.			

## 5.4 Specific Working Channels

### 5.4.1 The R&D Expense Capitalisation for Earnings Management

The capitalisation ratio of R&D expenses (named “rdamort”) is the capitalised R & D expenses as % of total R & D expenses. This paper use the capitalisation ratio of R&D expenses to represent high-tech companies’ earnings management behaviour related to the R&D costs. We try to corroborate whether institutional investors influence high-tech companies’ innovation by changing their earnings management behaviour. We create an interaction term (named “instrdamort”) between common fund ownership rate and the capitalisation ratio of R&D expenses to conduct a regression on the model (2). Table 6 gives the regression results.

We find the interaction term has a significant positive impact on corporate R&D expenses and personnel input. An increase of the interaction term by 10 percentage points raises the R&D expense to income ratio and R&D staff number to total staff number ratio to 0.01 and 0.07 percentage point, respectively. The intuition is that institutional investors care about both company innovation and short-term earnings performance and the capitalisation of R&D expenses makes it possible to seek a better balance between the two conflicting targets. With a higher capitalisation ratio

of R&D costs, high-tech companies can increase R&D expenses without adding too much pressure on short-term earnings. Therefore, institutional investors have strong motivation to press high-tech companies to raise the capitalisation ratio of R&D expenses.

But the interaction term has no significant influence on the innovation productivity measured by patents gained per million R&D expenses. The capitalisation of R&D expenses is only an accounting treatment method and it has nothing to do with the innovation productivity.

**Table 6: Regressions to Test the Channel of R&D Expense Capitalisation**

	(1) rdex	(2) rdem	(3) patent
L.#	0.821***	0.747***	0.014***
	(78.0)	(55.3)	(3.21)
Inst	0.001	0.234***	-0.003
	(0.09)	(7.89)	(-1.19)
Larshratio	-0.002	0.067***	0.002
	(-0.50)	(5.55)	(1.3)
Sales	-0.4***	-0.797**	-0.148***
	(-7.17)	(-4.42)	(-6.53)
Soe	0.535***	0.438	-0.029
	(2.63)	(0.66)	(-0.33)
Instrdamort	0.001**	0.007***	-0.0001
	(2.41)	(4.57)	(-0.83)
_cons	9.65***	21.81***	3.529***
	(8.26)	(5.94)	(7.55)
N	3074	3462	3209
Groups	880	888	887
R-sq: within	0.102	0.280	0.005
R-sq: between	0.903	0.821	0.058
R-sq: overall	0.807	0.491	0.043
Note: The t-test values are shown inside parentheses. ***, **, and * indicate the significance at 1%, 5%, and 10% of significant levels respectively. L.# represents the first-order lag term of the explained variable.			

#### 5.4.2 Management Compensation Incentives

Management compensations consist of both equity and monetary incentives. This paper uses the management ownership rate and top three managers' average annual salary to represent the two categories of compensation incentives.

To verify Hypothesis 4, that is, whether institutional investor ownership influences company innovation by changing the management compensation incentives, we generate two interaction terms to conduct a regression based on the Model (3). One interaction term (named "instmanagshare") is between the common fund ownership



rate and the management ownership rate, and the other interaction term (named “instmanagwage”) is between the common fund ownership rate and the natural logarithm of top three managers’ average annual salary. Table 7 shows the empirical results.

We find the management equity incentive channel is not significant in institutional investors’ impact on high-tech companies’ innovation. The management monetary incentive channel is significant in the impact on R&D expenses, yet not significant in the impact on R&D staff ratio and on the innovation productivity. In other words, institutional investors can influence high-tech companies’ R&D expenses by improving the management monetary incentives.

The results reflect China’s underdevelopment in the management equity incentives, which are popular in western countries. The management equity incentives are not popular in China so that they have may have no impact on corporate innovation.

**Table 7: Regressions to Test the Channel of Management Compensation Incentives**

	(1) rdex	(2) rdem	(3) patent
L.#	0.85 <sup>***</sup>	0.723 <sup>***</sup>	0.426 <sup>***</sup>
	(97.8)	(16.2)	(84.7)
Inst	-0.496 <sup>**</sup>	-0.055	-0.037
	(-4.81)	(-0.03)	(-0.43)
Larshratio	-0.009 <sup>**</sup>	-0.094 <sup>***</sup>	0.006 <sup>**</sup>
	(-2.26)	(-1.8)	(2.19)
Sales	-0.375 <sup>***</sup>	0.478 <sup>**</sup>	-0.048 <sup>**</sup>
	(-8.3)	(2.35)	(-4.38)
Soe	0.285 <sup>*</sup>	-2.33	-0.07
	(1.8)	(-1.15)	(-0.65)
Instmanshare	-0.0004	0.002	0.0001
	(-1.33)	(0.51)	(0.03)
Instmanwage	0.039 <sup>***</sup>	0.009	0.003
	(4.38)	(0.07)	(0.43)
_cons	9.29 <sup>***</sup>	3.02	1.01 <sup>***</sup>
	(9.65)	(0.13)	(4.9)
N	3443	3778	2844
Groups	886	889	887
R-sq: within	0.082	0.023	0.787
R-sq: between	0.943	0.351	0.955
R-sq: overall	0.779	0.077	0.721
Note: The t-test values are shown inside parentheses. ***, **, and * indicate the significance at 1%, 5%, and 10% of significant levels respectively. L.# represents the first-order lag term of the explained variable.			

### 5.4.3 Capital funding capacity

The intuition for the channel of capital funding capacity is that institutional investor ownership sends a signal about firm quality to the market. The market will favor those companies with higher institutional investor ownership rate and raise their valuations. Those companies have stronger capital funding capacity with easy access to seasoned equity offerings. Therefore, they can afford more R&D investment and personnel input.

We can verify whether institutional investors influence company innovation through the channel of capital funding capacity by studying the relationship between institutional investor ownership and following refinancing events. In the A share market, the regulator has less administrative controls on seasoned equity offering than on IPO financing. The price of seasoned equity offering is basically market-oriented and reflects the secondary market price. According to our calculation, additional placement accounted for over 80% in the seasoned equity offering in the A share market in 2016-2017. And more than 70% of the additional placement was private placement or targeted institutional investors. High-tech companies spent over 60% of their additional placement fundraising on R&D or technology upgrading projects. Therefore, institutional investors' perception of a company's value decides its success likelihood in capital refinancing.

To study the impact of institutional investor ownership on corporate capital refinancing, this paper sets up a dummy variable (named "financing") based on whether high-tech companies provided seasoned equity offerings from 2016 to 2018. If the company had refinancing events, then financing = 1, otherwise financing = 0. Financing is taken as the explained variable, and the common fund ownership rate in 2014-2015 (named "inst")<sup>5</sup> and the number of years the company had been listed for by end-2017 (named "year") is explanatory variables. We use the Logit model for selection analysis. The variable 'year' should have a positive influence on the company's success likelihood of equity refinancing. The longer the company has been listed, the more information disclosure the company will have. More information disclosure will lead to less degree of information asymmetry, making the company easier to acquire financing.

Table 9 and 10 shows the results of the Logit model. The Logit model has a fine goodness-of-fit as it correctly identifies more than 68% of the samples. We find institutional investor ownership significantly increases the possibility of future seasoned equity offerings for listed companies. For each 10 percentage point increase in the common fund ownership rate, high-tech companies' chance of equity refinancing in the following three years will increase by nearly 1 percentage point. The number of years the company had been listed also has a significant impact on the company's probability of equity refinancing. For each additional year of being listed, high-tech companies' likelihood of seasoned equity offerings in three years

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<sup>5</sup>As the A-shares market experienced substantial fluctuations in the bull-bear cycle from 2014 to 2015, we take the average common fund ownership rate from 2014 to 2015 as the explanatory variable in the Logit model.

will increase by 0.05 percentage point.

The capital constraint is a core factor to affect corporate R&D expenses (Zhang Jie and Tang Jie, 2019). By raising their capital funding capacity, institutional investor ownership can boost the innovation of high-tech companies. The results strongly support our Hypothesis 5.

**Table 9: Results of Logit model**

<b>Inst</b>	0.094 <sup>***</sup>
	(8.96)
<b>Year</b>	0.049 <sup>***</sup>
	(4.24)
<b>_cons</b>	-1.369 <sup>***</sup>
	(-11.85)
<b>N</b>	901
<b>LR chi2(2)</b>	136.26
<b>Prob&gt; chi2</b>	0
<b>Pseudo R2</b>	0.115
Note: The t-test values are shown inside parentheses. ***, **, and * indicate the significance at 1%, 5%, and 10% of significant levels respectively. L.# represents the first-order lag term of the explained variable.	

**Table 10: Goodness-of-fit of the Logit model**

Classified	True		Total
	D	~D	
+	116	68	184
-	217	500	717
Total	333	568	
Classified + if predicted $\Pr(D) \geq 0.5$ True D defined as financing != 0			
Sensitivity	Pr(+ D)		34.83%
Specificity	Pr(- ~D)		88.03%
Positive predictive value	Pr(D +)		63.04%
Negative predictive value	Pr(~D -)		69.74%
False + rate for true ~D	Pr(+ ~D)		11.97%
False + rate for classified +	Pr(~D +)		36.96%
False - rate for classified -	Pr(D -)		30.26%
Correctly classified			68.37%

## 6. Conclusion

This paper studies the role of institutional investors in firm innovation and its specific working channels, by using the panel data of 890 listed high-tech companies from 2013 to 2018. We find institutional investor ownership has a significant impact on high-tech companies' R&D expenses and personnel input, yet no influence on their innovation productivity. The impact on R&D expenses and personnel input is more significant in those companies with higher R&D expense intensity.

The capitalization of R&D expenses for earnings management as one of the corporate governance channel plays an important role for institutional investors to influence firm innovation. By pressing companies to raise their capitalization ratio of R&D expenses, institutional investors can seek a better balance between long-term value growth and short-term earnings performance. The management monetary compensation is another corporate governance channel in institutional investors' impact on firm innovation. But the management equity incentive plays no significant role in institutional investors' impact on firm innovation, probably because the management equity incentive is not popular and has some problem in China. The capital funding capacity channel is very significant because institutional investors raise firms' funding capacity for innovation by boosting their valuation with signals about firm quality.

Based on the conclusion of this paper, we propose the following policy recommendations:

First, institutional investors promote significantly the innovation investment of high-tech companies, especially those with high R&D intensity. China should support the development of institutional investors in the A share market by improving their business environment.

Second, institutional investor ownership provide signals on firm quality, which can alleviate the information asymmetry. China should give full play of institutional investors in reforming the registration system for equity offerings. Institutional investors can play more important role in IPO pricing and value discovery to improve the capital allocation efficiency.

Third, institutional investors have no significant impact on the innovation productivity. Their impact on firm innovation through the management equity incentive channel is also not significant. This indicates institutional investors still play a weak role in the corporate governance of listed companies in China. China should push forward structural reforms in corporate law, accounting rule and capital market regulation to improve the role of institutional investors in listed companies' corporate governance to boost the innovation productivity.

**ACKNOWLEDGEMENTS.** This study was financially supported by the project of Beijing Philosophy and Social Science Foundation in 2016(16YJC045, named "Research on the influence mechanism of Beijing Science and technology finance network collaboration on enterprise innovation performance"), and the project of the National Social Science Fundation in 2019(19BJL059).

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