Research on the Relationship Between Institutional Investor Network, Government R&D Subsidy and Corporate R&D Investment: Evidence from China

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Abstract: This paper studies the relationship between institutional investor network, government subsidy and R&D investment in Chinese market. This paper selects the data of A-share listed companies from 2015 to 2020 as samples, and uses UCIENT and Stata to process and analyze the data. In this study, companies in the financial sector were excluded to avoid cross-pollination. Through empirical analysis, the research results show that the higher the degree of institutional investors' network centrality, the higher the R&D investment of enterprises. This means that a well-positioned institutional investor network can obtain more professional, high-value information, and promote corporate R&D investment through joint pressure and voting by institutional investors. In addition, this study finds that government subsidies have an incentive effect on corporate R&D investment. Further analysis verifies the moderating effect of government R&D subsidies on institutional investor network and firm R&D investment. The finding shows that government subsidies can improve the promotion effect of institutional investor network location on firm R&D investment.

Keywords: Institutional investor network, Government Subsidy, Corporate R&D investment

1. Introduction

With the rapid development of institutional investors, they are gradually not satisfied with the "voting with their feet" form of selling the shares of investee companies. More and more active institutional investors hope to improve the company's business performance by participating in corporate governance and supervising the company's operation mode, so as to increase the stock value and obtain profits. Hence the "vote with your hands" method.

In the Chinese market, as of 2018, the proportion of institutional investors holding shares of listed companies has reached 39%, which has exceeded that of individual investors, which means that institutional investors have begun to play a leading role in the capital market. As the shareholding scale of the network alliance constructed by institutional investors continues to grow, its corresponding exit cost will also increase, so the possibility of institutional investors' network involvement in corporate supervision and decision-making will increase. Compared with individual institutional investors, the network form of investment institutions has more economic motivation to participate in corporate decision-making. One of the factors that can affect future competitiveness is

innovation investment. At the same time, with the rise of the cross-study of network theory and economy, the network relationship in the financial market has been paid more and more attention by scholars, and the social attribute of institutional investors also affects the R&D investment of enterprises through the way of affecting corporate governance.

Government subsidies, as another external intervention means, encourage enterprises to carry out innovative activities by issuing R&D subsidies to enterprises. Also, because of the agency problem, enterprise managers respond negatively to enterprise innovation activities for their own personal benefits. Whether enterprises' R&D enthusiasm is enhanced by government subsidies and to what extent government R&D subsidies can improve the R&D level of enterprises are also a major topic for many scholars to study for a long time. In view of the fact that government subsidies are distributed to companies in different ways, such as tax returns and financial grants, in order to facilitate measurement and be more representative, this paper selects R&D subsidy funds in government subsidies as a moderating variable to discuss the influence relationship between institutional investor network and R&D investment of enterprises.

2. Literature review and hypotheses

2.1. Institutional investor network and corporate R&D investment

Institutional investors influence R&D investment by influencing corporate governance. McConnell and Servaes took Tobin's Q value as a measurement index of corporate performance, conducted an empirical analysis on the samples of listed companies, and found that institutional investors can promote the improvement of corporate performance, showing a positive correlation, so it can be considered that institutional investors have a certain supervisory role in companies [1]. Institutional investors reduce agency problems by influencing corporate governance, thus affecting R&D investment. Black found that institutional investors seek the value-added brought by the long-term development of enterprises, and this purpose will lead them to use market information to analyze the long-term returns of research and development projects, so as to increase the R&D expenditure of enterprises [2].

Based on social network theory and social network analysis, the position of institutional investors' network represents the ability of different individuals to obtain information resources in the network. Generally speaking, the position of institutional investors' network can be measured by the degree of centrality. Liden and Wayne found through research that the higher the centrality of individuals in the network, the better their position in the network relationship, the greater the number of social resources they can control, and the stronger their ability to obtain information [3]. At the same time, the more central network position of an individual means that it has more influence itself, and the stronger the ability to influence and unite with other individuals or organizations in the network. Fan also shows through research that institutional investor networks have a positive impact on firm innovation. Therefore, this study puts forward the following hypothesis:

H1: The higher the network centrality of institutional investors, the higher the R&D investment of the company.

2.2. Government subsidies and corporate R&D investment

Scholars at home and abroad have studied the impact of government subsidies on enterprise R&D investment from different perspectives and using different research methods, but there is still no unified answer.

One is the incentive effect. Feifei Yu&Yue Guo show that government subsidies have a significant crowding out influence on enterprises' R&D investment behavior and that the influence is further moderated by the attributes of enterprise ownership [4]. On the one hand, it can provide financial

support for enterprises, fill the gap in capital preparation, and effectively reduce the project cost of enterprises in research and development. On the other hand, government subsidies are a kind of policy signal, which means that the government and the state are supporting the enterprise's current research and development projects. This is an encouragement for corporate management and shareholders, and can improve the confidence of enterprises. Based on this, this paper proposes the following hypothesis:

H2a: Government subsidies will increase companies' R&D investment.

The other is substitution effect. Link found that government subsidies reduce the proportion of investment in basic projects, but they can promote the development of applied research and high-level experiments [5]. Lichtenberg conducted an in-depth exploration of the relationship between government subsidies and enterprise innovation activities through a regression model, and found that when IV was used for estimation, the two presented a substitution relationship, but when FEM was used for prediction, the results showed that the two had complementary effects [6]. Because of the agency problem, the goals of the company's management and shareholders are inconsistent, and the government subsidy funds may not be effectively used. Out of consideration of their own interests, the management of the company will not necessarily use all the government subsidy funds for R&D and innovation activities, but to create short-term interests of the company. Based on this, this paper proposes the following hypothesis:

H2b: Government subsidies will reduce companies' R&D investment.

2.3. The impact of government subsidies on relationship

Based on the market failure theory and information asymmetry theory, the government grants subsidies to enterprises, which to the outside world is to release a signal to encourage research and development activities, and the new products or new technologies developed by the company are supported by the government, and the prospect of the company's pending research and development projects is recognized by the national government. Generally speaking, the company is in the protection of new products and new technologies. In order to prevent important information about research and development projects from being obtained by competitors, the company is more cautious when disclosing information, and often will not publicize the progress and data results of research and development projects. Therefore, except for the shareholders who participate in the operation of the company, other shareholders such as external institutional investment organizations and individuals are difficult to obtain effective R&D information and are at the disadvantage of information. This often causes external investors to worry about the company's research and development projects. In order to avoid the loss of their funds when they are recovered, in order to reduce their investment risks, institutional investors or other external investors will reduce investment or even not invest because they cannot identify the specific research and development situation of the enterprise. This phenomenon caused by information asymmetry is not good for enterprise research and development. In this case, the government releases a positive signal to the outside world by issuing research and development subsidies, alleviating the situation of information asymmetry, so that institutional investors can realize the status quo of the company's research and development and adjust their investment strategies. At the same time, for institutional investors, the policy signal conveyed by government subsidies means that the government supports the new products or technologies developed by the company, and institutional investors supervise the company together with other investment institutions through the institutional investor network. On the one hand, the involvement of institutional investors can reduce the practice of some executives to waste government subsidies for their own interests. On the other hand, when institutional investors learn the government's policy information, they may change the direction of enterprise guidance, promote enterprises to guide enterprises in the direction of government-supported research and development

through voting, pressure and other ways, and increase their research and development efforts. If the government subsidy has incentive effect, that is, if H2a is established, the government's R&D subsidy funds provided to the company will make up for the company's funding problem, promote the development of the company's R&D activities, provide the company's R&D investment, and then the company's long-term development, which is the economic motivation of institutional investors. If the substitution effect of government subsidies is assumed, that is, if H2b is established, is the guiding effect of government subsidies on institutional investors greater than the substitution situation of government subsidies? Based on this uncertainty, this paper will explore the relationship between institutional investor network, government subsidy and enterprise R&D input, analyze the regulatory role of government subsidy, and put forward the following hypothesis:

H3: Government subsidies will enhance the role of institutional investor network in promoting corporate R&D investment.

3. Data and methodology

This paper obtains data from China Stock Market & Accounting Research (CSMAR) database and takes A-shares of Chinese listed companies from 2015 to 2020 as the initial sample. To avoid cross-pollination, companies in the financial sector are excluded. Excel, Stata and Ucinet software were used for data analysis and processing to obtain the final sample of this paper.

3.1. Independent variable

In this paper, institutional investor network centrality (Ceni) is selected as the explanatory variable. The institutional investor network is analyzed by using EXCEL and UCINET software. This paper chooses the degree index. The calculation formula is as follows:

$$\mathrm{C}_{deg} = \frac{d_v}{|N|-1} \tag{1}$$

d_v is the number of neighbors of node V, N is the set of all nodes in the network, and given N is the number of nodes in the network.

Since the same company may be invested by different institutional investors, each institutional investor has its own degree of network centrality. Therefore, if this paper wants to compare the influence of different institutional investors' network location on the R&D investment of the companies they invest in, it is necessary to find the total value of institutional investors' network centrality. Therefore, EXCEL software is used to sum and average the network centrality of institutional investors with different holdings in the same company to obtain the network centrality of the company, so as to represent the network position of institutional investor.

3.2. Dependent variable

The explained variable of this empirical study is R&D investment (RD). Select the value of R&D investment in the income statement of financial statements, and take R&D investment/average total assets as the index to measure the corporate R&D investment.

3.3. Moderator variable

In this paper, the government research and development subsidy (Sub) is selected as the moderator variable. In order to make empirical analysis more convenient, this paper will only select the monetary part of government subsidies that can be calculated and analyzed, and exclude the non-monetary subsidies.

Table 1: Variables.

variables	symbol	definition
Dependent variable	RD	Corporate R&D investment, R&D investment/total assets at t+1 year
Independent variable	Ceni	Centrality of institutional investor network
Moderator variable	Sub	Government research and development grants
	Size	Company size, the natural logarithm of total assets
	AL	Asset-liability ratio, total liabilities/total assets of listed companies
Control variables	Age	Business age, (statistical deadline - year of listing)
	ROA	Return on assets, net profit/average total assets
	Ocf	Cash flow from operating activities , net operating cash flow/total assets
	Firsti	Shareholding ratio of the largest shareholder
Dummy variables	Ind	industry
	time	year

Note: Details of control variables are defined in this table

4. Model specification

In this paper, the research model of Xiao-Li Gong & Zhi-Qiang Du is used for reference [7]. In order to reduce the endogenous influence, the explained variables are treated with one-stage lag.

Verification on H1, H2:

$$RD_{it} = \beta_0 + \beta_1 Ceni_{it} + \beta_2 Size_{it} + \beta_3 AL_{it} + \beta_4 Age_{it} + \beta_5 Ocf_{it} + \beta_6 Firsti_{it} + \beta_7 ROA_{it} + \beta_8 \Sigma Ind_{it} + \beta_9 \Sigma time_{it} + \varepsilon i \tag{2}$$

$$RD_{it} = \beta_0 + \beta_1 Sub_{it} + \beta_2 Size_{it} + \beta_3 AL_{it} + \beta_4 Age_{it} + \beta_5 Ocf_{it} + \beta_6 Firsti_{it} + \beta_7 ROA_{it} + \beta_8 \Sigma Ind_{it} + \beta_9 \Sigma time_{it} + \varepsilon i \tag{3}$$

Verification on the moderating effect of government subsidies H3:

$$RD_{it} = \beta_0 + \beta_1 Sub_{it} + \beta_2 Ceni_{it} + \beta_3 Ceni_{it} \times Sub_{it} + \beta_4 Size_{it} + \beta_5 AL_{it} + \beta_6 Age_{it} + \beta_7 Ocf_{it} + \beta_8 Firsti_{it} + \beta_9 ROA_{it} + \beta_{10} \Sigma Ind_{it} + \beta_{11} \Sigma time_{it} + \varepsilon i \tag{4}$$

5. Empirical result

This paper conducts regression according to models 1, 2 and 3 respectively. The results are shown in the table.

Under model 1, the network centrality of institutional investors has a positive correlation with R&D investment, and it is significant at 1% confidence level. This indicates that when the network centrality of institutional investors is higher, the company will get more professional information through this social network. The stronger the ability of institutional investors to connect with other institutional investors in the network, the greater the investment in scientific research. So H1 is true.

Under model 2, government subsidies have a positive correlation with firm R&D investment, which is significant at 1% confidence level. This indicates that when the government provides more R&D subsidies, the firm's R&D expenditure will be higher, supporting hypothesis H2a and refuting hypothesis H2b.

In model 3, the interaction term (Ceni×sub) is used to verify the moderating effect of government subsidies. The results show that the interaction coefficient between institutional investor network centrality (Ceni) and government subsidy is 0.00000000013, and it is significant at the confidence level of 1%. This indicates that government R&D subsidies can improve the influence of institutional

investors' network location on enterprises' R&D investment. Institutional investors get the policy signals conveyed by the government's R&D subsidies, and promote enterprises' investment in government-supported R&D through voting, pressure, supervision and other means. Therefore, verify that hypothesis H3 is true.

Table 2: Regression results of model 1, 2, 3.

	model 1	model 2	model 3
	RD	RD	RD
Ceni	0.00280***		0.00221***
	(4.68)		(3.53)
Sub		2.21e-10***	1.30e-10*
		(4.74)	(2.37)
Ceni*sub			0.00000215**
			(3.22)
Size	-0.00171***	-0.00148***	-0.00182***
	(-6.72)	(-6.03)	(-7.13)
AL	-0.00116	-0.00154	-0.000819
	(-0.81)	(-1.08)	(-0.57)
ROA	0.0121***	0.0122***	0.0120***
	(3.78)	(3.8)	(3.74)
Ocf	0.0116**	0.0119**	0.0118**
	(3.21)	(3.29)	(3.26)
Firsti	-0.0000913***	-0.0000835***	-0.0000879***
	(-5.83)	(-5.35)	(-5.62)
Age	-0.000295***	-0.000282***	-0.000300***
	(-8.51)	(-8.17)	(-8.66)
Ind	control	control	control
time	control	control	control
Adjust R^2	0.2126	0.2155	0.3943
N	8279	8279	8279

6. Conclusion

Based on the data of China's A-share market from 2015 to 2020, this paper studies and analyzes the relationship among institutional investor network, government subsidies and corporate R&D investment. The empirical analysis is based on agency theory, social network theory, resource dependence theory and information asymmetry theory. The conclusions of this paper are as follows:

The higher the centrality of the institutional investor network, the higher the R&D investment of the company. Through the network of institutional investors, investment institutions can obtain detailed professional information resources. By analyzing the information, they can have a keen insight into market changes and guide enterprises to change their R&D activities. The higher the network position, the richer the information resources, the more institutional investors are able to connect with other investment institutions in the network to supervise the company and influence the company's decision-making through voting, so as to increase the R&D investment.

Government research and development subsidies will increase companies' research and development investment. The government encourages enterprises to conduct research and development by issuing research and development subsidy funds to enterprises. On the one hand, subsidy funds can reduce the financial risk of enterprises. On the other hand, the government's

research and development subsidies are seen as a positive policy signal by the outside world, representing the research and development of projects supported by the state and the market. This signal can motivate the company's management and shareholders, increase their confidence in the project and further increase their investment in the project.

Government R&D subsidies will enhance the role of institutional investor network in promoting enterprise R&D investment. As the company is more cautious about the information disclosure of new technology and research and development results and research and development process, it is difficult for external investors to obtain key information, which will cause information asymmetry. And government subsidies for business are seen as a positive sign. This can alleviate information asymmetry. Institutional investors can adjust investment strategies and corporate management decisions according to government signals, such as promoting enterprises to increase investment in this project through joint voting, supervision and other ways.

Most of the studies in the existing literature are based on the analysis of the shareholding of institutional investors, and the research on the social attributes of institutional investors is still insufficient. This paper constructs an institutional investor network for institutional investors from the social network level, uses network location indicators to measure the ability of institutional investors to influence corporate R&D activities, takes into account the identity of institutional investors as "social people", and explores from the perspective of social networks.

Secondly, in terms of research content, this paper puts institutional investor network, government subsidy and corporate R&D investment into the same framework. The current research results lack of empirical analysis of the relationship between the three. This paper takes government subsidies as a moderating variable to explore whether the support of government subsidies will affect the correlation between institutional investor network and enterprise R&D, which enrich the shortcomings of existing literature studies.

References

[1] McConnell John J. Servaes Henri. *Additional evidence on equity ownership and corporate value[J]. North-Holland, 1990, 27(2)*

[2] Black, B.S. *Agents Watching Agents: The Promise of Institutional Investor Voice[J]. Social Science Electronic Publishing, 1992, 39(4):811-893.*

[3] Sparrowe, R. T., Liden, R. C., Wayne, S. J., & Kraimer, M. L. (2001). *Social networks and the performance of individuals and groups. Academy of management journal, 44(2), 316-325.*

[4] Yu, F., Guo, Y., Le-Nguyen, K., Barnes, S. J., & Zhang, W. (2016). *The impact of government subsidies and enterprises' R&D investment: A panel data study from renewable energy in China. Energy Policy, 89, 106-113.*

[5] Link, A. N. (1982). *An analysis of the composition of R&D spending. Southern Economic Journal, 342-349.*

[6] Lichtenberg, F. R. (1987). *The effect of government funding on private industrial research and development: a reassessment. The Journal of industrial economics, 97-104.*

[7] Fan, Y., Ly, K. C., & Jiang, Y. (2023). *Institutional investor networks and firm innovation: Evidence from China. International Review of Financial Analysis, 89, 102751.*