

Research on the Relationship between Government-backed Venture Capital and Enterprise Innovation Performance

Chen Yaoyu

Business School of Changsha Central South University, Hunan Province, China

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Abstract: Venture capital is the way of financing for enterprises, and government-backed capital is the main source of venture capital in China. This paper uses panel data of SMEs (small and medium-Sized enterprises) to analyze the relationship between government-backed venture capital and enterprise innovation performance. The regression results show that: (1) government-backed venture capital promotes innovation performance; (2) government-backed venture capital in the period of enterprise development and maturity has a significant role in promoting enterprise innovation performance; (3) too high proportion of government-backed venture capital is not conducive to enterprise innovation.

1. Introduction

Innovation is the driving force of long-term economic development. China is in a critical period of industrial restructuring. The reports of the 19th National Congress of the Communist Party of China pointed out that we should firmly implement the strategy of innovation-driven development. International experience shows that the reason why the United States has made brilliant achievements in the field of innovation is that it has established a venture capital mechanism that can stimulate innovation. According to statistics, the number of venture capital institutions in China reached 2045 in 2016; the total amount of venture capital management in China reached 827.71 billion yuan; government-backed funds were the main source of venture capital in China, accounting for 36.13% of the total amount of management capital; the total number of venture capital investment in China was 19,296, of which 8,490 projects were invested in high-tech enterprises, accounting for 44.00%. It can be regarded that China's venture capital based on government-backed funds has supported a number of strategic emerging enterprises, which has played a helpful role in promoting industrial restructuring, expanding effective and high-end supply, and improving total factor productivity.

The main results of this paper are as follows: Firstly, the least squares regression analysis of panel data of SMEs is conducted by Eviews 10 software, drawing a clear conclusion that government-backed venture capital can promote innovation performance. At present, there is little empirical analysis to draw this conclusion. Secondly, it draws the conclusion that the government-backed venture capital in the period of development and expansion can promote innovation performance. Although individual studies (GOU Yan-nan 2013) empirically analyzed the relationship between venture capital entry period and innovation performance, they did not give the quantitative criteria for the entry period. This paper makes up for the above shortcomings and puts forward a reasonable quantitative criterion for the entry period of venture capital. Thirdly, this paper also draws a pioneering conclusion that the high proportion of government-backed venture capital is not conducive to enterprise innovation performance. This provides a reference for the support of government-backed funds in guiding industrial transformation in the future.

2. Research Hypothesis and Theoretical Analysis

2.1. Government-backed Venture Capital and Innovation Performance

Under the background of “Made in China 2025” and industrial restructuring, the innovation capability of enterprises is particularly important. Lerner (2000), Fu Lei-ming (2012), GOU Yan-nan (2014) and Yang Xi (2016) all show that venture capital is positively correlated with innovation performance.

Generally speaking, the reason why venture capital can promote innovation performance is that it has the following characteristics: (1) Institutional investors can more accurately judge the long-term value of enterprises and encourage managers to make more innovations because of the more open access to enterprise value information. (2) Venture capitalists can use screening mechanism to deal with the adverse selection of the invested enterprises in the high-tech industry with high uncertainty and screen out those enterprises with real innovation potential. (3) Uncertainty often exists in innovation activities. In this regard, the venture capital in the form of equity is better than the debt form in giving full play to its advantages and improving the efficiency of resource allocation and innovation.

The government funds are the main source of venture capital in China. More than 30% of venture capital belongs to the government-backed venture capital. Although the original intention of government investment is often to overcome the early development difficulties for science and technology enterprises, there is controversy about the actual effect of government-backed venture capital: Lerner believes that the investment of government-backed venture capital in emerging industries can promote private capital follow-up investment, which is conducive to improve the situation that enterprises' R&D investment is lower than the lowest level of social investment. However, GOU Yunnan's empirical results show that the impact of government-backed venture capital on innovation performance is significantly negatively correlated. In view of the divergence of opinions, this paper proposes that:

H1. Government-backed venture capital promotes enterprise innovation performance

2.2. The entry period and innovation performance of government-backed venture capital

Innovation performance may vary depending on the time of investment. It is argued that premature government entry is not conducive to innovation performance. The reasons can be summarized as follows: Firstly, the government-backed venture capital investment has a period of time, usually withdraws 4-7 years after entering, and seeks the maximum return within a limited period of time. However, the duration of innovation activities is generally longer. If the cycle of innovation activities is longer than the duration of venture capital, venture capital may become a constraint factor of innovation. For example, if the investment enters early, it may suggest that the enterprise should focus on the IPO rather than the innovation work on the eve of withdrawal. Stuck points out in his analysis of more than 800 enterprises in 21 countries that the innovation capability of venture capital-supported enterprises declined over time. Secondly, there exists the phenomenon that state-owned group companies simply turn over into investment and operation companies. Without adjusting their business and organizational structure, these companies engage in venture capital business and lack the ability to screen enterprises and provide value-added services. This drawback may affect the business and innovation ability of the invested enterprises over time. Thirdly, the administrative intervention of government-backed venture capital always exists, and the tear between enterprise and market will be more serious with the passage of time.

However, some scholars hold the opposite opinion: GOU Yan-nan (2013) based on the “cycle theory” proposes that the earlier the venture capital entered, the more consistent with the technological innovation cycle of science and technology enterprises, so as to provide strong financial support for innovation. Weiss (1991) also holds the same view that the longer the holding time is, the better the innovation performance of enterprises is. Based on the above analysis, hypothesis 2 is put forward:

H2.1. The government-backed venture capital of early entry is negatively correlated with

innovation performance

H2.2. The government-backed venture capital of medium-term entry is positively correlated with innovation performance

H2.3. The government-backed venture capital of late entry is negatively correlated with innovation performance

2.3. Proportion and innovation performance of government-backed venture capital

Compared with general venture capital institutions, government-backed venture capital institutions shoulder the public responsibility of guiding the market, and their portfolios are more complex. In this case, only when the invested enterprises with more investment and higher share holdings are treated, will the venture capital institutions participate in management more deeply, provide more value-added services, and promote the development of the invested enterprises. In this regard, Zingales (2008) draws the conclusion that ownership concentration is positively related to innovation performance in empirical analysis, but the regression coefficient of the conclusion is low. Hypothesis 3 is put forward:

H3. The high shareholding ratio of government-backed venture capital is conducive to innovation performance

3. Study Design

3.1. Data

This study uses data of companies that went list between 2004 and 2018 from SMEs board that has its unique advantages as the source of data. Compared to main board, SMEs board has more innovative technology companies. Additionally, its mechanism is more mature than Growth enterprise market. Selected from 469 listed companies, the final sample Size is 94, which excludes companies with incomplete data. Data including R&D input, stock structure and the period when venture capital enters is collected from prospectuses.

3.2. Variables

3.2.1. Dependent Variable

The study focuses on the relationship between government-backed venture capital and innovation performance. Although some scholars argue that R&D input may underestimate real innovation performance, the study uses R&D which is the ratio of the average of the last three-year annual R&D input before going list to the average of annual revenue, according to Lu Yao (2017) and Fu Lei-ming (2017).

3.2.2. Independent Variables

“Government” is a dummy variable, which equals 1 if a company is invested by government-backed venture capital. To identify whether a listed company was invested by venture capital, stockholders’ names in stock structure are checked. If the name contains words including ‘investment’ and ‘venture capital’, the company can be identified as a venture capital institution. Even if some stockholders do not have those distinguishing names, they can be regarded as venture capital institutions if their primary business is venture capital. To identify if a venture capital institution has government background, there are three ways. Firstly, those venture capital stockholders that are marked with words including ‘SS’ (State-own shareholder) and ‘SLS’ (State-own Legal-person Shareholder) can be regarded as government venture capital. Secondly, those institutional stockholders with special names indicating their government background, for example, State-owned Assets Operation Co., LTD of Anhui province, can be definitely regarded as a government-backed venture capital institution. Thirdly, some venture capital stockholders without distinguishing features above but actually controlled by government or major state-own companies should be considered as government venture capital.

“Early”, “Development”, “Expansion” and “Maturity” are dummy variables that are used to

indicate venture capital entry periods. If a company received government-backed venture capital at the period, the dummy variable equals 1. Regarding to Mohasseb, early period is when a company is developing its first product. Development period is when the product is in testing or pilot production and company may have possible revenue. Expansion period is when products are commercially available and company may have profit. Maturity period is when products are widely available. At present, there are few studies on relationship between venture capital entry period and innovation performance. Though GOU Yan-nan (2013) studied the relationship between venture capital and innovation performance, he failed to define venture capital timing quantitatively. As a improvement, this study makes quantitative definitions for periods of venture capital. Early period is the first three-year after the establishment of a company, while maturity period is the last three-year before listing. The time between early period and mature period is separated into 2 equal parts, the former of which is development period and the latter of which is expansion period. Admittedly, such quantitative definition may have some potential problems. After all, scholars have not reached the agreement about the definition of those periods.

“Govh”, “Vch” and “Ih” represnt shareholding ratios of government-backed venture capital institutions, venture capital institutions and institutions respectively.

3.2.3. Control Variables

“Size”, “Leverage”, “Growth”, “Ih” represent gross value of company assets, asset-liability ratio and increase rate of business revenue.

3.3. Statistical Description of Major Variables

Table1 Statistical Description of Major Variables

variable	definition	Sample Size	mean	Standard deviation	Maximum value	Minimum value
<u>Independent variable</u>						
R&D	the ratio of the average of the last three-year annual R&D input before going list to the average of annual revenue	94	0.035	0.027	0.200	0.000
<u>Dependent variable</u>						
Government	Dummy variable, whether a company is invested by government venture capital	94	0.574	0.497	1	0
Early	Dummy variable, whether government venture capital enters at early period	53	0.264	0.445	1	0
Development	Dummy variable, whether government venture capital enters at development period	53	0.302	0.463	1	0
Expansion	Dummy variable, whether government venture capital enters at expansion period	53	0.321	0.768	1	0
Mature	Dummy variable, whether government venture capital enters at mature period	53	0.132	0.342	1	0
Ih	Shareholding ratio of institutional shareholder	94	0.517	0.360	1.000	0.030
Vch	Shareholding ratio of venture capital insitution	94	0.241	0.218	1.000	0.004
Govh	Shareholding ratio of government venture caotial institution	94	0.070	0.123	0.586	0.000
<u>Control variable</u>						
Age	Years that a company exists before listing	94	10.766	5.797	30.000	2.000
Size	Total value of assets of the year before listing	94	1.530E+09	5.610E+09	4.350E+10	5.960E+7
Leverage	Aasset-liability ratio of the year before listing	94	0.98	4.62	45.24	0.14
Growth	Annual revenue Growth of the year before listing	94	0.368	0.447	2.119	-0.208

As shown in Table 1, among 94 samples, the mean of “R&D”, “Ih” and “Vch” are 3.52%, 51.65% and 24.07% respectively. Among 53 companies that have government-backed venture capital, 14 companies (26.41%) received investment in their early period. Figures for development period,

expansion period and mature period are 16 (30.19%), 17 (32.08%) and 6 (11.32%) respectively.

3.4. Variables Correlation

Table2 Variables Correlation

	R&D	Early	Development	Expansion	Mature	Government	Ih	Vch	Govh	Size	Growth	Leverage
R&D	1.0000											
Early	-0.8394	1.0000										
Development	0.1080	-0.2355	1.0000									
Expansion	0.1210	-0.2504	-0.2874	1.0000								
Mature	0.0389	-0.1183	-0.1357	-0.1443	1.0000							
Government	0.2590	0.2753	0.2371	0.2217	0.2247	1.0000						
Ih	-0.0550	0.2478	-0.0582	-0.1131	-0.1246	0.1378	1.0000					
Vch	0.0259	0.2244	0.0240	-0.2063	-0.1514	-0.0670	0.5140	1.0000				
Govh	-0.1511	0.2874	-0.0169	0.0385	0.0091	0.3647	0.3219	0.3400	1.0000			
Size	-0.0222	-0.0371	0.0657	0.1179	-0.0322	0.1334	0.2320	0.1259	0.0898	1.0000		
Growth	-0.1157	0.2353	0.0458	-0.0799	-0.0445	0.1330	0.1035	-0.0020	0.3202	-0.0099	1.0000	
Leverage	0.0466	-0.0412	-0.0587	-0.0584	0.3989	0.0894	-0.1302	-0.0960	-0.0253	-0.0169	-0.0582	1.0000
Age	-0.0495	-0.0847	-0.0150	0.4146	0.0408	0.2263	-0.0248	0.0959	0.3360	0.2880	-0.0981	-0.0494

From Table2: (1) Multicollinearity may exist between independent variable (“R&D”) and some control variables (“Size”, “Growth” and “Age”). (2) Entry periods of government venture capital may have multicollinearity with some control variables. For example, there is a high correlation (0.2353) between “Early” and “Growth”. Other high correlation (0.2880) is founded between “Size” and “Age”. (3) High correlations also can be found between shareholding ratio and some control variables. For instance, correlation of “Govh” and “Growth” is 0.3202 and that of “Govh” and “Age” is 0.3360, which indicates multicollinearity may exist among these variables.

3.5. Model Building

The study builds 3 regression models and uses least square regression in Eviews10 to test the hypotheses.

$$(1) R\&D = a_0 + a_1 * Government + a_2 * Age + a_3 * Size + a_4 * Growth$$

$$(2) R\&D = a_0 + a_1 * Early + a_2 * Development + a_3 * Expansion + a_4 * Maturity + a_5 * Leverage + a_6 * Growth$$

$$(3) R\&D = a_0 + a_1 * Ih + a_2 * Vch + a_3 * Govh + a_4 * Age + a_5 * Leverage$$

4. Analysis of Empirical Results

4.1. The Relationship Between Government Venture Capital and Innovation Performance

$$\text{Model1: } R\&D = a_0 + a_1 * Government + a_2 * Age + a_3 * Size + a_4 * Growth$$

Table3 Regression Result of Model1

Variables	Regression coefficients (t-stat)	Statistics	Value
Government	0.01732*** (3.400246)	Obs.	94
Age	-0.000610 (-1.107179)	F	2.701697
Size	-1.40E-13 (-0.719968)	Prob(F)	0.035484
Growth	-0.010424 (-1.947622)	R ²	0.108277
		Durbin-Watson stat	2.115646
*,** and ***represent the 10%,5%,1% level of significance respectively			

Huber-White adjustment, stepwise regression adjustment, generalized difference have been applied in the regression result of model1.

From Table3, the value of R^2 can be founded (0.108277), which indicates that model1, a model of panel data, has a high goodness of fitting compared to other researches in this field. Another important thing is that there is a positive correlation between “government” and “R&D” in the 1% level of significance. Despite the regression coefficient is low (0.01732), the study can still draw the conclusion that hypothesis 1 is valid.

Besides, the regression result also illustrates that impact of “Growth” on “R&D” is negatively correlated in the 10% level of significance. This conclusion represents the fact that some Chinese companies may ignore innovation when they see considerable growth in their revenue.

4.2. The Relationship Between Entry Periods of Government Venture Capital and Innovation Performance

Model2:

$$R\&D=a_0+a_1*Early+a_2*Development+a_3*Expansion+a_4*Maturity+a_5*Leverage+a_6*Growth$$

Table4 Regression Result of Model2

Variables	Regression coefficients (t-stat)	Statistics	Value
Early	0.002184 (0.23936)	Obs.	53
Development	0.0133** (2.54341)	F	1.311159
Expansion	0.01755* (1.75474)	Prob(F)	0.271853
Maturity	0.006936 (1.3033)	R^2	0.148807
Leverage	0.000146 (0.58975)	Durbin-Watson stat	2.054321
Growth	-0.00752 (-1.6096)		

*,** and ***represent the 10%,5%,1% level of significance respectively

Huber-White adjustment, stepwise regression adjustment, generalized difference have been applied in the regression result of model2.

Table4 shows that R^2 is 0.148807. Regression coefficients of 4 dependent variables can illustrate the relationship between entry periods and innovation performance. For instance, the regression coefficient of “Development” is 0.0133, which indicates a positive correlation between “Development” and “R&D” in the 5% level of significance. Similarly, another positive correlation exists between “Expansion” and “R&D” due to a positive regression coefficient (0.01755). Therefore, hypothesis 2.2 is valid. Furthermore, the regression coefficient of “Expansion” is larger than that of “Development”, which means that government-backed venture capital that enters at expansion period may contribute more to innovation performance compared to the one that enters at development period.

As for “Early” and “Maturity”, they have positive regression correlations 0.002184 and 0.006936). However, neither of two correlations has a convincing level of significance. Therefore, hypothesis 2.1 and hypothesis 2.3 should be rejected. The possible reason for this rejection is that the study fails to collect adequate samples of companies that received government venture capital at early and mature periods. Additionally, the nature of venture capital results in most venture capital entering at development and expansion periods, which makes data collection of the other two periods more difficult.

4.3. The Relationship Between Shareholding Ratio of Government-backed Venture Capital and Innovation performance

$$Model3: R\&D=a_0+a_1*Ih+a_2*Vch+a_3*Govh+a_4*Age+a_5*Leverage$$

Table5 Regression Result of Model3

Variables	Regression coefficients (t-stat)	Statistics	Value
Ih	0.003151 (0.413142)	Obs.	94
Vch	0.012417 (0.740161)	F	2.451540
Govh	-0.029692* (-1.852747)	Prob(F)	0.039631
Age	-5.09E-05 (-0.095365)	R ²	0.122262
Leverage	-0.056620 (-2.618611)	Durbin- Watson stat	1.898046
*,** and ***represent the 10%,5%,1% level of significance respectively			

Huber-White adjustment, stepwise regression adjustment have been applied in the regression result of model3.

There is a negative correlation between “Govh” and “R&D” in the 10% level of significance, which illustrates that the higher shareholding ratio government-backed venture capital institution has, the lesser R&D input a company will devote. Therefore, hypothesis 3 is rejected. Besides, another negative correlation is found between “Leverage” and “R&D” in the 1% level of significance, which suggests that when a company has financing problems, it can not focus on innovation.

Nevertheless, there is no convincing regression result for “Ih” and “Vch”. One of possible reasons is that samples collected in this study consist mainly of companies supported by government venture capital which may have intervention and influence the relationship between private venture capital and innovation performance.

5. Research Conclusions and Suggestions

In recent years, the society has been questioning the excessive government intervention in the market. Does the government's background venture capital play a reverse-acting role in promoting innovation performance? Using panel data of SMEs from 2004 to 2018, this paper examines a series of relationships between government-backed venture capital and innovation performance. The results show that government-backed venture capital can promote enterprise innovation; further analysis shows that government-backed venture capital has a significant positive effect on enterprise innovation performance in the period of enterprise development and expansion; however, the high proportion of government-backed venture capital holdings is not conducive to enterprise innovation.

The results of this study have important practical significance. Firstly, under the background of China's industrial restructuring, the degree of government participation in the market is the focus of academic debate. The result that government-backed venture capital can promote enterprise innovation shows that the government's guiding role cannot be abandoned under the market-oriented condition. It is a common practice for the major manufacturing countries in the world to formulate major industrial transformation policies and guide financial support by the government. Secondly, government-backed funds should choose to enter the enterprise to best promote innovation performance in the development period and expansion period. Early financial support may deprive entrepreneurs of the impetus to progress; late entry may also turn government-backed venture capital into pure profit-oriented capital operation, losing its original intention of helping innovation and promoting industrial restructuring. Finally, although the government-backed venture capital can overcome the market failure problem of allocating equity capital only through the market, if its share is too large, it may bring too much administrative

intervention, thus obstructing the innovation activities of enterprises. Therefore, government-backed venture capital institution should pay attention not to over-concentrate investment in an enterprise, nor over-participate in business management activities.

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