Research on the Impact of Venture Capital on Enterprise Innovation

Mingjuan Liu*, Yan Zhou

School of Economics & Management Nanjing University of Science & Technology Nanjing, China

*Corresponding author: 2290412507@qq.com

Keywords: Neural Network, Prediction Model, Big Data.

Abstract: This paper took 302 enterprises listed on GEM from January 21, 2014 to August 1, 2017 as samples, took the shareholding ratio of venture capital, the foregin background of venture capital and the number of venture capital institutions as explanatory variables, took enterprise research and development investment as the explained variable, and used multiple linear regression model to study the impact of venture capital on enterprise innovation. The empirical results show that venture capital shareholding promotes enterprise innovation; venture capital with foreign background and joint investment do better in promoting enterprise innovation. From the perspective of different industries, venture capital has a better effect on the innovation and appreciation of traditional enterprises.

1. Introduction

Venture capital mainly refers to a financing method that provides funds to an enterprise in its early stage and then acquires part of the equity of the enterprise. Venture capital institutions are not interested in holding the invested enterprises. Their main work is to invest in sunrise industries and emerging enterprises with good prospects, and then provide guidance technology, talent introduction and management structure optimization services to the invested enterprises, and finally withdraw through equity transfer such as merger and acquisition and listing, which is a pursuit of high-risk high-return business. The research results of developed countries show that venture capital can promote enterprise innovation. Due to historical reasons, China's venture capital is a little "immature" compared with foreign countries, and the positive influence of foreign venture capital on enterprise innovation remains to be investigated in China.

2. Hypothesis

Venture capital has incentives to support research and development activities. Venture capital mainly invests in small and medium-sized science and technology enterprises. Innovation ability is the main index to measure the value and core competitiveness of these enterprises, and it is also the foundation of many high-tech companies. The improvement of innovation ability can enable enterprises to obtain higher market valuation and obtain higher investment returns when venture capital exits in the future. Kortum and Lemer (2000) empirically concluded from American data that the intervention of venture capital can greatly improve the efficiency of innovation [1]. The high shareholding of venture capital institutions will signal to outside investors that the company is of high quality [2]. Moreover, the higher the shareholding ratio is, the stronger the ability of venture capital to play a supervisory role and the higher the pursuit of high returns [3]. However, Wen, Yang, Feng, Dong and Chang (2018) believe that venture capital will have a positive impact on innovation only when it exceeds a certain level. In the case of relatively small investment scale, venture capital may seriously damage the innovation ability of invested enterprises [4]. Based on the above assumptions, the following assumptions are proposed:

H1: Venture capital shareholding has a positive impact on enterprise innovation. The higher the shareholding ratio, the better the performance of enterprises in R&D investment.

The development of venture capital in foreign countries is decades ahead of that in China. With its strong strength and rich experience, venture capital has formed a set of effective investment ideas and

methods and become more standardized in operation and management. Due to the higher risk of investment in other countries, the venture capital with foreign capital background will have a more comprehensive investigation of the enterprise, and after the investment becomes a shareholder, it can also use a broader international vision and network of relations to provide more professional services, which will be more value-added to the enterprise. Li, Liu and An (2018) proved through empirical evidence that the foreign capital background of venture capital is directly proportional to the improvement effect of technological innovation of enterprises [5]. Therefore, the hypothesis is put forward:

H2: Venture capital participation with foreign capital background can better promote enterprises to increase R&D investment.

Venture capital can also be divided into separate investment and joint investment. Compared with the separate investment, joint investment of venture capital institutions can bring more capital to the enterprises, which makes the invested enterprises enjoy more heterogeneous resources in technology, experience and human resources, and reduce the risk they bear in R&D activities. Li, Liu and An (2018) also confirmed that the number of joint investment of venture capital institutions is proportional to the promotion effect of enterprise technological innovation [6]. Therefore, the hypothesis is put forward:

H3: Joint investment by venture capital institutions can better promote enterprises to increase R&D investment.

Huang fu, Liu, and Wang (2018) believe that venture capital plays a more significant value-added role in the innovation of enterprises in traditional industries due to the lower innovation level and innovation ability of traditional industries compared with high-tech industries [7]. High-tech enterprises have to spend a lot of capital, human resources and other resources to conquer new technologies, so they have a better performance in R&D investment, while traditional industries pay more attention to maintain business performance and less pursue high-risk R&D and innovation. Traditional industries have low innovation level, weak innovation consciousness, lack of innovation experience and high-level innovative talents. Venture capital has a greater use in traditional enterprises, which makes it get a greater improvement in innovation level. Therefore, the hypothesis is put forward:

H4: Venture capital institutions can better promote traditional enterprises to increase R&D investment.

3. Sample and descriptive statistics

In this paper, enterprises that successfully listed on the gem from January 21, 2014 to August 1, 2017 are selected as samples for study. After excluding samples with incomplete data and companies that have been delisted, there are a total of 302 samples. Among them, the data on venture capital variables and enterprise R&D expenses are all found in the prospectus of listed companies. By checking the names of shareholders and whether there are "investment management", "venture capital" and other words in the scope of business, and on the basis of excluding employee stock ownership and the company's actual controller's shareholding platform, we can judge whether the shareholder is a venture capital institution, and get the number of venture capital institutions in each enterprise's shareholders and the shareholding proportion of venture capital. We can judge whether there is foreign capital background in venture capital by checking the information of shareholders and foreign shareholders. Because of the similar nature of business between venture capital and private equity investment in China, this paper classifies private equity investment fund as venture capital institution in statistics of venture capital. R&D investment is the average value of R&D investment in the last three years disclosed in the listing announcement. The basic characteristic data of enterprises are downloaded from guotai'an database, including the date of establishment and listing, asset scale, asset liability ratio, weighted return on equity and industry classification. The data analysis software used is Eviews.

The average value of R&D investment in the last three years is selected as the variable to measure the innovation intensity of enterprises. The specific definitions of explanatory variables are as follows: VC share (the sum of the shareholding proportions of venture capital institutions with more than 1%

shareholding ratio), VC count (the number of venture capital institutions among shareholders holding more than 1% of the shares of the enterprise), VC-fore (dummy variable, when the venture capital institutions with more than 1% shareholding ratio have foreign capital support, this variable is defined as 1, otherwise it is 0). The control variables include asset size, age, asset liability ratio (Lev), return on net assets (ROE) and Tech (dummy variable, 1 when the enterprise belongs to high-tech industry, otherwise it is 0).

After getting the industry classification of listed companies given by China Securities Regulatory Commission (CSRC) from guotai'an database, this paper compares the high-tech industry statistical classification catalogue published by the National Bureau of statistics, and selects pharmaceutical manufacturing industry, special equipment manufacturing industry, software and information technology service industry, instrument manufacturing industry, computer, communication and other electronic equipment manufacturing industry, electrical machinery and equipment manufacturing industry, Internet and related services, chemical raw materials and chemical products manufacturing industry, railway, shipping, aerospace and other transportation equipment manufacturing industry as high-tech industries.

Among 302 enterprises, 241 enterprises obtained financial support from venture capital institutions, accounting for 79.8% of the total sample. The descriptive statistics of the main variables of the whole sample data model are given in table I. The unit of size is million yuan.

Table I. Descriptive statistics of full sample variables.

variables	Min	Max	Mean	Median	Sd.
VC-share	0	81	14.82	10.72	14.68
VC-fore	0	1	0.093	0	0.29
VC-count	0	13	2.25	2	2.07
Size	166.5745	18238.4264	670.4993	498.7673	1097.412
Age	2	32	13.25	13	4.87
Lev	4.47	76.45	35.32	33.59	15.84
ROE	5.8	71.36	23.41	21.22	9.75
Tech	0	1	0.758	1	0.43
R&D	0.2	36.74	6.83	5.3	4.85

Table II. Descriptive statistics of variables with and without venture capital.

variables	VC participation			no VC participation		
	Mean	Median	Sd.	Mean	Median	Sd.
VC-fore	0.116	0	0.32			
VC-count	2.81	2	1.94			
Size	621.10	5241.1	4154.0	8656.6	4610.1	23028.0
Age	13.2	13	4.77	13.44	14	5.29
Lev	35.48	33.85	15.70	34.69	33.26	16.51
ROE	22.61	20.48	9.51	26.59	25.05	10.12
Tech	0.776	1	0.42	0.689	1	0.47
R&D	6.94	5.3	4.96	6.41	5.21	4.39

After the samples were divided into two groups with and without VC participation, descriptive statistics and comparative studies were carried out. Table II. Shows the results. Then the sample enterprises are divided into two groups: high-tech industry and traditional industry. The descriptive statistics of each variable are shown in table III. It can be observed that compared with the companies without venture capital, companies with venture capital have smaller scale, lower profitability, high-tech companies account for a large proportion, and R&D costs are higher. Compared with traditional

industries, high-tech industry has more venture capital participation, lower asset liability ratio, better profitability and more R&D expenses.

Table III. Descriptive statistics of variables of high-tech industry and traditional industry.

variables	high-tech			traditional		
	Mean	Median	Sd.	Mean	Median	Sd.
VC-share	15.37	12.41	14.45	13.07	9.01	15.32
VC-fore	0.114	0	0.32	0.027	0	0.16
VC-count	2.34	2	2.05	1.95	2	2.11
Size	659.42	4757.3	12196.2	705.25	5559.6	5681.2
Age	12.84	13	4.81	14.53	15	4.87
Lev	33.38	32.55	15.39	41.41	42.33	15.79
ROE	24.20	22.07	10.08	20.92	18.43	8.19
R&D	7.54	5.67	5.20	4.60	4.03	2.44

4. OLS regression results of venture capital on Enterprise Innovation

In order to avoid the influence of a small number of extreme values on the regression results, we first adopt the 1% and 99% level of winsorize to deal with the shareholding ratio of venture capital, enterprise asset size, asset liability ratio and return on net assets, and then use Eviews software to conduct OLS regression. The regression results are shown in table IV, N is the sample size.

Table IV. OLS regression results of the impact of venture capital on Enterprise Innovation.

variables	(i)	(ii)	(iii)	(iv)	(v)
C	24.1009** (2.1575)	42.8329*** (3.1059)	42.7423*** (3.0739)	22.8179 (1.6185)	30.8225** (2.4303)
VC-share	0.0447** (2.4864)			0.0464** (2.0361)	0.0513** (2.4423)
VC-fore		2.1785** (2.3736)			
VC-count			0.3018* (1.9422)		
Ln(Size)	-0.9384* (-1.6651)	-1.9056*** (-2.7565)	-1.9590*** (-2.7878)	-0.6977 (0.9694)	-1.4868** (-2.3832)
Ln(Age)	-0.2154 (-0.3533)	0.0524 (0.0721)	0.0563 (0.0772)	-0.4676 (0.6251)	0.9079 (1.1531)
Lev	-0.0189 (-0.9811)	0.0077 (0.3397)	0.0087 (0.3775)	-0.0286 (1.1338)	0.0028 (0.1403)
ROE	0.0114 (0.4089)	0.0057 (0.1738)	0.0267 (0.8060)	0.0020 (0.058)	0.0318 (0.8569)
Tech	2.3933*** (3.8883)	2.0167*** (2.777)	2.0800*** (2.8588)		
N	302	241	241	229	73

Note: 1. * *, * *, * are significant at 1%, 5% and 10% levels respectively; 2. the statistical value of t is shown in brackets.

4.1 The influence of shareholding ratio on R&D

According to hypothesis H1, a multiple linear regression model was established:

$$R\&D=\beta_0+\beta_1 VC\text{-}share+\beta_2 \ln(Size)+\beta_3 \ln(Age)+\beta_4 Lev+\beta_5 ROE+\beta_6 Tech+\varepsilon \qquad (1)$$

In column (i), the coefficient of VC-share is 0.0447, which is significant at the level of 5%, which indicates that VC-shares can significantly improve the R&D investment of enterprises, and verifies the hypothesis H1. The coefficient of Ln (size) is -0.9384, which is significant at the 10% level, which indicates that with the scale of enterprise assets and R&D investment is negatively correlated, this is mainly because with the expansion of enterprise asset scale, the growth rate of R&D investment does not keep up with the growth of operating revenue. The regression coefficient of Tech is 2.3933, which is significant at the 1% level, which indicates that industry characteristics can significantly affect the R&D intensity of enterprises, and the R&D investment of high-tech industry is significantly higher than that of traditional industry.

4.2 The influence of foreign capital background on R&D

Select sub sample with venture capital participation, a multiple linear regression model was established:

$$R\&D=\beta_0+\beta_1 VC\text{-}fore+\beta_2 \ln (Size) +\beta_3 \ln (Age) +\beta_4 Lev+\beta_5 ROE+\beta_6 Tech+\varepsilon \qquad (2)$$

In column (ii), the coefficient of VC-fore is 2.1785, which shows that there is a positive correlation between the two, which is significant at the level of 5%. Therefore, it can be considered that the effect of venture capital with foreign capital background on improving the R&D investment of enterprises is greater than that of venture capital without foreign capital background, which verifies the hypothesis H2.

4.3 The influence of the number of venture capital institutions on R&D

According to the hypothesis H3, a multiple linear regression model was established:

$$R\&D=\beta_0+\beta_1 VC\text{-}count+\beta_2 \ln (Size) +\beta_3 \ln (Age) +\beta_4 Lev+\beta_5 ROE+\beta_6 Tech+\varepsilon \qquad (3)$$

In column (iii), the coefficient of VC-count is 0.3018 and the t value is 1.9422, which is significant at the 10% level, which indicates that the R&D investment of enterprises is positively correlated with the number of venture capital institutions. The more venture capital institutions in the shareholders of the enterprise, the greater the R&D intensity of the enterprise, which verifies the hypothesis H3.

4.4 The influence of shareholding ratio on R&D in different industries

According to the hypothesis H4, the sample is divided into two groups: high-tech industry and traditional industry, and the difference of the impact of venture capital on technological innovation of high-tech enterprises and traditional enterprises is studied, the multiple linear regression model was established:

$$R\&D=\beta_0+\beta_1 VC\text{-}share+\beta_2 \ln (Size) +\beta_3 \ln (Age) +\beta_4 Lev+\beta_5 ROE+\varepsilon \qquad (4)$$

In column (IV), the coefficient of VC-share in high-tech industry is 0.0464, which is significant at the 5% level; in column (v), the coefficient of VC-share in traditional industries is 0.0513. The two coefficients are significant at the level of 5%, and the latter is greater than the former, which indicates the effect of venture capital on R&D investment in traditional industries is better, which verifies the hypothesis H4.

In order to avoid the interference of random walk items on the empirical results, we relaxed the hypothesis that the variance of random interference items in OLS model was equal to constant, and white's heteroscedasticity correction was adopted. Although the t value of each explanatory variable was slightly different from the regression result of the original model, the significance of each variable remained unchanged, and the conclusion of the original model was still valid.

5. Conclusion

Based on the sample of GEM listed companies, this paper discusses the impact of venture capital on enterprise innovation. It is proved by empirical evidence that VC shareholding can improve the R&D investment of enterprises, and then improve the innovation level of enterprises. The higher the

shareholding ratio, the greater the impact on enterprise innovation. Further analysis of the impact of venture capital characteristics on enterprise innovation shows that the impact of venture capital with foreign background on enterprise innovation is greater than that of venture capital without foreign capital background. Venture capital joint investment can promote enterprises to increase R&D investment more than single investment. This paper also divides the invested enterprises into high-tech enterprises and traditional enterprises, which proves that venture capital has a positive impact on the innovation level of the two industries, but it is more effective to improve the innovation level of traditional industries. This paper also provides theoretical support for the government to build the capital market, improve the financial service system, and use the capital market to promote the development of the real economy.

Due to the limited knowledge level of the author and the lack of information and data, the empirical study of this paper mainly has the following two deficiencies: (1) the data about the risk investment in this paper are obtained from the prospectus of listed companies. When judging whether the shareholders are venture capital institutions and the foreign capital background of shareholders, we refer to the information that the author can find on the Internet. But we can't avoid mistakes, which may have some impact on the empirical results. (2) According to the research on European enterprises by geronikolaou and papacristou (2008), innovation creates a demand for venture capital, rather than venture capital providing innovation [8]. Because there is no data comparison of venture capital before and after entering the enterprise, this paper cannot exclude the endogenous problem.

References

[1] S. Kortum and J. Lemer, "Accessing the contribution of venture capital to innovation," J. Rand Journal of Economics, vol. 31, 2000, pp. 674-692.

[2] W. L. Megginson and K. A. Weiss, "Venture Capitalist Certification in Initial Public Offerings," J. The Journal of Finance, vol. 46, 1991, pp. 879-903.

[3] C. B. Barry, C. J. Muscarella and J. W. Peavy, "The Role of Venture Capital in the Creation of Public Companies: Evidence from the Going-public Process," J. Journal of Financial Economics, vol. 27, 1990, pp. 447-471.

[4] J. Wen, D. Yang, G. Feng, M. Dong and C. Chang, "Venture capital and innovation in China: The non-linear evidence," J. Structural Change and Economic Dynamics, pp. 148-162, May 2018.

[5] J. Li, D. Liu and S. An, "Research on the influence of venture capital characteristics on enterprise technological innovation," J. Shanghai Finance, pp. 75-84, July 2018.

[6] J. Li, D. Liu and S. An, "Research on the influence of venture capital characteristics on enterprise technological innovation," J. Shanghai Finance, pp. 75-84, July 2018.

[7] Y. Huangfu, C. Liu and W. Wang, "Venture Capital and Enterprise Innovation Growth: Research Based on Small and Medium-sized Board and GEM Listed Companies," J. Reform, pp. 102-114, September, 2018.

[8] G. Geronikolaou and G. Papachristou, "Venture Capital and Innovation in Europe," J. Modern Economy, pp. 454-459, March 2012.