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How VC Background and Timing of Entry Become a Booster to Corporate Innovation:The Impact Path of the Capitalization of R&D Expenditure

Xiaoyun Li

International Business School, Jinan University, Zhuhai, China

3203315343@qq.com

Abstract. Venture capital background and entry timing affect the innovation behavior of firms is widely recognized. Based on the data of A-share listed companies from 2012 to 2021, this paper finds that venture capital with foreign investment background plays a more significant role in improving the innovation performance of firms. Venture capital in the initial stage and development stage can promote firm innovation to a certain extent, and the venture capital entered in the expansion period will inhibit the innovation of firms. When venture capital has the background of foreign capital or enters in the development period, the capitalization of R&D expenditure plays a partial intermediary role between venture capital and firm innovation. To improve innovation performance, it is necessary to reasonably introduce foreign capital, encourage venture capital to enter in the development period of firms, and give full play to the positive signal role of capitalization of firm R&D expenditure.

Keywords: Venture Capital Income; Capital Background; Firm Innovation Ability.

1. Introduction

With the rapid development of economy, more and more firms need to gain competitive advantages by exploring new fields. However, many firms that actively innovate or transform and upgrade are faced with the problem of shortage of innovation funds. As an important source of capital for firm innovation, venture capital will select investment objects and grasp their entry opportunities to obtain investment income (Scheidegger A, 2000). Besides, it also provides a material basis for firms to obtain technology and invention patents (Xueqi Z et al., 2022). Traditionally, many venture capitalists choose to enter in the early stages of start-ups, but in Asia, venture capitalists are increasingly inclined to invest in the late stages of development (Genc S T, 2017). Venture capital entry in the later stage promotes financial performance improvement, but will sacrifice some innovation performance (Dai XY et al., 2022).

The capitalization of firm R&D expenditure is the R&D expenditure when the firm meets the capitalization conditions, but does not turn into intangible assets (Yang Di et al., 2022). The lower the capitalization rate of firm innovation R&D expenditure, the greater the reduction in R&D expenditure (Ioannis TBEAK, 2019). After venture capital enters the firm, the firm capitalizes the R&D expenditure, so that the R&D expenditure affects its innovation performance.

At present, scholars' research mainly plays a role in the characteristics of venture capital, but the research on the joint effect of venture capital background and entry timing on firm innovation performance is not in-depth enough. There is still a gap in the mechanism of capitalization of R&D expenditure in the former two. Based on the signaling theory, this paper uses R&D expenditure capitalization as a mediating variable, so as to deepen the understanding of the mechanism of different venture capital factors affecting firm innovation.

2. Literature Review and Research Hypotheses

2.1. Background and Timing of Venture Capital Affect Corporate Innovation

Venture capital with foreign background positively regulates the impact of risk tolerance on innovation performance, and thus increases its willingness to bear high risk to obtain a high rate of return (Fuguang Huang et al., 2009). VC with foreign capital background can amplify the impact on the social responsibility activities of the invested firms (Qiu-Jin L, 2021) and encourage firms to actively innovate. Some scholars also believe that compared with the foreign investment background, the national VC has a stronger innovation orientation and a longer investment cycle, which is more conducive to firm innovation (HanB, 2021).

To study the role of VC background on firm innovation, the hypothesis is proposed:

H1a: The VC with foreign capital background can drive firm innovation.

H1b:The VC with only domestic capital background can drive firm innovation.

Venture capitalists tend to choose startups that are more willing to provide resources and guidance in innovation (Snieska V & Venckuviene V, 2009). In the early stage of development, a large amount of capital is needed for product development, and the entry of VC has the role of financing and consultation. When introducing venture capital for innovation, firms in development period are more limited than those in mature period, and VC can ease this limit. Some scholars also believe that compared with early investment, late-stage investment can be used more for R&D, thus significantly promoting firm innovation (Xiwen L, Yunjia Z, 2022).

To study the role of VC entry on firm innovation, hypotheses are put forward:

H2a: VC in the start-up period can drive corporate innovation.

H2b: VC in the development period can drive corporate innovation.

H2c: VC in the expansion period can promote corporate innovation.

H2d: VC in the mature period can drive corporate innovation.

2.2. Intermediary Mechanism of Capitalization of R&D Expenditure

After obtaining venture capital investment, firms can transmit positive value appreciation signals through the capitalization of R&D expenditure to stimulate their innovation performance (Aboody & Lev, 1998; Dinh et al., 2019). In the R&D process, venture capital entry can effectively relieve the pressure of the company's intangible asset R&D cost. Companies willing to capitalize R&D spending are inclined to take high risks and obtain high returns, and need to release signals to attract venture capital institutions to invest funds to help them innovate(Cazavan-Jeny A & Jeanjean T, 2006). The market has a strong attraction to the positive pricing of R&D spending. firm R&D capitalization closes firm innovation to external investors by transmitting positive signals of high R&D intensity and high development (Annika B, 2022).

To study the mechanism of capitalization of R&D expenditure, the hypothesis:

H3a: Capitalization of R&D expenditure has an intermediary role between foreign investment in venture capital and firm innovation.

H3b: Capitalization of R&D expenditure has an intermediary role between domestic venture capital only and firm innovation.

H3c: Capitalization of R&D expenditure plays an intermediary role between venture capital and firm innovation in the initial stage.

H3d: The capitalization of R&D expenditure plays an intermediary role between venture capital and firm innovation in the development period.

H3e: Capitalization of R&D expenditure plays an intermediary role between venture capital and firm innovation in the expansion period.

H3f: The capitalization of R&D expenditure plays an intermediary role between venture capital and firm innovation in the mature period.

3. Research Methods

This paper selects A-share non-financial listed companies from 2012 to 2021 as samples, obtains the data of sample companies from China Macroeconomic Platform and national patent database, and screens the data of venture capital.

This paper selects the number of patents applied by firms as the explained variable to reflect the importance of firms to innovation and their contribution of input or output (Kortum S & Lerner J, 2000; Hall H B & Ziedonis H R, 2001).

The explanatory variables selected in this paper are the background and entry timing of venture capital investment. In terms of venture capital background, the author mainly studies whether venture capital participation with foreign capital background affects firm innovation (Humphery-Jenner M & Suchard J, 2013). In terms of the timing of venture capital, the author divides the firm development stages according to the differentiation criteria of previous literature (Xiwen L, Yunjia Z, 2022).

The intermediary variable R&D expenditure capitalization is measured by the proportion of capitalized development expenditure (Di Y et al., 2022).

Table 1. Definitions and descriptive statistics of main variables

Variable	Variable definition	N	mean	sd	min	max
Patents	Firm innovation performance, the number of patent applications	1336	26.95	77.46	0	679
FORVC	Whether there is a foreign background VC investment into the firm, the value is 1, not 0	1336	0.29	0.45	0	1
DOMVC	Whether there is only domestic background VC investment into the firm, the value is 1, if 0	1336	0.94	0.24	0	1
Early	Whether the first round of VC investment in the initial period, the value is 1, not 0	1336	0.1	0.3	0	1
Development	Whether the first round of VC investment in the development period, the value is 1, if not, 0	1336	0.09	0.28	0	1
Expansion	Whether the first round of VC investment in the expansion period, the value is 1, if not, 0	1336	0.26	0.44	0	1
Mature	Whether the first round of VC investment in the maturity period, the value is 1, if 0	1336	0.15	0.36	0	1
CAPRD	The capitalization of R&D expenditure, the ratio of the capitalized development expenditure to the total R&D expenditure.	1336	6.69	8.03	0	21.42
Lnnumbers	The number of employees, the number of employees in listed firms	1336	6.69	2.81	0	12.08
ROE	Return on equity of an firm	1336	0.06	0.1	-0.42	0.46
Size	The total assets of the firm at the time of the ipo are log-taken for the total assets of the year	1336	11.22	0.85	8.88	13.2
Regul	The intensity of regional environmental regulation and the proportion of the total internal expenditure for environmental protection in the regional public expenditure	1336	0.09	0.13	0	1.32
Industry	The industry in which the business operates	1336	20.71	16.46	1	60

The number of employees, the control variable selected in this paper, reflects the company's talent reserve. The return on equity reflects the efficiency of capital use, and the asset scale can reflect the industry competitive advantage and production capacity of the firm. The level of competition in the industry in which an firm is located affects firm innovation (Avnimelech & Schwartz, 2009). The increase in environmental protection investment has led to more effective new technological innovations in the industry (Hu S et al., 2019).

The standard deviation of firm innovation performance, VC background, VC entry timing and capitalization of R&D expenditure are heterogeneous in Table1. VC background and entry time have research value for firm innovation performance.

Table 2 is the correlation analysis of the main variables. Venture capital with foreign background indicates a significant positive correlation (P<0.01), while only venture capital with domestic background indicates a significant negative correlation (P<0.05). Besides, VC entered in the development stage is significantly and positively correlated with corporate innovation at the 1% level. Capitalization of R&D spending is also significantly positively correlated at the 1% level. The mean value of VIF for each variable was 1.32, without the problems of multicollinearity.

Table 2. Correlation analysis

	Patents	FORVC	DOMVC	Early	Develo~t	Expans~n	Mature	CAPRD	Lnnumb~s	ROE	Size	Regul	Industry
Patents	1												
FORVC	0.136***	1											
DOMVC	-0.066**	-0.053*	1										
Early	0.033	0.235***	0.083***	1									
Develo~t	0.080***	0.225***	0.076***	-0.102***	1								
Expans~n	-0.053*	0.182***	0.075***	-0.197***	-0.181***	1							
Mature	0.027	-0.193***	0.106***	-0.141***	-0.130***	-0.252***	1						
CAPRD	0.144***	-0.025	-0.097***	-0.078***	0.041	-0.097***	0.075***	1					
Lnnumb~s	0.086***	-0.437***	-0.068**	-0.409***	-0.129***	-0.016	0.096***	0.217***	1				
ROE	0.019	0.147***	0.051*	-0.056**	0.133***	0.043	0.008	-0.019	-0.032	1			
Size	0.113***	-0.140***	0.105***	-0.185***	-0.081***	0.033	0.01	0.257***	0.475***	-0.077***	1		
Regul	-0.058**	-0.100***	0.075***	-0.138***	-0.084***	0.042	-0.006	0.043	0.261***	-0.009	0.136***	1	
Industry	0.112***	0.138***	-0.027	0.018	0.065**	-0.006	-0.003	-0.071***	0.076***	-0.068**	0.109***	-0.022	1

4. Empirical Analysis

4.1. Benchmark Regression Analysis

This paper explores the impact of venture capital background on corporate innovation through Models (1)-(2). In foreign investment background, the regression coefficient of significant positive correlation between venture capital and firm innovation performance was 33.53 (p <0.01), which assumed that H1a could be verified. The regression coefficient of the significant negative correlation between venture capital and firm innovation performance with only domestic investment background was -22.1 (p <0.05). Hypothesis H1b cannot be verified. The possible reason is that mixed capital with foreign investment can exert more experience advantages to promote firm innovation.

This paper uses the model (3)-(6) to explore the impact of venture capital investment timing on firm innovation. The regression coefficient of significant positive correlation between venture capital and firm innovation performance in the initial stage was 19.46 (p <0.05), and the regression coefficient of significant positive correlation between venture capital in the development stage was 22.2 (p <0.01), assuming that H2a and H2b can be verified. Companies in the start-up and development stages will be more inclined to use venture capital in innovative research and development to form a competitive advantage. VC that entered during the expansion period was negatively associated with firm innovation performance, assuming that H2c could not be verified. The possible reason is that the venture capital introduced by firms during the expansion period will be used to expand their business

areas and occupy more market share. VC entered during the maturity period showed no significant correlation with firm innovation performance, assuming H2d could not be verified.

Table 3. Benchmark regression results

	(1)	(2)	(3)	(4)	(5)	(6)
	Patents	Patents	Patents	Patents	Patents	Patents
FORVC	33.53***					
DOMVC		-22.10**				
Early			19.46**			
Development				22.20***		
Expansion					-9.260*	
Mature						4.350
Lnnumbers	4.321***	1.335	2.509***	1.899**	1.584*	1.591*
ROE	3.197	29.91	30.78	18.19	28.68	26.65
Size	6.491**	9.081***	7.939***	8.118***	8.229***	8.041***
Regul	-54.70***	-48.02***	-50.51***	-49.49***	-50.43***	-51.60***
Industry	YES	YES	YES	YES	YES	YES
_cons	-85.94***	-69.89**	-87.35***	-84.28***	-80.26***	-81.10***
N	1336	1336	1336	1336	1336	1336
R^2	0.061	0.036	0.036	0.038	0.034	0.032
t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$						

4.2. Inspection of the Intermediary Mechanism

Table 4 presents the test of the intermediary mechanism for the capitalization of R&D expenditure. In model (1), VC with foreign background was significantly positively correlated with firm innovation performance (coefficient = 33.53, p <0.01). In Model (2), VC with foreign capital background reveals a significant positive correlation with the capitalization of R&D expenditure at the level of 1%. In model (3), the capitalization of R&D expenditure reveals a significant positive correlation (coefficient = 1.12, p <0.01), and VC with foreign capital background was positively correlated with firm innovation performance (coefficient = 31.56, p <0.01). Capitalization of R&D expenditure plays a partial intermediary role between venture capital with foreign participation and innovation performance, assuming that H3a is established. In model (4), the regression coefficient of only domestic capital investment is negative, and in model (5), VC with only domestic capital background is significantly negatively correlated with the capitalization of R&D expenditure. It is assumed that H3b is not verified.

Table 5 shows the mediating mechanism of R&D expenditure capitalization between venture capital timing and firm innovation. In model (2), the regression coefficient of venture capital investment entered in the initial stage is not significant, assuming that H3c cannot be verified. In Model (4), venture capital entering in the development stage is significantly positively correlated (coefficient = 22.2, p<0.01). In Model (5), venture capital entering in the development stage is significantly positively correlated with the capitalization of R&D expenditure at the level of 1%. In Model (6), venture capital entering in the development stage is significantly positively correlated with firm innovation performance (coefficient = 19.29, p<0.05), and the capitalization of R&D expenditure is significantly positively correlated with firm innovation performance at the level of 1%.The capitalization of R&D expenditure plays a partial intermediary role between the venture capital and the development period, assuming that H3d is established. In the model (7) and (8), the regression

coefficient of the venture capital investment entered in the expansion period is negative, which cannot play an intermediary role in the capitalization of R & D expenditure. In the model (10), the regression coefficient of the VC entering in the maturity period is not significant, assuming that H3e and H3f can not be verified.

Table 4. Mediating mechanism between VC background and firm innovation

	(1)	(2)	(3)	(4)	(5)	(6)
	Patents	CAPRD	Patents	Patents	CAPRD	Patents
FORVC	33.53***	1.760***	31.56***			
	(6.40)	(3.31)	(6.04)			
DOMVC				-22.10**	-3.946***	-17.34*
				(-2.43)	(-4.34)	(-1.91)
CAPRD			1.120***			1.205***
			(4.18)			(4.43)
Lnnumbers	4.321***	0.516***	3.742***	1.335	0.319***	0.952
	(4.54)	(5.33)	(3.91)	(1.52)	(3.62)	(1.09)
ROE	3.197	-1.715	5.119	29.91	0.0830	29.81
	(0.15)	(-0.78)	(0.24)	(1.38)	(0.04)	(1.38)
Size	6.491**	1.888***	4.376	9.081***	2.165***	6.472**
	(2.33)	(6.68)	(1.56)	(3.19)	(7.61)	(2.24)
Regul	-54.70***	-1.542	-52.97***	-48.02***	-0.686	-47.19***
	(-3.17)	(-0.88)	(-3.09)	(-2.73)	(-0.39)	(-2.70)
Industry	YES	YES	YES	YES	YES	YES
_cons	-85.94***	-16.99***	-66.91**	-69.89**	-14.88***	-51.97*
	(-2.97)	(-5.77)	(-2.30)	(-2.36)	(-5.02)	(-1.75)
N	1336	1336	1336	1336	1336	1336
R^2	0.061	0.096	0.073	0.036	0.101	0.050
adj. R^2	0.056	0.092	0.068	0.031	0.097	0.045
t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$						

4.3. Robustness Test

This paper adopts the robustness test. Table 6 shows the PSM regression test for the VC background. In Models (2) and (3), the regression coefficients of venture capital with foreign capital background and the regression coefficients of R&D expenditure capitalization are significantly positive correlated, so H3a is robust. In model (4), the correlation of VC with only domestic capital background is not significant, and it is assumed that H3b is not robust.

Table 7 is the PSM regression test of the timing of venture capital entry. In model (5) and model (6), the regression coefficients of venture capital entered in the development stage and the regression coefficients of R&D expenditure capitalization are significantly positive correlated, assuming that H3d is robust. The regression coefficients of model (1) and (10) are not correlated, and the regression coefficients of Model (8) are negative, assuming that H3a, H3e and H3f are not robust.

Table 5. Mediating mechanism between VC timing and firm innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Patents	CAPRD	Patents	Patents	CAPRD	Patents	Patents	CAPRD	Patents	Patents	CAPRD	Patents
Early	19.46**	0.414	18.94**									
Development				22.20***	2.416***	19.29**						
Expansion							-9.260*	-1.857***	-6.987			
Mature										4.350	1.343**	2.660
CAPRD			1.256***			1.207***			1.224***			1.258***
Lnnumbers	2.509***	0.395***	2.012**	1.899**	0.403***	1.413	1.584*	0.361***	1.142	1.591*	0.355***	1.144
ROE	30.78	-0.393	31.27	18.19	-1.412	19.89	28.68	-0.0944	28.80	26.65	-0.516	27.30
Size	7.939***	1.965***	5.470*	8.118***	1.982***	5.726**	8.229***	2.019***	5.758**	8.041***	1.990***	5.537*
Regul	-50.51***	-1.370	-48.79***	-49.49***	-1.126	-48.13***	-50.43***	-1.081	-49.10***	-51.60***	-1.272	-50.00***
Industry	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
_cons	-87.35***	-16.83***	-66.21**	-84.28***	-17.14***	-63.59**	-80.26***	-16.73***	-59.78**	-81.10***	-17.02***	-59.67**
N	1336	1336	1336	1336	1336	1336	1336	1336	1336	1336	1336	1336
R^2	0.036	0.089	0.052	0.038	0.095	0.052	0.034	0.099	0.049	0.032	0.092	0.047
adj. R^2	0.032	0.085	0.047	0.033	0.091	0.047	0.030	0.095	0.044	0.028	0.088	0.042
t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$												

Table 6. PSM regression test of venture capital background

	(1)	(2)	(3)	(4)	(5)	(6)
	Patents	CAPRD	Patents	Patents	CAPRD	Patents
FORVC	28.64***	1.507**	26.72***			
DOMVC				-18.36	-3.080***	-14.80
CAPRD			1.269***			1.154*
ROE	26.64	-1.129	28.07	40.91	2.308	38.25
Size	5.648	2.522***	2.448	17.84***	2.471***	14.99**
Regul	-40.89*	0.966	-42.11*	-38.04	-9.987	-26.51
Industry	YES	YES	YES	YES	YES	YES
_cons	-59.72	-20.66***	-33.51	-158.6**	-14.13**	-142.3*
N	725	725	725	315	315	315
R^2	0.070	0.080	0.084	0.043	0.127	0.052
adj. R^2	0.064	0.074	0.077	0.027	0.113	0.033
t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$						

Linear regression using OLS whose non-linear disturbance term will be included in the disturbance term. In this paper, the number of explained variables was treated and Tobit regression, with significant results and robust conclusions.

5. Conclusion and Discussion

Based on the data of A-share listed companies from 2012 to 2021, this paper enhances the theoretical understanding of the role of heterogeneous venture capital on firm innovation performance, and the

research finds that VC with foreign investment background can better improve the innovation performance of firms. Secondly, the VC in the initial stage and development stage has a stronger role in promoting firm innovation, and the VC entered in the expansion period will inhibit firm innovation. Finally, when VC has foreign capital background or enters the development period, the capitalization of R&D expenditure plays a partial intermediary role between venture capital and firm innovation, and firms can make venture capital through capitalization innovation R&D expenditure play greater innovation benefits. This paper enriches the theory of the internal mechanism of venture capital on corporate innovation, and also provides ideas for the research in this field. In the future, we can continue to enrich the research on the impact of VC background and entry timing.

Table 7. PSM regression test of venture capital entry timing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Patents	CAPRD	Patents	Patents	CAPRD	Patents	Patents	CAPRD	Patents	Patents	CAPRD	Patents
Early	6.096	-0.0428	6.120									
Development				22.72**	2.570***	18.49**						
Expansion							-8.206*	-1.981***	-6.086			
Mature										7.913	1.193*	5.539
CAPRD			0.555			1.644***			1.070***			1.991***
ROE	-10.31	-1.442	-9.512	49.87	1.512	47.39	28.73	-0.706	29.48	52.41	1.129	50.17
Size	17.61***	2.438***	16.25***	23.52***	3.203***	18.25***	8.094***	2.306***	5.626**	15.26***	2.163***	10.95***
Regul	-130.2**	5.999	-133.5**	-52.29	11.95***	-71.94	-33.14	-1.128	-31.93	-49.00*	-5.181**	-38.69
Industry	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
_cons	-165.8***	-21.33***	-154.0***	-239.8***	-30.32***	-190.0***	-75.50**	-17.79***	-56.47*	-159.0***	-15.68***	-127.7***
N	415	415	415	454	454	454	1042	1042	1042	701	701	701
R^2	0.048	0.091	0.051	0.075	0.183	0.095	0.037	0.072	0.049	0.047	0.056	0.084
adj. R^2	0.037	0.080	0.037	0.065	0.174	0.083	0.033	0.067	0.044	0.040	0.049	0.077
t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$												

The future of the venture capital market requires a greater affirmation of the importance of venture capital with foreign background participation. Encourage VC institutions to enter the development period to promote firms to develop products and upgrade services. Give full play to the company's capitalization of research and development experience, in advanced technology to overcome difficulties.

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