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Research on CVC Performance Evaluation in Shandong Province

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Abstract
More and more attention has been paid to CVC. However, there are few literatures that study the performance of CVC from the perspective of entrepreneurial enterprises. In this paper, CVC performance indicator system is established according to CVC motivation of investment enterprises, and DEA analysis is carried out after dimension reduction by factor analysis. From the perspective of entrepreneurial companies, the main reason for the poor performance of CVC in Shandong province is the low scale efficiency, followed by the need to further improve the pure technical efficiency. In order to improve the performance of Shandong entrepreneurial enterprises, we should adjust the scale of investment and further improve the efficiency of internal resource utilization.
Keywords: CVC, performance, DEA, entrepreneurial companies.

1.Introduction

Corporate Venture Capital (CVC) refers to the direct or indirect minority equity investment made by non-financial companies with main business activities to entrepreneurial enterprises outside the organization for strategic purposes. Compared with general venture capital, CVC has unique advantages for both financing parties, so it has attracted more and more attention. On the one hand, investment enterprises are faced with their own innovation difficulties and hope to gain innovation impetus by investing in entrepreneurial enterprises. On the other hand, entrepreneurial companies in the period of rapid development need external financing channels to obtain the double support of capital and technology.

At present, most studies on CVC are from the perspective of investment enterprises, analyzing whether investment enterprises improve performance and enterprise value through CVC. Compared with the perspective of investment companies, the perspective of entrepreneurial enterprises is obviously insufficient. For entrepreneurial companies, there is a significant difference between the investment motivation and resource endowment of investment enterprises and the impact on the performance of entrepreneurial companies. Gompers and Lerner (1998) found that financing performance is better than that of ICV when there is strategic match between investment company and entrepreneurial companies. Chemanol, et al. (2013) pointed out that CVC is indeed conducive to entrepreneurial innovation due to technology matching between the parent company and the entrepreneurial enterprise as well as greater tolerance for innovation failure. After that, scholars did some exploratory empirical research on entrepreneurial performance, innovation performance, underpricing effect, growth model and other aspects.

With the development of CVC today, how is the performance of entrepreneurial companies? How to improve the performance of entrepreneurial companies from the perspective of investment enterprises? The solution of these problems is crucial to support the entrepreneurial companies. Take Shandong Province as an example. As a big economic province in China, Shandong attaches great importance to the development of entrepreneurial enterprises and the performance of CVC. Therefore, it is of positive practical significance to take Shandong province as an example to study CVC performance.

In this paper, CVC performance evaluation indicator is decomposed into strategic performance indicator and financial performance indicator based on the strategic motivation and financial motivation of investment enterprises. The main difference between investment enterprises and other sources of capital is that investment enterprises not only hope to benefit from the high financial performance of investment enterprises, but also regard CVC as a window to promote technological innovation and

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obtain strategic development. From the perspective of organizational learning and innovation, researchers regard CVC as a form of external R&D, which can stimulate CVC investment companies to innovate efficiency and develop their knowledge base, technologies, products and processes (Chesbrough and Tucci, 2004; Dushnitsky and Lenox, 2005). Therefore, CVC performance evaluation should not only focus on the financial performance of entrepreneurial companies, but also include strategic performance.

Strategic performance is closely related to the innovation ability of enterprises. Innovation ability represents the ability to learn and grow, and can reflect the innovative performance of entrepreneurial enterprises. For CVC, the innovation ability of entrepreneurial companies is crucial (Wan and Lu 2014). To a large extent, the strategic goal of investment enterprises is to obtain new technological Windows by observing entrepreneurial companies and stimulate their internal innovation. Therefore, it is reasonable to analyze the innovation ability of entrepreneurial enterprises to evaluate the influence of CVC on the strategic performance of entrepreneurial enterprises.

Based on the existing research results, most scholars take R&D investment, patent number obtained and patent cited times as the proxy variables of company innovation. Among them, R&D investment is equal to the proportion of the enterprise's R&D investment amount in the total assets at the end of the period. R&D investment intensity usually refers to the ratio of R&D investment and operating income, which all reflect innovation investment. The number of patents (the number of applications or grants) and the number of patent citations usually reflect the output of innovation. From the perspective of evaluating the impact of CVC on the strategic performance of entrepreneurial enterprises, it is more reasonable to analyze the innovation input of entrepreneurial enterprises than the innovation output. Both the number of patents filed and the number of patents granted need a longer period to be reflected. The utilization rate of Patent literature in China is not high, and the number of citations of patent literature cannot reflect the real innovation performance. The important difference between CVC and other types of investment lies in the maintenance and cultivation of innovative ability of entrepreneurial companies. Among the innovation Input indicators, r&d Input is greatly affected by the enterprise scale, so this paper chooses R&D Input intensity as the indicator of strategic strategy performance.

Financial indicator is a reliable basis to measure the financial performance of entrepreneurial companies. Financial performance refers to the specific performance of managers using enterprise resources to achieve business objectives. It is the business benefit and operator's performance during a certain period of operation. It is affected by the company's own profitability, asset operation level, solvency, growth and other factors. From the perspective of CVC, operating capacity is the embodiment of an enterprise's internal management capacity, which has little relationship with CVC. Therefore, this paper draws on and summarizes previous studies, and selects indicators of profitability, growth ability and debt paying ability to measure the financial performance of an enterprise. In order to better reflect the performance changes of enterprises, this paper adopts factor analysis method to reduce the dimension of financial indicators, determines representative factors and conducts empirical analysis with DEA model so as to conduct empirical research on the performance of venture capital.

2.Experimental Introduction

2.1 DEA model selection and DMU determination

DEA is a relatively mature and effective evaluation method in efficiency evaluation research. In this paper, BCC and CCR models of DEA are adopted to analyze the performance of the research samples. In this paper, listed companies in GEM in Shandong from 2017 to 2019 that are controlled or Shared by listed companies are selected as the Decision-Making Units (DMU). GEM listed companies with high and new technology, innovation as the main characteristics, as a representative sample of entrepreneurial enterprises. Through literature review and data review, it is found that the venture investment behavior of GEM listed companies is mainly completed by the way of listed companies' equity participation and holding. Listed companies directly participate in activities related to the disclosure of information is less, the paper cannot obtain empirical data. Therefore, this paper studies the performance of CVC by studying listed companies' equity participation or holding of GEM listed companies.

2.2 Sources of data and sample selection

First of all, Shandong enterprises listed on the GEM are screened out from the RESSET database, and the top 10 shareholders are consulted. Then,

Shandong enterprises listed on the GEM from 2017 to 2019 are selected for holding and participating shares of listed companies. In order to ensure the integrity and validity of the data, the companies that do not meet the requirements are removed according to the following standards: ST, *ST company; From 2017 to 2019, the same investment company will invest in companies with a duration of less than 3 years; A sample of entrepreneurial companies delisted and data missing during the study period. After selecting 18 GEM listed companies that meet the requirements, further screening will be conducted according to the situation of investment companies: 1 entrepreneurial company corresponds to only 1 CVC investment company. If at the same time two or more of the ten shareholders of a entrepreneurial companies are venture capital institutions jointly owned, controlled or independently established by listed large enterprises, then the shareholder with the largest proportion of equity is selected to determine the investment company. Samples of CVC investment company or entrepreneurial companies belonging to financial enterprises or whose main business is venture capital are excluded.

Finally, a total of 9 GEM listed companies meet the above conditions. This paper takes the data of these 9 companies for 3 consecutive years from 2017 to 2019 as sample observations for empirical analysis. Sample company data were collected from RESSET database and CSMAR 'a database. In this paper, Excel, SPSS, DEA SOLVER and other analysis software were used for data processing.

2.3 Evaluation indicator system construction and indicator description

This paper takes the shareholding ratio of investment enterprises as the input indicator of CVC performance evaluation.

An important difference between CVC and other types of investment is that CVC focuses on maintaining and cultivating the innovative ability of entrepreneurial companies, not just on financial performance. Research and development investment is greatly affected by enterprise scale, so this paper chooses research and development investment intensity as the indicator of strategic performance. This paper summarizes previous studies, and selects financial indicators such as profitability, growth ability and solvency ability to measure the financial performance of entrepreneurial companies. Specific indicators are shown in the table 1 below:

Table 1. **Input-output indicators**

Input		Output	
Indicators	First level indicators	Secondary indicators	
Investment company shareholding ratio --	Financial performance	Earnings Per Share	X1
		Return on Equity	X2
		Return on Assets	X3
		Net profit margin on sales	X4
		EPS growth rate	X5
		revenue growth rate	X6
		Net profit growth rate	X7
		Total Assets Growth Rate	X8
		Asset-liability ratio	X9
	Strategic performance	Investment intensity	Y

In order to better reflect the changes in corporate performance, this paper uses Factor Analysis to reduce the dimensionality of financial indicators when measuring the performance of invested companies, determines representative factors and uses DEA model for empirical research on the performance of CVC.

The factor analysis method uses statistical methods to screen representative factors among many factors, and express the existing indicators as a linear combination of representative indicators, thereby reducing the dimensionality and simplifying the existing indicator system. Before factor analysis, it is necessary to conduct KMO and Bartlett's Test on the evaluation indicator system and data to test whether the evaluation indicator system and data constructed in this article are suitable for factor analysis.

In order to avoid the impact of differences in data dimensions and orders of magnitude, SPSS software was used to standardize the financial performance data of Shandong GEM listed companies from 2017 to 2019, and then KMO and Bartlett's tests were conducted.

Table 2. **KMO and Bartlett tests**

Kaiser-meyer-olkin measurement of Sampling Adequacy		.667
Bartlett's Test of Sphericity	Approx Chi-Square	439.127
	df	36
	Sig.	.000

As shown in table 2, the KMO value is 0.667 > 0.5, and the Sig value of Bartlett's Test of Sphericity is 0.000 < 0.05, and its P value is far less than the significance level, so the null hypothesis is rejected. It shows that all financial performance indicators in the indicator system are correlated. In order to avoid repeated statistics of relevant indicators and result errors, factor analysis must be carried out on the original output variables before data can be brought into DEA model for calculation.

Table 3. **Communalities**

	Initial	**Extract**
X1	1.000	.802
X2	1.000	.980
X3	1.000	.957
X4	1.000	.879
X5	1.000	.886
X6	1.000	.927
X7	1.000	.971
X8	1.000	.942
X9	1.000	.524
Extraction method: Principal Component Analysis.		

According to Table 3, it can be seen that the variance of common factors extracted by principal component analysis is greater than 0.5, and most of them are greater than 0.7, indicating that variables can be reasonably expressed by common factors. Next, SPSS 19.0 was used to conduct factor analysis on the data of 6 indicators, and the analysis results were shown in Table 4:

Table 4. **Total variance of the Explained**

Component	Initial Eigenvalues			Extraction Sums of Squared loading			Rotation Sums of Squared loading		
	Total	% of Variance	Cumulation %	Total	Variance %	Cumulation %	Total	Variance %	Cumulation %
1	5.393	59.923	59.923	5.393	59.923	59.923	4.339	48.211	48.211
2	2.475	27.504	87.428	2.475	27.504	87.428	3.529	39.216	87.428
3	.644	7.152	94.579						
4	.281	3.119	97.699						
5	.157	1.746	99.444						
6	.021	.235	99.679						
7	.019	.209	99.888						
8	.008	.089	99.977						
9	.002	.023	100.000						
Extraction method: Principal Component Analysis.									

In Table 4, the eigenvalues of the first two factors are greater than 1 and the accumulative variance contribution reaches 87.428%, indicating that these two factors can fully reflect the original variable information and the information of the original variables is lost less. Therefore, two common factors were extracted to represent financial performance variables, denoted as R1 and R2. Then

SPSS software was used to calculate the Rotated Component Matrix analysis of R1 and R2 to determine the nature and meaning of each common factor, as shown in Table 5:

Table 5. **Rotated Component Matrix A**

	Component	
	1	2
X1	.391	.806
X2	.328	.934
X3	.114	.972
X4	-.043	.937
X5	.905	.260
X6	.962	.047
X7	.970	.171
X8	.968	.076
X9	.666	.285
Extraction method: The principal components. Rotation method: Varimax with Kaiser Normalization		
a. The rotation converges in 3 iterations.		

As can be seen from the above table, the common factor R1 has a high degree of interpretation for growth ability and solvency, so its meaning can be defined as growth factor. The common factor R2 has a high degree of explanation for the profitability, so the common factor R2 is defined as the profit factor.

The score coefficients of each common factor were calculated, and the results were shown in Table 6:

Table 6. Component Score Coefficient Matrix

	Component	
	1	2
X1	.019	.221
X2	-.011	.269
X3	-.072	.304
X4	-.110	.309
X5	.212	-.010
X6	.249	-.086
X7	.239	-.046
X8	.248	-.077
X9	.146	.023
Extraction method: Principal component Analysis. Rotation method : Varimax with Kaiser Normalization. Components. Score.		

According to the score coefficient of the original input variables and the corresponding common factors in the table, the final indicator value of each common factor is calculated, and the calculation is shown in Equations (1) and (2).

$$R1=0.019X1-0.011X2-0.072X3-0.110X4+0.212X5+0.249X6+0.239X7+0.248X8+0.146X9 \quad (1)$$

$$R2=0.221X1+0.269X2+0.304X3+0.309X4-0.010X5-0.086X6-0.046X7-0.077X8+0.023X9 \quad (2)$$

According to the above analysis, the common factors are determined as growth factor and profit factor respectively. When using DEA model for analysis, due to the requirement of data validity, it is necessary to convert and normalize the negative values in the common factor score coefficient table.

3.Results

Empirical analysis based on DEA method is as follows: investment enterprises stake as input indicators, earnings factors, growth factors and investment intensity as output indicator, from 2017 to 2019 CVC (CVC) of the input and output indicator after data processing, using DEA SOLVER software calculates the nine entrepreneurial companies performance evaluation results, it is concluded that the technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE) of the sample company. The relationship among the three is: TE= PTE*SE. Where, TE refers to the ratio between factor input and its output utility; PTE refers to the utilization of the existing technical level in its operation process; SE refers to the gap between the existing scale and the optimal scale of an entrepreneurial companies' company under the premise of a certain level of technology and management.

Table 7. **Descriptive statistics of entrepreneurial enterprise efficiency indicators**

Year	Technical efficiency	Pure technical efficiency	Scale efficiency	DEA Effective enterprise ratio	DEA Approximate effective ratio
2017	0.5056	0.8375	0.590806893	22%	11%
2018	0.4589	0.8276	0.523340306	22%	22%
2019	0.5018	0.9188	0.535263567	22%	22%

4.Discussion

4.1 technical efficiency

The technical efficiency is an important indicator reflecting the overall efficiency of the organization. Generally speaking, TE is 1, indicating its comprehensive efficiency is relatively effective; greater than 0.8 and less than 1 are approximate effective; less than 0.8 is invalid. According to Table 7, the average comprehensive efficiency in the past three years is less than 0.6, and only 2 entrepreneurial companies have a comprehensive efficiency of 1, indicating that the overall comprehensive efficiency of entrepreneurial companies is not high, and investment fails to bring high performance of entrepreneurial companies.

From the perspective of the proportion of DEA effective enterprises and the proportion of DEA approximate effective enterprises, the proportion of DEA effective enterprises is not high, 22% in the last three years, and the sum of the proportion of effective enterprises and the proportion of approximately effective enterprises does not exceed 50%, which also proves that the overall efficiency of the sample entrepreneurial companies is not high.

4.2 Pure technical efficiency

Pure technical efficiency refers to in the best state of scale, the use of technology and management efficiency, can reflect the decision-making unit can effectively use existing resources through management to maximize the potential of production. When the value of this indicator is 1, it indicates that technology and management are effective at the optimal scale, and that the organization can effectively use resources to achieve the highest output; otherwise, it indicates that the utilization of existing resources is not sufficient. As can be seen from Table 7, the mean value of PTE in the recent three years is higher than 0.8, indicating that the overall ability of entrepreneurial companies to utilize resources is fair.

4.3 Scale efficiency

Scale efficiency is an indicator reflecting the influence of scale factors and the difference between the actual scale and the optimal scale. The higher the scale efficiency is, the more reasonable the scale is. When the scale efficiency is 1, it is the state of scale effectiveness. In this case, the scale return remains unchanged. According to Table 7, the average size efficiency of entrepreneurial companies in the past three years is lower than 0.6 and shows a downward trend. This indicates that entrepreneurial companies generally do not reach the optimal scale, and there is still a large room for improvement. Unreasonable investment is an important factor affecting the performance of venture enterprises.

4.4 Returns to Scale

Table 8. **Returns to Scale statistics table**

Year	Increasing		Invariant		Diminishing	
	Number of Enterprises	proportion %	Number of Enterprises	proportion %	Number of Enterprises	proportion %
2017	3	33.33	2	22.22	4	44.44
2018	0	0.00	3	33.33	6	66.67
2019	0	0.00	1	11.11	8	88.89

The constant return to scale indicates that CVC has been in the maximization of input and output efficiency, and the performance of entrepreneurial companies is in the state of the highest efficiency. Increasing returns to scale means that the investment enterprises invest less and the performance of the venture enterprises does not reach the optimal state, so the investment amount should be increased appropriately. Diminishing returns to scale is the problem of investment redundancy, which indicates that investment enterprises should appropriately reduce investment so as to improve the performance of entrepreneurial companies.

In 2017, the return to scale of 33.33% of the sample enterprises increased, indicating that there was insufficient investment. The proportion of performance improvement of the entrepreneurial companies was greater than that of the investment enterprises, and the increase of investment proportion of the investment enterprises significantly improved the performance of the venture enterprises. 44.44% of the sample enterprises have diminishing returns to scale, indicating that they are in a state of investment redundancy. Increased investment of the investing enterprises cannot improve the performance of the entrepreneurial companies, but will reduce the performance level. Therefore, the investment of the investing enterprises should be reduced. It is worth noting that the proportion of enterprises with diminishing returns to scale has been increasing year by year in the past three years. In 2018, the proportion of sample enterprises with diminishing returns to scale rose to 66.67%, and in 2019, it was as high as 88.89%. This suggests that from an absolute point of view, an increasing number of sample entrepreneurial companies should be concerned about the diminishing marginal benefit of expanding their scale.

4.5 DEA result analysis of entrepreneurial companies in 2019

Table 9. **DEA data of entrepreneurial companies in 2019**

No.	DMU	BCC-O	CCR-O	SE	RTS of Projected DMU
1	300105	0.96836	0.43131	0.445402536	Decreasing
2	300110	0.69466	0.41716	0.600523997	Decreasing
3	300224	1	0.16298	0.16298	Decreasing
4	300233	1	0.59341	0.59341	Decreasing
5	300285	1	1	1	Decreasing
6	300308	0.94612	0.45211	0.477856931	Decreasing
7	300321	0.66034	0.1509	0.228518642	Constant
8	300423	1	1	1	Decreasing
9	300479	1	0.30868	0.30868	Decreasing

According to Table 9, among the 9 entrepreneurial companies in 2019, only 2 had efficient DEA.The proportion of enterprises with low technical efficiency is too high and the variance is large. This indicates that the problem of technical efficiency is serious, which should be paid enough attention to.

Among the 9 entrepreneurial companies, 4 have a pure technical efficiency of 1, indicating that these startups are efficient in using resources at the current technological level. The pure technical efficiency of four entrepreneurial companies is less than 1, indicating that the corresponding entrepreneurial companies should improve their internal management ability, so as to promote their pure technical efficiency and thus improve their technical efficiency. Among the 9 entrepreneurial companies, only 2 had a scale efficiency of 1, and the proportion of non-efficient enterprises was too high, with a large variance. This indicates that the sample companies generally have a serious problem of low scale efficiency, and the efficiency should be improved by adjusting the investment scale.

Observe the 8 entrepreneurial companies with diminishing returns to scale, and their technical efficiency is low. Only 2 entrepreneurial companies have effective DEA. There are 7 entrepreneurial

companies with fair technical efficiency but low scale efficiency, which means that entrepreneurial companies need to adjust their production scale in priority. There is a entrepreneurial companies with low pure technical efficiency and scale efficiency, so it needs to adjust the production scale and improve the management technology of the company at the same time.

5.Conclusions

Through the above analysis, the following conclusions can be drawn: The main problem of CVC performance in Shandong is the low scale efficiency. It indicates that scale factor is an important factor affecting the performance of Shandong CVC. The investment scale of most investment enterprises does not reach the optimal level, so it is necessary to adjust the investment scale to improve the performance of entrepreneurial companies. Shandong CVC performance also has the problem of low pure technical efficiency. It indicates that internal technology and management ability also restrict the performance of entrepreneurial enterprises. From the perspective of resource utilization, it should strengthen the ability of resource utilization and enhance the innovation and financial performance of entrepreneurial enterprises.

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