Research on the influence of resources on output of high-tech enterprises in Shandong Province—Based on the moderating effect of government support behavior

Xiu Li[a], Hongxia Dong

Taishan University, Tai'an, China
[a]lixiude@163.com

Abstract: *In recent years, Shandong Province government has strengthened the cultivation of high-tech enterprises, guided the increment, and expanded the enterprise group, but it still faces challenges such as insufficient innovation power, imperfect innovation ecology, and lack of core driving engine. Based on this situation, it is of great practical and theoretical significance to study the relationship between resources, government support behavior and achievements of high-tech enterprises in Shandong Province. This paper takes high-tech enterprises in Shandong Province as the research object. First, using cluster analysis method, according to different government support behavior, high-tech enterprises in Shandong Province are divided into 3 clusters, which are named as "active participation", "early support" and "independent" clusters, and the characteristics of each cluster are condensed. Secondly, the influence mechanism of high-tech enterprise resources on the output of high-tech enterprises in Shandong Province is accurately grasped through multiple regression analysis. Thirdly, the paper analyzes the difference of the influence of government support behavior on the output of high-tech enterprises by various resources in high-tech industry. Fourthly, based on the results of empirical analysis, this paper puts forward some measures to improve the human resources, R&D investment and technological competitiveness of high-tech enterprises in Shandong Province.*

Keywords: High-tech enterprise resources, achievement output, influence mechanism

1. Introduction

In March 2022, the Ministry of Science and Technology formulated the *"Work Points of the Torch Center of the Ministry of Science and Technology in 2022"* to provide new opportunities for the development of high-tech enterprises, and the high-quality development of high-tech enterprises has become the theme of the development of the times. In recent years, Shandong Province government has strengthened the cultivation, guided the increment and enlarged the enterprise group of high-tech enterprises, but it still faces the challenges of insufficient innovation power and ability, imperfect innovation ecology and lack of core driving engine[1]. Based on this, this paper studies the influence mechanism of resources, government support behavior and achievement output of high-tech enterprises in Shandong Province with great practical and theoretical significance.

2. Connotation definition and characteristics of high-tech enterprises

With the rapid development of China's economic level and high-tech in recent years, the concept of high-tech enterprises is constantly explored. *The Measures for the Administration of the Identification of High-tech Enterprises* promulgated in April 2008, and the documents such as *the Key High-tech Fields supported by the State and the Notice* on the *Issuance of the Newly Revised Measures for the Administration of the Identification of High-tech Enterprises* promulgated in 2016 have laid a theoretical and practical foundation for the development of the concept of high-tech enterprises. According to the conditions and indicators for the identification of high-tech enterprises proposed in the relevant policy documents, high-tech enterprises can be regarded as knowledge-intensive, capital-intensive and people-intensive economic entities registered in China for more than one year, mainly engaged in the production of high-tech products, scientific and technological research and development and innovation[2], and will

be transformed into independent intellectual property rights of high-tech enterprises through innovation results to further obtain economic profits. This type of enterprise is engaged in the field of electronic information technology, biological and new medical technology, aerospace technology, new material technology, new energy and conservation and environmental protection technology, new energy vehicle technology, advanced manufacturing technology, new energy and mineral technology, etc[3].

There are abundant research results on the characteristics of high-tech enterprises. Through combing the research results, it is found that researchers generally believe that high-tech enterprises have the characteristics of knowledge and technology intensive, high unpredictability of development, high added value, and high industrial growth rate[4]. First of all, high-tech enterprises are different from traditional enterprises in that their core competitiveness lies in innovative knowledge and technology, which requires more scientific and technical personnel[5]. Therefore, in the personnel structure of high-tech enterprises, people with high cultural and scientific level account for a large proportion, and high-tech enterprises are characterized by intensive knowledge and technology[6]. Second, high-tech enterprises are engaged in the production of high-tech products, science and technology research and development and innovation[7], and the output cycle of high-tech products, science and innovation research and development and innovation results cannot be determined, so high-tech enterprises have the characteristics of high risk to some extent[8]. Third, because high-tech enterprises belong to knowledge and technology intensive industries, they have the characteristics of low energy consumption, advanced production technology, small output, fast technology iteration, and high added value[9][10].

3. Research on achievements and output of high-tech enterprises in Shandong Province

As for these research, Tang Luyuan et al. (2023) proposed that the conversion rate of scientific and technological achievements is an important indicator of the achievement output of high-tech enterprises, and the index was subdivided into technology demand clarity, technology demand intensity, technology demand depth and technology demand fit degree. Li Zibiao et al. (2017) proposed that the achievements of high-tech enterprises are composed of factors such as enterprise scale, age and innovation ability. Wang&Lo (2003) believed that among high-tech enterprises, human resources, technology level, R&D investment and others are core resources, and among technology development resources, human resources are indispensable for the development of high-tech enterprises. Therefore, diversified means must be adopted to ensure the technological competitiveness of high-tech enterprises. When analyzing the input-output performance of high-tech enterprises, Huang Zixuan (2013) takes the productivity and business income of high-tech enterprises as performance indicators. Lopez-Cabrales et al., (2006) pointed out that human resources are enterprises who gather talents with abilities and specific technologies to produce products and services, and the adoption and planned introduction of such people are crucial to the development of enterprises. Broadbent&Weill (1993) proposed that technology level is the key factor of an enterprise's product and service innovation ability. Therefore, based on the above research results, this paper defines the independent variables affecting high-tech enterprises as human resources, technical level, R&D investment and other influencing factors.

4. Research on government-supported behavior

There are abundant research results on government support behavior at home and abroad. Montoro (2010) and Kang (2012) argued that government support includes research and development funds and financial subsidies for various activities of enterprises. Shu and Wang (2015) pointed out that government support behavior consists of implementing beneficial policies and projects, providing technical support, providing financial support, and helping enterprises to obtain various licenses. Czarnitzki (2005) pointed out that pre-tax deduction of R&D expenditure can encourage R&D and promote innovation activities of enterprises. Peng Jisheng and Sun Wenxiang et al. (2008) classified government support behaviors into four categories and confirmed the impact of government support behaviors on the output of high-tech enterprises by using regression analysis. Yang Zhenning et al. (2010) proposed that the government should focus on intellectual property protection to promote the improvement of enterprise performance; Long Jing et al. (2012) pointed out that the government support behavior covers the introduction of talents, fiscal and tax support, macroeconomic orientation and other policies. Based on the research results at home and abroad, this paper defines the government support behavior of participating high-tech enterprises in Shandong Province as those 7 types, including entrepreneurship education, hardware support, guidance and consultation, industrialization support, financial assistance, R&D investment and

sales channels.

In the existing research, it is found that government support behavior has both direc[11][12]t and indirect effects[13][14][15] on enterprise outcomes. First of all, in the research on the direct impact of government support behavior on enterprise outcomes, Shao Chuanlin (2015), Maseko et al. (2010) and Wang Conghu (2006) confirmed that government support behavior has a significant promoting effect on enterprise outcomes. Link,Scot (2009) Lin Zhouyu et al. (2015) and Xiao Wen et al. (2014) analyzed the inhibitory effect of government support behavior on enterprise outcomes. Second, in the study on the indirect impact of government support behavior on enterprise output, Hong Yong and Li Yingmin (2012), Nie Anyyu (2011) and Yin Zhifeng (2013) confirmed the mediating role of government support behavior in the relationship between enterprise output and enterprise achievement. Moreover, Ding Kai, Zhu Shunli (2016), Feng Haihong et al. (2015), Li Zuofeng and Zhang Mingshen (2012), Fan Qi and Han Minchun (2011) et al confirmed the moderating effect of government support behavior on the relationship between enterprise outcomes and output through empirical analysis.

5. Research design

5.1 Research hypothesis and research model

Based on the above research results, this paper constructs a research model from the micro perspective of "high-tech enterprise resources" and the macro perspective of "government support behavior", and proposes the following hypotheses, as shown in Figure 1.

Hypothesis 1: The human resources of high-tech enterprises in Shandong Province can promote their high-quality development.

Hypothesis 2: The technical level of high-tech enterprises in Shandong Province can promote their high-quality development.

Hypothesis 3: The R&D department of high-tech enterprises in Shandong Province can promote their high-quality development.

Hypothesis 4: The participation mode of government entrepreneurship support projects plays a moderating role in the influence of various resources of high-tech industry on the high-quality development of high-tech enterprises.
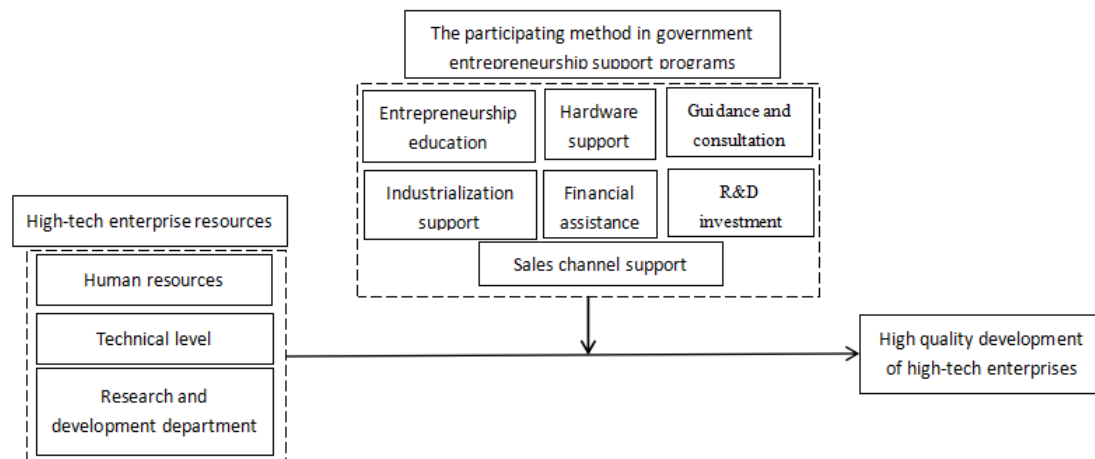

Figure 1: Research model

5.2 Research method and research process

This study takes the high-tech enterprises in Shandong Province that the government participates in the support project as the research object, classifies the high-tech enterprises according to the different ways of government support, and then analyzes the relationship and influence mechanism of the resources of various types of high-tech enterprises on the output of high-tech enterprises. To this end, this paper is prepared to conduct research from the following stages: First, we need to collect the relevant research data of high-tech enterprises in Shandong Province, and sort out the high-tech enterprises in

Shandong Province supported by the Shandong provincial government; Secondly, through cluster analysis, the high-tech enterprises sorted out in the previous stage are classified. Third, we need to accurately grasp the different characteristics of high-tech enterprises in Shandong Province under the different support means of Shandong government; Fourthly, based on the resource-based theory, through regression analysis, the correlation between the resources possessed by high-tech enterprises in Shandong Province and the high-quality development of high-tech is explored. (See Figure 2)
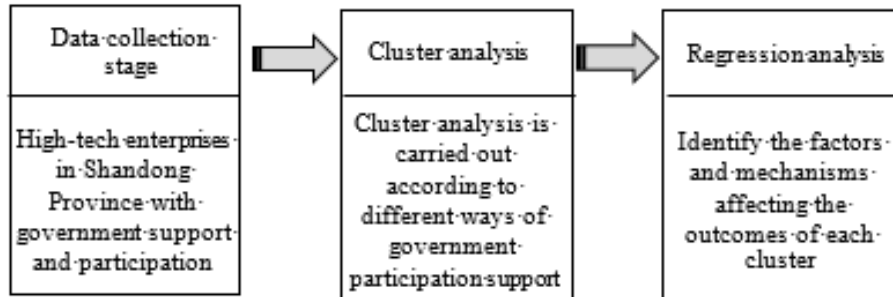

Figure 2: Research process

5.3 Data collection and variable definition

This paper focuses on the high-tech enterprises in Shandong Province with the participation of government support, and collects relevant research data of high-tech enterprises in Shandong province through sampling survey. Among them, the independent variables are employees of high-tech enterprises (existing human resources, future talent introduction plans, etc.), R&D organization (whether there is a professional organization for cutting-edge technology R&D Department), technology level (technology income, etc.), and R&D investment (R&D personnel, internal expenditure of R&D funds, etc.). (See Table 1)

Table 1: Independent variable selection index

First level independent variable indicator	Second level independent variable indicator
Employees of high-tech enterprises	Existing human resources
	Future talent introduction plan
R&D organization	Whether there is cutting-edge technology research and development professional organization
Technical level	Technology income
R&D investment	R&D scientific and technological personnel
	R&D Internal expenditure

6. Analysis result

6.1 Cluster analysis result

According to the government support behavior (entrepreneurship education, hardware support, industrialization guidance, financial assistance, sales channel support, R&D investment, guidance and consultation), this paper carries out K-means cluster analysis, and divides high-tech enterprises in Shandong Province into three different types of clusters. In the process of cluster analysis, random samples did not involve R&D investment and guidance consultation, so these two variables were deleted. Detailed analysis results are shown in Table 2. High-tech enterprises in Shandong Province can be divided into three types, Cluster 1 is "active participation", the government participation in this cluster is mainly hardware and capital support cluster; Cluster 2 is the "early-stage support type", and the government support behavior in this cluster mainly includes early-stage education; Cluster 3 is the "independent type", which shows that the government's participation in supporting behavior is less.

Table 2: Analysis results of high-tech enterprise clusters in Shandong Province according to different ways of government support

Variables	Group 1 (n= 103)	Group 2 (n=64)	Group 3 (n=464)
Entrepreneurship education (entrepreneurship lectures, training of entrepreneurship institutions, etc.)	126	281	015
Hardware Support (Startup related)	1.000	000	002
Industrialization guidance (commercialization of entrepreneurial projects, etc.)	214	219	002
Financial assistance (government financing, etc.)	971	844	000
Sales support (channel support, etc.)	049	047	006
Characteristic	Hardware and capital Support cluster	Start-up education and financial support cluster	Government-free participation cluster

6.2 Hypothesis test result

First, the factors affecting the output of high-tech enterprises in Shandong Province are accurately mastered through regression analysis (see Table 3 for details). In the three clusters of "active participation type", "initial support type" and "independent type", the relationship between the resources of high-tech enterprises and the achievements of high-tech enterprises in Shandong Province has shown a significant impact. In the "active participation" cluster, the existing human resources, technical level and R&D investment can promote the achievements of high-tech enterprises in Shandong Province. In the "initial support" cluster, R&D organization and R&D investment have a promoting effect on the achievements and outputs of high-tech enterprises in Shandong Province. In the "independent" cluster, existing human resources, future talent introduction plan, R&D organization, technical level, R&D investment all play a role in promoting the achievements and outputs of high-tech enterprises in Shandong Province. Therefore, Hypothesis 1, Hypothesis 2, Hypothesis 3 are all true.

Table 3: Regression analysis result

	Active participation type				Initial support type				Independent type			
	Utd. Bâ	St. Bâ	T	P	Utd. Bâ	St.Bâ	T	P	Utd. Bâ	St.Bâ	T	P
Constant	3.274		10.12	0.001	0.920		2.188	0.033	2.430		18.20	0.001
Existing human resources	0.014	0.356	3.346	0.001					0.023	0.343	8.090	0.001
Future introduction plan									0.770	0.177	4.336	0.001
R&D organization					0.888	0.256	2.215	0.031				
Technical level	0.331	0.249	3.076	0.003					0.149	0.133	3.481	0.001
R&D Investment	0.364	0.215	2.207	0.045	0.652	0.375	2.188	0.033	0.284	0.151	3.429	0.001
	R Square			Adjusted R Square			F			P		
Active participation type	0.352			0.332			17.90			0.001		
Initial support type	0.355			0.3			6.387			0.001		
Independent type	0.353			0.344			41.50			0.001		

Second, according to the results, the details of the influence mechanism between resources and achievements of high-tech enterprises in Shandong Province are shown in Table 3. According to the different government support behavior, the influence of high-tech enterprise resources on the outcome output is significantly different in each cluster. In the "active participation" cluster, the most significant factor affecting the output of high-tech enterprises in Shandong Province is human resources, followed by technology level, and R&D investment factors have an impact on the output of high-tech enterprises. In the "early support" cluster, the influence of R&D investment on the output of high-tech enterprises in Shandong Province is significant. In the "independent" cluster, human resource is the most significant factor affecting the output of high-tech enterprises in Shandong Province, followed by sales channels. Therefore, Hypothesis 4 is valid.

7. Development countermeasures of high-tech enterprises in Shandong Province

This paper analyzes the relationship between resources and outputs of high-tech enterprises in Shandong Province, and verifies that the way of government support behavior plays a moderating role in the influence of various resources of high-tech industries on the results of high-tech enterprises. First of all, according to the different ways of government support in Shandong Province, this paper uses cluster analysis to classify high-tech enterprises in Shandong Province into three types, which are "active participation", "early participation" and "independent". These three types have different characteristics. Secondly, through regression analysis, it is confirmed that the resources of high-tech enterprises in Shandong Province have a promoting effect on the output of achievements. Third, it accurately grasps the differences among the factors that affect the output of high-tech enterprises in Shandong Province in the three clusters of "active participation", "early participation" and "independent".

From the above research results, it can be seen that Shandong provincial government should strengthen the policy support of high-tech enterprises in Shandong province by formulating and issuing policy documents for the development of high-tech enterprises. In the introduction of policies, we can comprehensively consider the development characteristics of high-tech enterprises in Shandong Province, fully mobilize the role of science and technology departments, personnel departments and related departments, introduce a diversified series of plans and programs, give full play to the guiding role of these departments, increase the publicity of preferential policies for enterprises, and ensure the full implementation of preferential policies.

According to the research results, the proportion of high-tech talents in our province is relatively low, so we should formulate systematic, dynamic and scientific talent policies from macro, meso and micro levels. First, the national development strategy of "science and technology power, talent power" and the realistic environment of Shandong Province are constantly developing and changing, and the dynamic formulation and adjustment of talent policies, especially the formulation of talent policies in our province should coordinate all relevant departments and emphasize the systematization of talent policies; Second, the development of science and technology policies should take into account the whole cycle of talent development. At present, the talent policy of Shandong Province focuses on "external introduction" rather than "internal education", and gives one-off research start-up fund incentives and other policies in the introduction of talents, but the cultivation of talents after the introduction of talents and the cultivation of existing talents are often ignored. Third, the cultivation of young scientific and technological talents still needs to be strengthened. At present, the preferential policies for young scientific and technological talents in our province are still lacking in systematic and overall design, and sometimes there is a phenomenon of seniority, which leads to a fault in the construction of scientific and technological talents. Fourth, we need to refine the talent policy to provide accurate services for scientific and technological talents in our province. To stimulate the enthusiasm of scientific and technological talents, it is necessary to master the needs of scientific and technological talents, and constantly improve the policy system for their needs to enhance the implementation effect of talent policies.

For high-tech enterprises in Shandong Province, R&D investment is the fundamental to promote enterprise innovation, and increasing R&D investment will greatly promote the high-quality development of high-tech enterprises in Shandong Province. At the same time, the further transformation of R&D investment into the internal competitiveness of enterprises is also a key factor for the high-quality development of high-tech enterprises in Shandong Province. However, from the analysis results, it is obvious that high-tech enterprises in Shandong Province have not invested enough in R&D intensity, which has become the bottleneck factor restricting the development of high-tech enterprises in Shandong Province. Shandong Province needs to further deepen the integration of production, education, research and use. Through further reform, enterprises should coordinate the economic goals and the goals of scientific and technological progress, pay attention to economic interests as well as fulfill their social responsibilities to make positive contributions to promoting social progress. Enterprises can convert part of the annual income into R&D funds, invest them into the research and development process of products and services, obtain unique core technologies, and improve the core competitiveness of high-tech enterprises in Shandong Province.

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