Based on the Linear Regression Method, the Influence of Research and Development Investment of Listed Enterprises in Hebei Province on the Performance of Enterprises

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Abstract—According to the influencing factors of corporate financial performance, an enterprise performance evaluation index system composed of profitability, development ability and debt paying ability is constructed, and the comprehensive performance evaluation results of enterprises are obtained by the factor analysis method. Then, the explanatory variables, explained variables and control variables were determined, panel regression model was constructed, and the specific effect and degree of influence of R&D input on performance of listed enterprises in Hebei Province was obtained. Finally, in view of the main problems of the influence of R&D input on performance, the corresponding countermeasures and suggestions are putting forward.

Keywords- listed companies; R&D; financial performance; Linear regression; Empirical analysis

1 INTRODUCTION

The continuous development of global economy has put forward higher requirements for enterprises. Research and development results are critical to achieving sustainable competitive advantage. Under the current market environment, the main position of Chinese listed enterprises become more and more obvious in the market. At the same time, listed enterprises also directly affect the rationality of the entire market resource allocation. In recent years, our country has increased investment in scientific and technological innovation, and our overall strength has been improved. However, there is no consistent conclusion on the relationship between R&D investment and performance in empirical studies.

After reading a large number of relevant literature, it is found that the relationship between R&D input and firm performance is divided into two categories. Most scholars believe that R&D input and firm performance are positively correlated with hysteresis effect, while a few scholars believe that they are negatively correlated or non-linear[1].

Based on the listed enterprises in Hebei Province, this paper studies the influence of R&D input on performance of listed enterprises in Hebei Province. Most enterprises in Hebei Province have low R&D investment and insufficient growth. The whole process of enterprise R & D is slow, and enterprise competitiveness is insufficient, which can not promote the development of regional economy well. This paper uses the method of empirical analysis, according to the influence factors of enterprise financial performance, to construct the evaluation index system. Factor analysis method was used to evaluate the financial performance of listed enterprises in Hebei Province from 2012 to 2020, and research hypotheses were put forward to determine the explanatory variables, explained variables and control variables, and multiple regression models were constructed to obtain the relationship between R&D input and corporate financial performance, analyze the reasons, and propose countermeasures and suggestions to promote the development of enterprises. It is of great practical significance to improve the competitiveness of listed enterprises in Hebei Province and promote the sustainable development of economy.

2 THEORETICAL ANALYSIS AND RESEARCH HYPOTHESI

Since Schumpeter put forward the innovation theory, R&D activities have been one of the hot issues concerned by researchers. As early as the beginning of the 20th century, Western economists used empirical data to explore the impact of technological input on the economic output of enterprises [2].

Through reviewing the global literature on the impact of R&D investment on firm performance, four main viewpoints are summarized. First, R&D investment is beneficial to the improvement of company performance. Second, excessive R&D investment will reduce the company's performance. The third is that there is no obvious correlation between R&D investment and company performance. Fourth, the relationship between R&D investment and company performance is non-linear. Ye Xiangsong and Liu Jing (2018) used provincial data as a research sample and found that the effect of new technology R&D activities on company productivity varies with the type of innovation activities. At present, domestic technology research and development is stuck in a bottleneck. Low attention to scientific research and high attention to technology research and development, the former need government support, the latter will have a great negative impact on total factor productivity. Through the results of the dynamic panel smooth transfer model, this study further shows that the government must give stable and long-term support or subsidies to scientific research, so that scientific research can maximize the role of improving total factor productivity. Therefore, based on the above analysis, this paper proposes:

Hypothesis 1: There is a negative correlation between R&D investment and financial performance of listed enterprises in Hebei Province.

Hypothesis 2: There is a certain lag in the impact of R&D investment on performance of listed companies in Hebei Province.

3 EMPIRICAL RESEARCH DESIGN

3.1 Variable Setting

3.1.1 R&D Investment

In this paper, R&D expenditure is used to measure enterprises' R&D input, and R&D intensity (RDS) is used to measure R&D input in order to remove the influence of scale and industry.

3.1.2 Financial Performance

As for the measurement indicators of financial performance, previous studies mainly divided into financial data and market data. Considering the instability of market data, this paper uses financial data to measure financial performance. This paper obtains the enterprise financial performance as the index to measure financial performance through the factor analysis method.

3.1.3 Control Variable

Referring to relevant researches at home and abroad, this paper introduces three control variables: total asset growth rate (TAT), enterprise SIZE (SIZE) and cash holding level (CHL).They are shown in Table 1.

Table 1 variable definitions

Variable Name		Formula Mode
Explained variable	PERF	Factor analysis
Explanatory variables	RDS	R&D/ Total operating income
Control variable	TAT	(Total assets this year –last year)/last year
	SIZE	ln(total assets)
	CHL	Monetary fund / Total asset

3.2 The Empirical Model

3.2.1 Factor Analysis Model

$$X_P = \alpha_{p1}F_1 + \alpha_2 F_2 + \cdots \alpha_{pm}F_m + \varepsilon_p$$

(1)

3.2.2 Examine the Relationship Between R&D Investment And Financial Performance

Many economists use multiple regression models to study the impact of R&D investment on enterprise performance and its lag effect [4].

3.2.2.1 Test the relationship between R&D investment and financial performance

$$PERF_{(i,t)} = \alpha_0 + \beta_1 RDS_{(i,t)} + \beta_2 SIZE_{(i,t)} + \beta_3 CHL_{(i,t)} + \beta_4 TAT_{(i,t)} + \varepsilon_0 \qquad (2)$$

3.2.2.2 Test the lag effect of R&D investment and financial performance

$$PERF_{(i,t)} = \alpha_1 + \beta_1 RDS_{(i,t-1)} + \beta_2 SIZE_{(i,t-1)} + \beta_3 CHL_{(i,t)} + \beta_4 TAT_{(i,t)} + \varepsilon_1 \qquad (3)$$

3.3 Samples And Data Sources

This paper selects the listed companies in Hebei Province from 2012 to 2020 as the initial research sample. After eliminating ST companies and deleting companies with incomplete data, we finally get the panel data samples of 42companies.

The data used comes from Wind database and Cathay Pacific (CSMAR) database, using Excel, SPSS and STATA15 for data processing, factor analysis and regression analysis.

4 EMPIRICAL TEST AND RESULT ANALYSIS

4.1 Descriptive Statistics

Descriptive statistical analysis is carried out with the data of listed companies in Hebei from 2012 to 2020. The results are shown in Table 2:

Table 2 Descriptive statistics of listed companies in hebei

Variable	Obs	Mean	Std.Dev.	Min	Max
REPF	378	0.999	1.676	-3.763	6.933
RDS	378	0.038	0.038	0.000	0.259
SIZE	378	22.241	1.548	18.851	25.971
CHL	378	-5.323	6.536	-33.237	8.050
TAT	378	0.679	0.320	0.174	1.687

As can be seen from Table 2, the maximum values of explanatory variable RDS differ greatly, indicating that R&D investment among enterprises varies greatly. The explained variable REPF is the same, with a maximum value of 6.933 and a minimum value of -3.763, which to some extent reflects the great difference in the competitiveness intensity of the comprehensive performance of enterprises.

4.2 Correlation Analysis

Use STATA15 to perform correlation analysis on the data, and the results are shown in Table 3.

Table 3 Correlation coefficient table

	REPF	RDS	*SIZE*	*CHL*	*TAT*
REPF	1.000				
RDS	0.157***	1.000			
SIZE	-0.338***	-0.238***	1.000		
CHL	-0.288***	-0.060	0.072	1.000	
TAT	0.132**	-0.309***	-0.033	-0.075	1.000

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

As can be seen from Table 3, correlation coefficients of all variables are less than 0.5, and there is no multicollinearity between them, so regression analysis can be conducted. R&d investment intensity, the proportion of technical personnel, enterprise size, cash holding level and total asset turnover are significantly correlated with enterprise comprehensive performance. Specifically, there is a significant positive correlation between the comprehensive performance of the sample enterprises and the R&D investment intensity at the 1% confidence level, indicating that the R&D investment intensity has a positive impact on the comprehensive performance of the enterprises. At the confidence level of 5%, the proportion of technical personnel has a significant positive correlation, indicating that the proportion of technical personnel has a positive impact on the comprehensive performance of enterprises. Moreover, enterprise scale, cash holding level and total asset turnover all have significant influence on enterprise comprehensive performance. In the correlation study, the influence of other factors has not been controlled, so the above results are only a preliminary inference. To sum up, explanatory variables and control variables have good explanatory ability to explained variables, and a deeper relationship needs to be further explored [5].

4.3 Regression Analysis

In this paper, the relationship between R&D input and comprehensive performance of listed enterprises in Hebei Province is studied by taking comprehensive performance of enterprises as the explained variable, R&D input intensity as the explanatory variable, and enterprise scale, cash holding level, total asset turnover as the control variable. This paper uses panel regression model for regression analysis.

The regression results are shown in Table 4, and the regression results of four lagging stages are shown in Table 5.

Table 4 Regression results

	REPF	REPF1	*REPF2*	*REPF3*
RDS	1.351	1.909	1.241	1.655
	(3.773)	(1.704)	(1.056)	(1.064)
SIZE	-0.156*	-0.079*	-0.131***	-0.069**
	(0.089)	(0.047)	(0.049)	(0.030)
CHL	-0.038***	0.000	-0.023*	-0.026***
	(0.011)	(0.007)	(0.012)	(0.006)
TAT	1.252***	1.194***	-0.520**	0.087
	(0.444)	(0.245)	(0.222)	(0.179)
_cons	3.354	0.877	3.105**	1.271*
	(2.232)	(1.137)	(1.223)	(0.667)
N	378	378	378	378

*** p<.01, ** p<.05, * p<.1

As can be seen from Table 4, the regression coefficient of R&D investment intensity on enterprise comprehensive performance is 1.351, the regression coefficient of R&D investment intensity on enterprise profitability performance is 1.909, the regression coefficient of R&D investment intensity on enterprise solvency performance is 1.241, and the regression coefficient of R&D investment intensity on enterprise development capability performance is 1.655. None of them passed the significance test, indicating that the impact of R&D investment intensity and comprehensive performance of enterprises in the current period is not significant, and hypothesis 1 is valid.

There may be the following reasons for their insignificance in the current period: On the one hand, it takes a certain amount of time for R&D activities of enterprises to change from input to output, and there may be a certain lag; On the other hand, research and development activities are highly risky. If money is invested, it may not yield results. In addition, the R&D investment of enterprises is uncertain, and investors may change with the development of enterprises' R&D activities. Therefore, the influence of the two factors is not significant in the current period. Therefore, this paper studies the lag effect of R&D investment intensity on firm performance[7].

Table 5 lag four-period regression results

	REPF	REPF	*REPF*	*REPF*
L.RDS	4.333			
	(3.327)			
L2.RDS		7.009**		
		(2.958)		
L3.RDS			7.515***	
			(2.877)	
L4.RDS				7.125**
				(2.864)
SIZE	-0.153*	-0.212***	-0.226***	-0.249***
	(0.084)	(0.079)	(0.082)	(0.093)
CHL	-0.045***	-0.063***	-0.057***	-0.044***
	(0.011)	(0.012)	(0.010)	(0.014)
TAT	1.380***	1.572***	2.064***	2.079***
	(0.431)	(0.464)	(0.502)	(0.549)
_cons	3.100	4.178**	4.230**	4.843**
	(2.086)	(1.959)	(2.019)	(2.233)
N	336.000	294.000	252.000	210.000

*** p<.01, ** p<.05, * p<.1

As can be seen from Table 5, the regression coefficient between R&D investment intensity and comprehensive performance of enterprises one stage behind is 4.333, which fails to pass the significance test. The R&D investment intensity of the second phase lag shows a significant positive correlation with the comprehensive performance of the enterprise, and passes the significance test at the 5% level. The regression coefficient is 7.009, which means that every increase of one unit of R&D investment intensity will increase the comprehensive performance of the enterprise by 7.009 units. The R&D investment intensity of three lagging periods has a significant positive correlation with the comprehensive performance of the enterprise. It passes the significance test at the 1% level, and the regression coefficient is 7.515, which means that the comprehensive performance of the enterprise increases by 7.515 units for every increase of one unit. The research and development investment intensity of the four lagging periods has a significant positive correlation with the comprehensive performance of the enterprise. It passes the significance test at the 5% level, and the regression coefficient is 7.125, which means that every increase of one unit of research and development investment intensity will increase the comprehensive performance of the enterprise by 7.125 units[8].

The lag regression results show that R&D investment intensity has a lag effect on the comprehensive performance of enterprises. To some extent, this indicates that it takes a long period for enterprises to conduct research and development from R&D input to productive output, and then to social circulation and performance. Further observation shows that the t

value of the third lagging period is greater than that of the second lagging period and the fourth lagging period, indicating that the positive impact of R&D investment intensity on the comprehensive performance of enterprises is the most obvious in the third lagging period, and the promoting effect is weakened in the fourth lagging period. In addition, it is also found that with the increase of lag period, the promoting effect of R&D investment intensity on comprehensive performance of enterprises first increases and then decreases. However, from the overall point of view, research and development investment intensity can play a positive role is certain. It is of great significance to analyze all aspects of R&D activities comprehensively and systematically to improve enterprise performance [9].

From the perspective of control variables, firm size has a significant negative correlation with comprehensive performance. To some extent, this indicates that the comprehensive performance of large enterprises is not necessarily strong. When an enterprise is larger, it becomes more difficult to expand. Smaller enterprises have higher flexibility and innovation, which can promote the development of comprehensive performance of enterprises. From the perspective of cash level, cash holding level has a significant negative correlation with enterprise comprehensive performance. It indicates that enterprises should reduce cash carrying cost for diversification, so as to improve the comprehensive performance of enterprises. The total assets turnover has a significant positive correlation with the comprehensive performance of enterprises. It indicates that the faster the turnover speed from input to output, the higher the comprehensive performance of the enterprise.

5 CONCLUSION

This paper takes 42 listed enterprises in Hebei Province, adopts multiple regression model for empirical analysis, studies the impact of R&D input on financial performance of listed enterprises in Hebei Province, and explores the lag effect of R&D input on financial performance. After research and analysis, the conclusion is as follows: R&D investment has a certain lag on the comprehensive performance of enterprises. The intensity of R&D investment from the second period to the fourth period can improve the financial performance of enterprises, and the impact of the third period is the greatest. It takes a certain amount of time for R&D investment to be transformed into R&D products, so as to improve the competitiveness of enterprises. It is found that the ratio of technicians in the current period and one period behind has a positive impact on the comprehensive performance of enterprises, and the impact is the greatest in the current period. The reason of this result is related to the redundancy of enterprise technical personnel and the instability of enterprise innovation output. With the progress and development of science and technology, the innovation knowledge and ability of technical personnel cannot meet the needs of society, so the impact is the greatest in the current period.

Companies should combine national strategies, industry backgrounds, and their own corporate characteristics to improve their R&D output and corporate performance.

1) Improve the efficiency of the use of funds

Establish a corresponding fund tracking system to make the use of funds transparent. Improve and improve the performance appraisal system of the enterprise, and improve the efficiency of the use of funds in all departments of the enterprise.

2) Strengthen the intensity of talent introduction and training

The state is now paying more and more attention to high-tech talents. To ensure the long-term development of enterprises, listed companies in Hebei Province have increased their proportion of R&D investment, which has led to the emergence of a phenomenon of plethora of talents. Enterprises should strengthen the intensity of talent introduction and training, introduce core R&D personnel who have more advanced technologies, and increase the transformation rate of enterprises' achievements.

3) Improve the efficiency of R&D achievement transformation

Strengthen the internal management efficiency of the enterprise, adopt diversified forms of research and development, increase the transformation rate of the enterprise's results, and efficiently use the enterprise's research and development investment to maximize the return on investment ratio.

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