A Study on the Correlation between R&D Investment and Financial Performance: ~~Taking~~ A Case of the Automobile Manufacturing Industry ~~as an Example~~

ABSTRACT

With the rapid development of science and technology, scientific and technological innovation ~~has~~have become the first productive force in the context of economic globalization. China's manufacturing industry has always been one of the pillar industries of the national economy; ~~,~~ the automobile manufacturing industry ~~in the manufacturing industry~~ occupies a dominant position in the manufacturing industry. With the economic growth and ~~,~~ improvement the living standard of the population, people's demand for automobiles has gradually increased. ~~,e~~Coupled with the current economic and social comprehensive green transformation and upgrading, enterprises that only maintain the existing scale of research and development, may not be able to meet the growing demand of the people. For the automobile manufacturing industry, increasing R&D investment will help enterprises occupy the market and improve their financial performance. Therefore, this paper uses Stata software to study the relationship between R&D investment and financial performance. It is found that there is a negative correlation between R&D investment and the current financial performance of the automobile manufacturing industry, and there is a lagging effect of R&D investment on current financial performance of automobile manufacturing industry due to the existence of certain time problems ~~of~~with R&D projects. By studying and analyzing the data, it is hoped that suggestions related to R&D investment can be provided to the automobile manufacturing industry to promote the sustainable development of the enterprise.

Keywords research and development investment, financial performance, automobile manufacturing industry

1. Introduction

Nowadays, under the background of science and technology globalization, with the rapid development of information technology, the competition among enterprises is becoming more and more intense, and strengthening investment in research and development has become one of the most important means for enterprise development. ~~In order to~~To meet ~~the~~ market demand and occupy a leading position in the market, enterprises need to create products different from other enterprises from their own point of view, ~~to~~ enhance their self-advantage and competitiveness ~~of enterprises~~, ~~to~~and expand the market. ~~In the~~ Due to current resource and environmental constraints, ~~the~~ enterprise labor costs ~~increase. The~~increase. The enterprise's existing production model has been unable to meet the needs of sustainable development, so ~~enhance~~ the importance of scientific and technological innovation is also reflected. "Innovation to drive development, development to create advantages" in the "14th Five-Year Plan" put forward in the guidance can also illustrate the importance of innovation and development. In recent years, China has put forward relevant tax policies. ~~,~~ R & D investment funds can be used to make greater efforts to add deductions, which will enable enterprises to improve their independent research and development capabilities, and further enhance ~~the~~their ability to innovate. In this context, if enterprises want to improve their competitiveness, we must enhance the sense of innovation to increase R & D investment.

In recent years, China's automobile manufacturing industry has increased sales in general to maintain the growth trend, ~~with~~With the domestic economic environment ~~is~~ improving, the industry's operating income continues to increase, and China's automobile manufacturing industry is also increasing ~~the~~ capital investment in R & D activities. R & D personnel ~~is~~are the soft power of the enterprise to carry out R & D activities, the independent innovation ability of the enterprise depends to a certain extent on the expertise of the R & D personnel, R & D results are reflected in the number of patents obtained by the enterprise. In recent years, the number of enterprise R&D personnel and the number of enterprise patents have increased year by year, indicating ~~which can be seen~~ that the automobile manufacturing industry is paying more and more attention to R&D investment.

China's automobile manufacturing industry has been growing after a long period of development, has a better industrial foundation, has made certain achievements in the automobile field, and occupies an important position

in China's modern economic growth and manufacturing industry. With China's green low-carbon development of the economic system and the current economic and social development of comprehensive green transformation, the automobile manufacturing industry is also facing industrial structure transformation and upgrading. Technological innovation is a key factor in promoting the sustainable development of the automobile manufacturing industry.,Eenterprises by increasing investment in research and development, can develop more advanced technology and product upgradesing, so as toto improve product performance and quality, to meet the growing demand of consumers. Enterprises focus on R & D investment in order totoimprove their core competitiveness and of enterprises, not to be eliminated by the competition in the industry. This paper takes the automobile manufacturing industry as an example, through the collection and analysis of relevant index data, the relationship between R&D investment and financial performance is sorted out to theoretically enrich and improve the important impact of R&D investment on the financial performance of enterprises in the automobile manufacturing industry. The relationship between R&D investment and financial performance is hereby empirically presented with specific and objective data. It can enrich the research on the impact of R&D investment on financial performance in the field of automobile manufacturing and provide suggestions for the sustainable development of automobile manufacturing enterprises.

2. Literatures review

Scholars have done a lot of research on the impact of R&D investment on financial performance, and the following is a compendium of existing studies to lay the foundation for this thesis.

There are generally two views in the academic community, one is that there is a positive correlation between R & D investment and enterprise financial performance, that is, the higher the R & D investment, the higher the level of financial performance. [1]Academics believes that intangible assets can bring higher income than fixed assets for enterprises, but limited to the high difficulty of obtaining relevant data has led to researchers have not to conducted in-depth research on the correlation between R & D investment and financial performance. [2] Academics using the relevant data of the electronics and pharmaceutical industries for empirical analysis, the results found that there is a positive correlation between R&D investment and corporate performance, but the degree of significance of this correlation is small. [3] Bogner and Bansal (2007) used regression analysis to find that R&D expenses have a positive impact on firms' innovation capability by analyzing data from '30022' patent records of 42 firms. [4] The R&D investment data and financial data of 71 companies in the high-tech industry during 2003-2007 were studied to empirically test the positive correlation between R&D expenditure investment and the financial performance of high-tech companies. [5] Ningbo regional science and technology-based enterprises as an example, through the analysis found that the enterprise R & D investment and its asset size, liability size between the existence of a two-way promotion relationship; enterprise R & D investment strength to reflect the enterprise's innovation ability, its technological innovation ability for enterprise financial performance haves a strong positive impact. [6] After Aacademics analyzeing the relevant data of private technology companies in Guangdong Province, it is pointed out that R&D activities can positively affect the pre-tax profit of private enterprises as well as the total income of enterprises. [7] Academics empirically analyzed by the multiple linear Soble test, found that technological innovation has a strong positive impact on the financial performance of listed manufacturing enterprises. [8] Verwaal(2017), using data from 223 listed manufacturing companies in the Netherlands, argued that listed companies will have high cognitive and normative barriers to global outsourcing knowledge exchange, which will lead to innovative activities that will negatively modulate the relationship between global outsourcing and the financial performance of listed manufacturing companies. [9] Academics taking green technology innovation as a perspective, through the analysis of the new energy automobile industry, the results found that corporate R&D personnel and capital investment have a facilitating effect on corporate performance.[10] Academics empirically analyzed the data to conclude that technological innovation outcomes have a highly significant impact on financial performance. [11] Academicsused typical correlation analysis and panel regression to analyze 80 sustainability reporting firms, and the study showed that an increase in the combination of engineering and technological innovation and financial performance led to a corresponding rise in manufacturing employment.

Secondly, there is a negative correlation between R&D investment and the financial performance of the enterprise in the current period, but it has a positive impact on the financial performance with a lag of several periods. [12] After Aacademics empirically analyzeding the data ofon the R&D investment of enterprises, it is found that R&D investment will have a lagging effect on the financial performance of enterprises, and the time limit of the effect is more than ten years. [13] Academics taking the listed companies inon the small and medium-sized boards of the Shenzhen Stock Exchange as samples, using the annual statement data of a total of four years from 2005 to 2008, and utilizing the research methods of factor analysis and stepwise regression analysis, it is concluded that the proportion of R&D (technological improvement) expenses is significantly negatively correlated with the profitability of enterprises. [14] Academics taking the machinery, medicine, electronic and information equipment, automobile and information service industries as an example, it is concluded through the research that R&D investment will not have a significant impact on the financial performance in the current period, butperiod but can have a significant positive impact on the financial performance improvement in the lag period of 1-2 years. [15] Academics studied China's high-end equipment

manufacturing industry listed enterprises, found that the R & D intensity of the enterprise's profitability does not have a significant impact, as well as ~~for~~ the enterprise's operating capacity, solvency, and development capacity, which will have a negative impact. [16] Academics selected 278 strategic emerging industries listed enterprises data to do quantitative analysis, found that the enterprise R & D investment significantly affects the financial performance of the enterprise in the current period, and the impact of the negative, but can be lagged two periods of the financial performance of a significant positive impact. [17] Academics through the manufacturing industry listed enterprises in Hubei Province, through empirical research found that the manufacturing industry listed companies in Hubei Province, the intensity of investment in research and development costs and the current period of enterprise financial performance is negatively related to the lag of a period of enterprise financial performance has a significant positive impact. [18] Through the strategic emerging industries innovation investment impact on financial performance research empirical evidence found that innovation investment and enterprise financial performance of the current period significantly negative correlation, lag innovation investment and enterprise financial performance is positively correlated with the lag phase, lag phase II to promote the effect is more significant.

Based on the above analysis of the literature, it is concluded that the R&D investment of enterprises is closely related to their financial performance, and the academics all take a certain industry as the landing point, or conduct specific research for a certain industry. Therefore, this paper attempts to explore the impact of R&D investment on the financial performance of listed companies of automobile manufacturing enterprises based on the existing research results of the academic community with China's automobile manufacturing industry as the research object, in view of which, this study puts forward the following main hypotheses:

Hypothesis 1: There is a negative relationship between R&D investment and current financial performance of China's automobile manufacturing industry.

Hypothesis 2: There is a lag in the impact of R&D investment on the current financial performance of China's automobile manufacturing industry.

3. Methodology

3.1 Sample Selection and Data Sources

In this paper, the empirical data of the A-share listed automobile manufacturing industry from 2018-2022 is selected as the research sample, and the data of R&D investment, financial performance, and control variables of automobile manufacturing sample enterprises from 2018-2022 are collected. Data on R&D investment, financial performance, enterprise size, gearing ratio, asset turnover ratio, and gross operating margin were obtained from the Cathay Pacific database (CSMAR), and 64 listed automobile manufacturing enterprises were selected through screening~~,~~ and were statistically analyzed ~~by~~ using Stata and SPSS software, and data processing and calculations were performed using Excel software.

This paper screens the sample data of China's A-share listed automobile manufacturing enterprises for the five-year period from 2018 to 2022 according to the following rules: (i) Remove the enterprises with ST and *ST in the data sample, ~~which~~that have abnormal business conditions and abnormal financial data, and if they are not removed, this part of the data will have an impact on the overall data. (ii) In order to ensure the complete continuity of the sample data, enterprises with partially missing sample data during 2018-2022 are excluded. (iii) Enterprises with missing variables such as R&D investment and financial performance are excluded. Finally, 64 valid enterprises were obtained, forming 320 valid data analysis values, and the continuous variables were shrink-tailed at the 1% and 99% levels.

3.2 Variable Description

3.2.1 Explained Variables

The explanatory variables in this paper are enterprise performance, the main purpose of enterprise R&D investment is to realize the improvement of profitability, and profitability is closely related to the return on total assets, he can also show the overall development of the enterprise, so this paper selects the return on total assets to explain the financial performance of the enterprise, expressed by ROA. Enterprise net assets net interest rate (ROE) can be used to measure the level of corporate management, but also can reflect the comprehensive situation of the enterprise in a year, this paper robustness test will be ROA replaced by ROE variable.

3.2.2 Explanatory variables

The explanatory variable of this paper is R&D investment, which is studied through the literature with reference to the study of [19], so this study applies the ratio of R&D investment to operating income to explain R&D investment, which is denoted by R&D.

3.2.3 Control variables

In order to make the results of the study more reliable, the study was carried out through the literature, mainly referring to the study of [20], the following variables were selected as control variables in this paper:

3.2.3.1 Firm size

Different firm sizes can have different impacts on the financial performance of firms, and firm size is used as one of the controlling factors, which is expressed in terms of the logarithm of total assets, denoted by SIZE.

3.2.3.2 Gearing ratio

The gearing ratio can show the solvency of the enterprise, drawing on the research of previous scholars, the gearing ratio is selected as one of the control factors, which is expressed by LEV.

3.2.3.3 Total Asset Turnover (TAT)

TAT is the ability of an enterprise to generate revenue per unit of assets over a given period of time and is expressed as TAT.

3.2.3.4 Gross Profit Margin

Gross Profit Margin is used to measure the profitability of an enterprise and can be an indicator of future profitability and growth potential. It is expressed in terms of GPM.

3.3 Model construction

Many scholars have studied the relationship between R&D investment and financial performance, so this paper chooses the following model to study the relationship between R&D investment and corporate financial performance:

$$ROA_{it} = \alpha_0 + \alpha_1 R\&D_{it} + \alpha_2 SIZE_{it} + \alpha_3 LEV_{it} + \alpha_4 TAT_{it} + \alpha_5 GPM_{it} + \beta_{it}$$

In order to test whether there is a lag period of R&D investment on corporate financial performance of automobile manufacturing companies, the following model is developed:

$$ROA_{it-1} = \alpha_0 + \alpha_1 R\&D_{it-1} + \alpha_2 SIZE_{it-1} + \alpha_3 LEV_{it-1} + \alpha_4 TAT_{it-1} + \alpha_5 GPM_{it-1} + \beta_{it-1}$$

In the model.i is the firm;t is time;α_1 Measures the effect of R&D investment on firm performance;α_2 Measuring the effect of firm size on financial indicators.α_3 Measuring the effect of gearing ratio on financial indicators.α_4 Measuring the impact of total gearing ratio on financial indicators.α_5 Measuring the effect of gross operating margin on financial indicators.

4. Results

Table 1Descriptive statistics (N=320)

Variable	Mean	Std.dev.	Min	Max.
ROA	0.0372	0.0630	-0.7139	0.1889
ROE	0.0573	0.1533	-1.4106	0.2938
R&D	5.0455	2.9280	0.4700	30.0000
SIZE	23.0045	1.4048	20.6017	27.5470
LEV	0.4726	0.1648	0.0973	0.7989
TAT	0.6795	0.2752	0.1209	1.8307
GPM	0.2066	0.0904	-0.2882	0.4769

Note: For variable codes, please refer to 3.Description of the study design

By the wide distribution of data of each variable in Table 1, it shows that there are large differences in both financial performance and objective business conditions of different enterprises. Before the regression analysis, the main data index fitness of the regression formula was tested, and the VIF of each variable was between 1.2-2.25, less than 10, so it can be shown that there is no obvious homogeneity between the variables, and the F-value was 31.05 Adjusted R-squared was 0.3202 Through the test, the multiple regression analysis can be carried out.

Table 2Regression results of the impact of R&D investment on current period financial performance

(N=320)

variant	Unstandardized coefficient		t	~~significance~~ Sig. (p-value)	VIF
	B	standard error			
R&D	-0.0040	0.0011	-3.68	0.0003***	1.20
SIZE	0.0060	0.0028	2.13	0.0342**	1.88
LEV	-0.1437	0.0265	-5.42	0.0000***	2.25
TAT	0.0485	0.0133	3.66	0.0003***	1.57
GPM	0.2270	0.0466	4.88	0.0000***	2.10
D-W			2.02		
F			31.05		
Adjusted R^2			0.3202		

Note 1: For variable codes, please refer to 3. Description of the study design
Note 2: ***, **, and * represent tests at the 1%, 5%, and 10% levels, respectively, significantly c orrelated

As can be seen from Table 2, it indicates that research and development investment (R&D) at the 1% level has a significant negative impact on the current period illustrative financial performance (ROA), and the enterprise R&D investment can not be fully converted into outputs, confirming that hypothesis one is valid. In terms of control variables, enterprise size product (SIZE) positively affects financial performance (ROA) at the 1% level, total asset turnover (TAT) and gross operating margin (GPM) extremely affect financial performance (ROA) at the 1% level, and gearing ratio (LEV) has a significant negative effect on financial performance (ROA) at the 1% level.

Table 3Regression results of the effect of R&D investment on financial performance in the lagged period

(N=256)

variant	Unstandardized coefficient		Standardized coefficient	t	~~significance~~ Sig. (p-value)
	B	standard error	Beta		
R&D L.	-0.0029	0.0007	-0.1849	-4.27	0.0000***
SIZE	0.0073	0.0019	0.2126	3.82	0.0002***
LEV	-0.1098	0.0183	-0.3742	-5.99	0.0000***
TAT	0.0499	0.0089	0.2816	5.60	0.0000***
GPM	0.3271	0.0305	0.6083	10.71	0.0000***
D-W			1.85		
F			41.01		
Adjusted R^2			0.5726		

Note 1: For variable codes, please refer to 3. Description of the study design
Note 2: ***, **, and * represent tests at the 1%, 5%, and 10% levels, respectively, significantly c orrelated

Table 4 Regression results of the impact of R&D investment on financial performance in lag two (N=192)

variant	Unstandardized coefficient	Standardized coefficient	t	~~significance~~ (p-value)

	B	standard error	Beta		
R&D L2.	-0.0021	0.0007	-0.1456	-3.05	0.0026**
SIZE	0.0056	0.0021	0.1692	2.74	0.0068**
LEV	-0.0944	0.0201	-0.3280	-4.69	0.0000***
TAT	0.0589	0.0093	0.3430	6.33	0.0000***
GPM	0.3435	0.0314	0.6612	10.93	0.0000***
D-W			1.77		
F			31.96		
Adjusted R^2			0.6131		

Note 1: For variable codes, please refer to 3. Description of the study design
Note 2: ***, **, and * represent tests at the 1%, 5%, and 10% levels, respectively, significantly c orrelated

As seen in the regression results of lag one and lag two, the D-W values of lag one sample and lag two are 1.85 and 1.77 respectively, indicating that none of the data is autocorrelated and the model is well constructed, the regression coefficient of R&D investment in lag one is -0.0029, the T-value is -4.27, and the significance P-value is 0.0000, and that of R&D investment in lag two is -0.0021, T-value is -3.05 and significance P-value is 0.0026. 0.0021, T-value is -3.05, significance P-value is 0.0026, lag one and lag two R&D investment (R&D) on corporate financial performance (ROA) is still a negative impact, may be due to the return cycle of R&D investment is longer, R&D investment in the output lagged one and lagged two can not be fully converted, so resulting in the impact of the lagged one and lagged two is still a negative impact on the financial performance. Therefore, the impact of lag one and lag two on financial performance is still negative.

However, a comprehensive comparison of the current period, lag one period and lag two period found that although the financial performance of enterprises are negative, but there is in growth, indicating that the increase of enterprise R & D investment will inevitably enhance the enterprise's financial performance, but China's automobile manufacturing enterprises research and development investment (R & D) on enterprise performance (ROA) of the impact of a serious lag, the hypothesis that the second is established.

Table 5 Robustness test regression table

variant	Model (1) the current period	Model (1) one period behind	Models (2) Phase II lag
		ROE	
R&D	0.001***	0.002**	0.017**
	(-0.0174)	(-0.0116)	(-0.0079)
SIZE	0.2	0.066*	0.158
	(-0.0542)	(0.0841)	(0.0812)
LEV	0.009***	0.08*	0.438
	(-0.3857)	(-0.2426)	(0.1229)
GPM	0.054*	0.00***	0.001***
	(0.5443)	1.2986	(0.7903)
TAT	0.217	0.185	0.151
	(0.0989)	(0.0904)	(0.09)
Constant	1.3601	-2.0527	-2.04
Adjusted R^2	0.1842	0.2033	0.1488
F	6.2	5.87	3.02

Note 1: For variable codes, please refer to 3. Description of the study design
Note 2: ***, **, and * represent tests at the 1%, 5%, and 10% levels, respectively, significantly c orrelated

The sales of enterprise products and the status of services reflect the business situation of the enterprise, and profitability is the ability of the enterprise to earn profits through the sale of products and services. Enterprise net assets net interest rate (ROE) can be used to measure the level of enterprise management, but also reflects the comprehensive status of the enterprise in a year, for the operator is to summarize the past, help the operator to make important decisions, by China's listed companies to pay attention to the long term. In order to strengthen the reliability of the conclusion, this paper replaces the indicator of total net assets rate (ROA), which is a measure of the financial performance of the enterprise dependent variable, with the enterprise return on net assets (ROE).

By comparison, it is found that after the explanatory variables are replaced, the regression coefficient of current research and development investment (R&D) on financial performance (ROE) in model (1) in Table 5 is -0.0174, which has a significant negative effect at the 1% level, so hypothesis 1 passes the robustness test.

Hypothesis 2 passes the robustness test in Table 5 as model (1) current research and development investment (R&D) in lag one has a significant effect on financial performance (ROE) at the 5% level and model (2) current research and development investment (R&D) in lag two has a significant effect on financial performance (ROE) at the 5% level. The regression coefficient changes from -0.0016 to -0.0079, which partly explains the weakening of the negative impact of research and development investment (R&D) on financial performance (ROE) in lag one and two periods.

In summary, the regression results are consistent with the findings of this paper, that is, there is a negative correlation between R & D investment and China's automobile manufacturing industry's current financial performance, R & D investment in China's automobile manufacturing industry's current financial performance impact has a lag, and the negative impact has a weakening trend.

5. Conclusion and Recommendation

This paper analyzes the impact of R&D investment on the financial performance of companies listed in the domestic automobile manufacturing industry based on the panel data of listed companies in the automobile manufacturing industry in Shanghai and Shenzhen A-shares from 2018 to 2022.Based on the data of R&D investment, enterprise asset size, return on total assets, asset-liability ratio, turnover ratio of total assets, and gross operating profit margin of China's listed companies from 2018 to 2022, we conduct empirical analyses.

5.1 Conclusion

~~*5.1.1*~~

There is a negative correlation between R&D investment and the current financial performance of China's automobile manufacturing enterprises. Traced back to the development of the enterprise to see, short-term R & D activities require a large amount of capital injection, R & D cycle is long, the eventual success of the project is still debatable, so from the likely loss of the value of the enterprise this R & D investment and the enterprise's current financial performance to produce a negative correlation between the R & D inputs to enhance the R & D inputs in the current year can not be effective in improving enterprise performance.

~~*5.1.2*~~

R & D investment and China's automobile manufacturing enterprises in the current period between the financial performance of the existence of a lag, lag a period and a lag of two periods of R & D investment on the current performance of the enterprise has a negative impact, and the negative impact of the trend of weakening, corporate financial performance has a rise in space, indicating that from the R & D investment stage to the results of the success of the transformation stage takes a longer period of time, the early stage is in the input stage, the late stage for the output stage, so the The impact of R&D investment on financial performance is reflected in the negative impact of the year, lagging one to two years also presents a negative impact but obviously weakened. This is because after a long period of accumulation, the enterprise's R & D level continues to improve, the success rate continues to improve, and it is estimated that the possibility of producing R & D results increases, which will bring great profits to the enterprise.

5.2 Recommendation

~~By way of conclusion above:~~

~~*5.2.1*~~

The empirical results show that the R&D investment of China's automobile manufacturing enterprises is negatively correlated and lagged with the current period of corporate financial performance, so the company should do a good job of budgeting and cost control before carrying out the R&D project, and pay attention to both the R&D investment and the long-term sustainable development of the enterprise, to avoid the lag period is too long, which leads to a greater impact on the enterprise's finances.

~~*5.2.2*~~

There should be a lag, so the company then R & D investment should have good patience, continuous investment of funds and personnel, do not rush, short-term did not see the return to give up a large number of previous investment. When all the R & D investment can be converted into output, you can enjoy the brand awareness, reputation, market competitiveness, revenue and profits due to R & D for the enterprise.

~~*5.2.3*~~

With China's 5G, big data, artificial intelligence, cloud native, edge computing and other technologies through the research and development, production and other aspects of energy vehicles, automobile manufacturing enterprises should pay more attention to research and development investment, strengthen independent

innovation, overcome the industry's own weaknesses and lack of items, grasp the historical opportunity of new energy vehicles, improve innovation performance, and obtain greater market benefits.

~~5.2.4~~

Avoid blind expansion. From the descriptive analysis it can be seen that the enterprise scale of automobile manufacturing industry is expanding year by year,[21] although the reason for the reduction of enterprise financial performance does not necessarily include the expansion of enterprise scale, but the expansion of the scale involves the long-term development, which needs to be carefully considered.

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