Correlation Analysis on the Relationship between R&D Investment and Enterprise Performance—Moderating Effect Based on Effectiveness of Internal Control

Shan Duan[1], Wangxiongjie Zheng[2,*]

[1]Institute of Scientific and Technical Information of Zhejiang Province (Zhijiangnan Think Tank) Hangzhou, 310018, Zhejiang, China

[2]School of Business Administration, Zhejiang University of Finance and Economics, Hangzhou, 310018, Zhejiang, China

*Corresponding Author.

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Abstract: This paper takes manufacturing companies in Zhejiang region from 2016 to 2018 as sample companies, discusses the relationship between R&D investment and enterprise performance, and introduces the effectiveness of internal control as a regulating variable to study the relationship between internal regulation and R&D investment and enterprise performance. Empirical research finds that: R&D investment can indeed improve the performance of enterprises, but it has a certain lag; However, effective internal control can adjust the relationship between the two, and has played a role of "providing timely help" or even "icing on the cake" in the current investment period, that is to say, effective internal control can reduce the side effect of r&d investment on current enterprise performance, but can enhance the positive effect of subsequent periods on enterprise performance.

1. Introduction

As we all know, the development of manufacturing is the cornerstone of a country's economic development, and the development of high-end manufacturing marks a country's rise of strategic industries. Across the world, first-class powers such as the United States and Japan have never stopped seizing the field of high-end manufacturing technology. Since China's reform and opening up, the development of its manufacturing industry has been a miracle, becoming synonymous with "large scale and fast speed". However, "how to achieve innovative development faster and better?" It has become a new target for the current stage of development of China's manufacturing industry.

Innovation is like the necessary fuel for the long-term operation of enterprises, only continuous scientific investment in research and development, can continue to maintain the superiority of enterprises. From the micro level, enterprises increasing investment in research and development can enable it to achieve greater development advantages in the competitive market, according to the long-term development strategy. However, because R&D investment has the characteristics of inter-period returns, high risk, and information asymmetry, if R&D investment lacks reasonable and effective internal supervision and management, enterprise R&D efficiency will be difficult to improve, and even cause the waste and loss of input resources. Therefore, the study of internal validity is essential, as it is an important tool for improving the business management of a company's R&D activities also have some positive monitoring effect. Enterprises need to standardize activities from the internal level, and effectively control the whole process of R&D activities to reduce R&D risks and improve management level of R&D activities. From this we can see that researching the impact of R&D investment on enterprise performance and the regulation role of internal control will help enterprises to better meet the innovation-driven provides a theoretical basis for better coordination of internal control and more effective management of the two for enterprises. It brings a new direction for thinking.

Based on the above, this paper selects the 2019 data of listed companies in the manufacturing

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industry in Zhejiang Province to explore the relationship between R&D investment and firm performance, using internal control effectiveness as a moderating variable.

2. Material and methods

2.1 Hypotheses

The innovation investment of an enterprise is mainly related to the intensity of the enterprise's R&D investment [1-5].Sridhar S and Narayanan S [6] believe that the intensity of R&D investment has a threshold effect on corporate performance, that is, R&D investment reaches the first threshold, so that it can have a positive effect on corporate performance, and when it reaches the second threshold, it has a positive impact on corporate performance. The effect becomes less obvious. Therefore, the R&D investment of an enterprise is to a certain extent consistent with the company's sustainable development strategy, and the R&D results can eventually be transformed into the economic benefits of the enterprise, bringing considerable development to the enterprise, so the research hypothesis is proposed:

H1 R&D investment helps improve corporate performance.

The resources available to the company in the course of its operations are limited, and using some of it for R&D investment means increasing funding pressure in other areas. Bootorabi, F [7] used 96 randomly selected high-tech listed companies as research samples to study the relationship between the total return on assets and R&D investment indicators. The empirical results show that the intensity of R&D investment has no significant impact on the return on assets. Relevance, the explanation of the article is because there is a certain lag between R&D investment and the performance it brings to the company. It is conceivable that the R&D investment has the characteristics of a long cycle, so the return he brings to the enterprise must not be immediate. In the short term, companies investing in R&D will definitely reduce the negative impact of corporate profits on performance. However, when the R&D achievements are transformed into the actual productivity of the enterprise, then it will undoubtedly greatly enhance the competitive strength of the enterprise, bring technical advantages, and bring generous returns to the enterprise. In the long run, the company's product research and development can bring advanced technology to the company and can occupy more technical resources in the market, thereby improving corporate performance. Therefore, the research hypothesis is proposed:

H2 The impact of R&D investment on corporate performance is lagging.

Guan Xiaochun [8] and others selected the data of 2007-2016 listed companies on the Shanghai Stock Exchange A-share as the research object. He used the internal index of Dibo China's listed companies as a comprehensive indicator of internal control: the better the quality of internal control, the better the company's performance. Cheng Liwei [9] believes that internal control plays a significant role in improving the performance of state-owned enterprises. At the same time, he believes that the establishment of a sound and complete internal control system can greatly reduce the management costs of enterprises and reduce the risk of managers' adverse selection due to their own interests. Effective internal control is helpful for enterprises to increase their confidence in R&D investment, and to deliver accurate enterprise information to enterprise owners with correct efficiency. And after investing in R&D, internal control can effectively supervise and manage and improve R&D efficiency. In addition, the internal control system can control R&D risks, effectively avoid risks, and minimize risks. Therefore, whether before or after R&D investment, the internal control system will affect R&D activities. Based on the above analysis, this paper believes that the effectiveness of internal control can strengthen the promotion of R&D investment on corporate performance, so the hypothesis is proposed:

H3 The effectiveness of internal control has a moderating effect on the relationship between R&D investment and corporate performance.

2.2 Data and model

This paper selects the data of manufacturing enterprises in Zhejiang from 2016 to 2018 as the

research sample. The data source is mainly from the database on ifind. After excluding some samples of companies with missing data, a total of 95 companies were obtained.

Table 1 Variables and their definitions

	Variable Symbol	Variable Name	Variable Definition
Dependent Variable	ROA	Business Performance	ROA=Net profit/Total assets at the end of the year
Independent Variable	RDA	Enterprise R&D investment intensity	RDA=R&D spending/Total assets*100%
	Pearson	R&D Personnel Input	Person=Technical staff/Total number of employees*100%
Moderator	ICC	Effectiveness of Internal Control	Assignment based on median1 or 0
Control Variable	Ln(Asset)	Enterprise Size	Ln(Asset)=Ln(Total)

To verify H1 and H2, the construction model is:

$$ROAt=\beta0+\beta1RDA+\beta2Person+\beta3\ Ln\ (Asset)t+\delta \quad (1)$$

In order to verify the adjustment effect of internal control effectiveness on the two, the model is:

$$ROAt=\beta0+\beta1RDA+\beta2Person+\beta3Icct+\beta4Icct*RDA+\beta5Ln(Asset)t+\delta \quad (2)$$

β is a constant term and δ is a residual value.

This paper builds a research model, as shown in Figure 1.

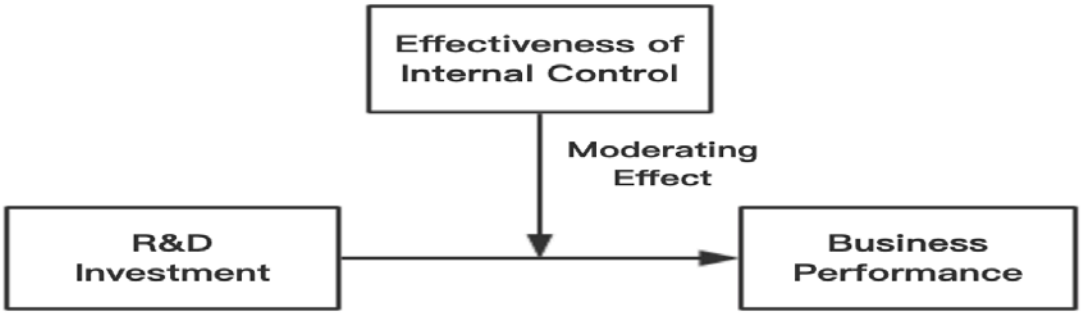

Figure 1 Research model

3. Results

3.1 Descriptive statistical analysis

Table 2 lists the minimum and maximum values, standard deviations and mean values of related variables in different years. Judging from the maximum value and the minimum value, the data fluctuation of the same sample in each year is not very large, but the gap between the two extreme values is still very obvious. For example, from the perspective of the proportion of technical personnel, the companies with the largest proportion of technical personnel in 2016-2018 are between 70% and 80%, but the smallest are only less than 10%. This shows that there is a big gap between the enterprise performance, R&D expenditure investment and R&D personnel investment of different companies. The average value of effective internal control is 54%, which means that the proportion of effective internal control enterprises is 54%. This shows that the quality of domestic control is still moderate, and half of the internal control of enterprises is effective. The numbers accorded to equations must appear in consecutive order inside each section or within the contribution, with number enclosed in brackets and set on the right margin, starting with the number 1.

Table 2 Study variable descriptive statistics

	N	Minimum Value	Maximum Value	Mean Deviation	Standard Deviation
2018Person	95	5	79	28.61	15.396
2017Person	95	6	76	27.51	13.024
2016Person	95	16	71	26.53	11.25
2018ROA	95	-3.6037	0.21203	-0.0133413	0.39044426
2017ROA	95	-2.83409	0.19564	0.0200673	0.29963329
2016ROA	95	-0.04674	0.18714	0.0605247	0.04795553
2018RDA	95	0.00071	0.09097	0.0274464	0.01695934
2017RDA	95	0.00057	0.08385	0.0243802	0.01594367
2016RDA	95	0.00012	0.09273	0.0249637	0.01846507
Effectiveness of Internal Control	95	0	1	0.46	0.501
2018 Enterprise Scale	95	18.99635	24.87417	22.0849149	1.10437544
2017 Enterprise Scale	95	19.68853	24.66622	22.0113677	1.04651787
2016 Enterprise Scale	95	19.43811	24.4453	21.7420629	1.04562645

3.2 Variable correlation analysis

Table 3 Correlation coefficients of various variables from 2006 to 2018

Variable		Person	ROA	Ln(Asset)	RDA	ICC
Person	Pearson correlation	1	0.124	0.168	0.1	0.009
	Significance (bilateral)		0.229	0.104	0.336	0.93
ROA	Pearson correlation	0.124	1	0.306**	-0.015	0.206*
	Significance (bilateral)	0.229		0.003	0.884	0.046
Ln(Asset)	Pearson correlation	0.168	0.306**	1	-0.235*	-0.036
	Significance (bilateral)	0.104	0.003		0.022	0.732
RDA	Pearson correlation	0.1	-0.015	-0.235*	1	0.311**
	Significance (bilateral)	0.336	0.884	0.022		0.002
ICC	Pearson correlation	0.009	0.206*	-0.036	0.311**	1
	Significance (bilateral)	0.93	0.046	0.732	0.002	

**. Significantly correlated on the .01 level (both sides).

*. Significantly correlated at the 0.05 level (both sides).

It can be seen from the Pearson coefficients given in the Table1-3 that the effectiveness of internal control (ICC) and R&D expenditure input (RDA) have a significant positive correlation in the three years. There is a relatively obvious negative correlation between the size of the enterprise and the investment in R&D expenses. The R&D expenditure input has a significant negative correlation with ROA, and the effectiveness of internal control has a significant positive correlation with ROA. According to the preliminary explanation, enterprise R&D investment has a negative effect on current enterprise performance, and good internal control can often improve enterprise performance.

3.3 Regression analysis

3.3.1 Multiple linear regression of R&D investment and enterprise performance

In order to obtain the cross-effect effect between R&D investment and corporate performance, this paper carries out regression analysis on the model (1) with data lagging 1 period, 2 periods and the current period.

Table 4 Multiple linear regression results of R&D investment and corporate performance

	ROA-0	ROA-1	ROA-2
constant	0.018***	0.081***	0.061***
	0.210	-0.288	-0.456
Independent Variable			
RDA	0.000*	0.036***	0.027**
	-1.478	2.678	1.727
Person	0.289	0.074***	0.091**
	1.332	1.647	1.965
Control Variable			
Ln(Asset)	0.045***	0.073***	0.068**
	1.628	1.011	1.017
R2	0.397	0.14	0.16
F	35.459	13.54	16.52
Adjust R2	0.377	-0.018	-0.17

Note: ***, **, and * indicate that the test is significant at 1%, 5%, and 10% levels.

It can be seen from Table 4 that the R2 of R&D investment on the performance of the enterprise in the current period, the first period of the investment, and the second period of the investment are 39.7%, 14%, and 16%, respectively. This shows that although the data does not fully reflect the results, it is still acceptable. Not bad, more obvious. From the regression data of R&D expenditure investment and corporate performance, it can be seen that RDA has a significant negative correlation with ROA in the current period, and a significant positive correlation with the ROA in the next two periods. Corporate performance will have a negative impact, but it will have a positive impact on corporate performance in the future, which is Hypothesis 2: R&D investment has a lagging effect on corporate performance. The results of the study show that R&D investment has a negative impact on corporate performance in the first phase, has a positive impact afterwards, and has a gradual increase trend, indicating that in the short term, corporate R&D investment is not conducive to the development of the company, but in the long run, The enterprise's R&D investment will bring considerable development to the enterprise, and ultimately can enhance the value of the enterprise. This is a good test of the first two hypotheses of this paper, that R&D investment does have a positive effect on corporate performance, and R&D investment is conducive to the value-added of the company, and the company's R&D investment has a lag in its performance. From the point of view of the coefficient, although the impact of enterprise R&D investment on ROA has changed significantly, the overall trend is increasing year by year, which means that this effect will take more than two periods to appear. The coefficients of Person and ROA show a trend of increasing year by year and gradually increasing, and are very significant in the input period 1 and the input period 2 but not in the current period. On the whole, the input of R&D personnel will have a positive impact on corporate performance, and will increase as the lag period increases.

3.3.2 Multiple linear regression of internal control effectiveness, R&D investment and corporate performance adjustment effect

This paper designs model (2) to explore the moderating effect of internal control effectiveness (ICC) on the impact of R&D investment (RDA) on corporate performance (ROA). As can be seen from Table 5, when performing regression analysis on the data, the change of Sig F is less than 0.05, proving that the effectiveness of internal control does have a regulatory effect on R&D investment and corporate performance.

Table 5 Model results

Model	R^2	Adjust R^2	R^2 Changes	F Changes	Sig.F Changes
Mode(2)	0.056	0.054	0.056	30.32	0.001

Table 6 Multiple linear regression results of internal control effectiveness, R&D investment and corporate performance adjustment effect

	ROA-0	ROA-1	ROA-2
Constant	-0.032	-0.118***	-0.065***
	-1.689	-6.245	-4.243
RDA	-0.02*	0.023***	0.018**
	-1.689	2.651	2.163
Person	0.012**	0.024**	0.021
	0.936	1.963	1.236
ICC	0.126***	0.232***	0.164***
	11.61	18.65	13.75
ICC*RDA	0.046***	0.076***	-0.004
	3.654	5.224	-0.075
Ln(Asset)	0.047***	0.145***	0.053***
	3.865	8.664	6.331
R^2	0.056	0.35	0.42
F	42.63	120.65	162.69
Adjust R^2	0.002	0.002	0.004

Note: ***, **, and * indicate that the test is significant at 1%, 5%, and 10% levels.

It can be seen from Table 6 that after introducing the variable of internal control effectiveness, R2 is 0.056, 0.35, 0.42 when the current investment, the first investment, and the second investment, respectively, that is, the impact of R&D investment on corporate performance is obviously. In addition, the effectiveness of internal control has a positive impact on corporate performance in each period, but from each period, the effect of the impact is different. The regression coefficient of the multiplication term (ICC*RDA) of the current period and the first period of investment is significantly positive, which shows that the effectiveness of internal control can strengthen the impact of R&D investment on the performance of the enterprise, which validates hypothesis 3. In the current period of reinvestment, the effectiveness of internal control can suppress the negative impact of R&D investment on corporate performance during the rescheduling period. That is, effective internal control can reduce the risks caused by R&D investment and improve the competitiveness of the enterprise. Among companies with ineffective internal control, the negative impact of R&D expenditure on corporate performance is particularly obvious. In the long run, effective internal control makes up for the shortcomings of R&D investment, expands its advantages, enhances its positive impact on corporate performance, and reduces risks.

3.4 Robustness Test

In order to make the results of the study more reliable and robust, this paper selects another variable return on equity (ROE) to replace ROA as another measure of corporate performance, to test the above regression again, and the test results are basically the same as before. The above conclusion is still true. The test results are shown in Table 7.

Table 7 Robustness test

	ROE-0	ROE-1	ROE-2
RDA	-0.081***	0.076***	0.023
	-7.652	6.264	1.632
Person	0.043***	0.023	0.028*
	3.689	2.451	2.965
ICC	0.169***	0.159***	0.130***
	16.85	13.64	9.632

ICC*RDA	0.065**	0.009	-0.036*
	3.652	0.652	-1.542
R^2	0.121	0.177	0.223
F	71.653	103.65	86.54

Note: ***, **, and * indicate that the test is significant at 1%, 5%, and 10% levels.

4. Discussion

With the enthusiasm for innovation and entrepreneurship in recent years, the research of domestic and foreign scholars on R&D investment has also tended to be in-depth, and the conclusions drawn have also tended to be diverse. By studying the financial data of 95 listed manufacturing companies in Zhejiang from 2016 to 2018 as a sample, this paper first demonstrates the impact of R&D investment on corporate performance and investment phases 1 and 2, and then introduces the effectiveness of internal control of the company As a moderating variable, and empirical analysis, in-depth exploration of the moderating role of internal control effectiveness in how R&D meat performs on corporate performance. The main conclusions are:

The impact of R&D investment on corporate performance is very obvious. Among them, it has a significant negative correlation with corporate performance in the current period, and a positive correlation with corporate performance in the next two phases. The listed company's R&D investment has a significant negative effect in the current period, indicating that the company's R&D investment will seize the company's financial resources in the current period. In simple terms, R&D investment will reduce the company's profit and reduce the company's performance. In an in-depth analysis, R&D investment has reduced the error tolerance rate of capital turnover, greatly increased the financial pressure of the enterprise, and increased the operational risk of the enterprise to a certain extent. In the first phase and the second phase of investment, R&D investment obviously brought huge returns to the enterprise. From the analysis, it can be seen that R&D investment requires a time period and the process of absorption of knowledge and achievements. It is not difficult to think that once the R&D achievements of an enterprise seize the market, it will definitely bring huge returns to the enterprise, thereby improving the competitiveness of the enterprise, but this will take some time to achieve, and the positive impact of R&D investment on the enterprise It will become more obvious with time.

5. Conclusion

The investment of R&D personnel of listed companies has a significant positive effect on the current corporate performance, which shows that in the process of the company becoming larger and stronger, the investment of R&D personnel is essential, and they have a considerable contribution to the growth of the company. Therefore, enterprises should pay attention to the absorption and training of R&D personnel, which can not only improve the R&D capability of the enterprise, but also increase the company's potential to a certain extent. The data of Phase 1 and Phase 2 investment show that the investment of R&D personnel will also have a positive impact on the performance of the company in the later period, which further enhances the introduction of talents by the company. In terms of personnel investment, listed companies should not be constrained, as long as there are excellent researchers, they can bring substantial profits to the enterprise in the future.

Among listed companies with effective internal control, although R&D investment has a negative impact on corporate performance in the current period, this negative impact is significantly smaller than that of listed companies with ineffective internal control. In the first phase of investment, when R&D investment begins to have a positive impact on corporate performance, listed companies with effective internal control have greater returns than those without. But when it comes to the second phase of investment, this effect becomes less obvious.

After introducing the control variable of enterprise size, this paper finds that: enterprise size has a negative correlation with enterprise performance and enterprise R&D investment.

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