

# Research on the Impact of R&D Investment on the Performance of Chinese Communication Listed Companies

Subo Xu, Yaodong Wang

Heilongjiang Bayi Agriculture University, Daqing 163319, China.

## Abstract

R&D investment is the main way for communications listed companies to innovate, which helps improve their market competitiveness. This article takes the listed communication companies in Shanghai and Shenzhen in 2015-2017 as research samples, establishes a regression model to explore the relationship between R&D investment and corporate performance, and analyzes the impact of R&D investment strength and R&D staff size on the performance of communications listed companies. Research shows that both the strength of R&D investment and the size of R&D personnel have a significant positive impact on company performance; at the same time, the increase in R&D investment strength of listed communications companies has a significantly greater impact on company performance than the size of R&D personnel. This research analyzes the impact of R&D investment on the financial performance and market performance of communication listed companies from the two dimensions of capital investment and staff size, with a view to providing a theoretical basis for improving corporate performance.

## Keywords

R&D investment; communications listed companies; financial performance; market performance.

## 1. Introduction

As a typical representative of high-tech enterprises, communication listed companies must continue to innovate, increase research and development investment, and enhance their independent innovation capabilities. As a research hotspot, the research on the impact of R&D investment on corporate performance has been widely concerned by scholars. With the continuous research, different scholars have not reached unique research conclusions on this issue. On the one hand, most mainstream scholars have found that research and development expenditure has a positive impact on the improvement of company performance through research; on the other hand, a small number of scholars have concluded through research that research and development expenditure has a negative or even irrelevant conclusion on company performance improvement. Based on this, the author believes that it is necessary to deeply investigate the impact of R&D investment of communication listed companies on performance, in order to provide a certain theoretical reference for improving company performance.

## 2. Theoretical Analysis and Research Hypotheses

The endogenous growth theory suggests that changes in corporate performance are due to inherent reasons such as core technology and R&D investment. For listed communication companies, R&D capability is an important guarantee for their development and growth, and high-end technology is the decisive factor for their development. Communication companies have high R&D difficulties and large capital requirements. Such companies must increase

investment in R&D funds and strive to create a better R&D atmosphere to attract high-tech talents, realize a virtuous circle of enterprises, and promote enterprise development. Therefore, the following assumptions are made:

H1a: The intensity of investment in R&D has a significant positive impact on the improvement of financial performance of communications listed companies.

H1b: The intensity of investment in research and development has a significant positive impact on the improvement of market performance of communications listed companies.

The company's R&D scale can reflect the company's R&D quality, and reflects the company's management's emphasis on innovation. The author believes that the company's expansion of research and development personnel is to improve the company's financial performance and market performance, and ultimately maximize the company's benefits. The article makes the following assumptions:

H2a: The size of R&D personnel has a significant positive impact on the improvement of the financial performance of communications listed companies.

H2b: The size of R&D personnel has a significant positive impact on the improvement of market performance of communications listed companies.

High-tech talents are the valuable wealth of communications companies and determine their future development prospects. Therefore, we believe that the scale of high-tech talents is particularly important for such enterprises, so we make the following assumptions:

H3: The impact of the size of R&D personnel on the performance of listed communications companies is significantly better than the intensity of R&D investment.

### 3. Research Design

#### (A). Sample selection and data source

The article selected 106 communication listed companies in Shanghai and Shenzhen in 2015-2017 as the research sample, excluding ST and missing data companies, and obtained 63 valid research samples with a total of 441 sets of data. The data of R&D investment intensity used in this paper comes from the annotated information of the annual report of listed companies announced by Juchao Information Network. The other data are derived from the WIND database and processed with statistical software such as SPSS23.0 and Excel.

#### (B). Variable definitions

This article selects R&D and NUMBERS as explanatory variables, and selects SIZE, LEV, and EPS as control variables to analyze the company's ROE and MP. The measurement methods of each variable are shown in Table 1:

#### (C). Model design

Based on the above analysis, the article constructs the following four models to verify the relationship between R&D expenditure and performance. Formula (1) tests hypothesis H1a to test the relationship between the company's R&D expenditure and financial performance; formula (2) tests hypothesis H1b to test the relationship between the company's R&D expenditure and market performance; formula (3) verifies the hypothesis H2a, Verify the relationship between the size of the company's R&D personnel and financial performance; formula (4) verify the assumption H2b, verify the relationship between the size of the company's R&D personnel and market performance; formula (1), formula (2) and formula (3), formula (4) Comparative analysis validates Hypothesis H3 and verifies whether the relationship between the size of the company's R&D personnel and the improvement in performance is significantly better than the relationship between the amount of company's R&D expenditure and the improvement in performance.

**Table 1.** Definition of main variables

Variable type	Variable code	Variable definition description
Explained variable		
Financial Performance	ROE	Return on net assets = company's annual net profit / company's annual net assets
Market performance	MP	Operating profit margin = company's annual operating profit / company's annual operating income
Explanatory variables		
Investment intensity of R&D funds	R&D	Value: R&D expenditure for the current year / operating income for the current year, in which the amount of R&D expenditure includes various expenditures incurred during the research phase and development phase
R&D staff size	NUMBERS	Value: the number of R&D personnel in the company that year
Control variable		
Company Size	SIZE	Value: the natural logarithm of the company's total assets at the end of the year
Company Size	LEV	Value: Total liabilities at the end of the period / Total assets at the end of the period
Basic earnings per share	EPS	Value: Weighted average of the current net profit of the company attributable to common shareholders / total of the company's common shares

$$ROE_{it} = \partial_0 + \partial_1 RD + \partial_2 SIZE + \partial_3 LEV + \partial_4 EPS + \beta_{it} \quad (1)$$

$$MP_{it} = \partial_0 + \partial_1 RD + \partial_2 SIZE + \partial_3 LEV + \partial_4 EPS + \beta_{it} \quad (2)$$

$$ROE_{it} = \partial_0 + \partial_1 NUMBERS + \partial_2 SIZE + \partial_3 LEV + \partial_4 EPS + \beta_{it} \quad (3)$$

$$MP_{it} = \partial_0 + \partial_1 NUMBERS + \partial_2 SIZE + \partial_3 LEV + \partial_4 EPS + \beta_{it} \quad (4)$$

## 4. Empirical Results and Analysis

### (A). Descriptive statistics

According to the descriptive statistical analysis data of the main variables in Table 2, the financial performance (ROE) and market performance (MP) of communication listed companies are significantly different, and a negative number appears, indicating that the overall performance level of communication companies needs to be improved; the strength of the company's R&D investment The average value of (R&D) is only 0.07, which indicates that the overall capital investment of communication listed companies is insufficient; the maximum and minimum values of the number of enterprise R&D personnel (NUMBERS) are 31703 and 11, respectively, and the difference is large, indicating that the R&D personnel of different communication enterprises There is a large gap in the size; the company size (SIZE) has taken

a natural logarithm of the total assets at the end of the period, with the maximum and minimum values of 23.634 and 10.929, respectively, indicating that there is a significant difference between various telecommunications enterprises; the average value of the enterprise asset-liability ratio (LEV) Less than 50%, but the difference between the maximum value and the minimum value is obvious, indicating that the communications listed companies as a whole are underutilized; the maximum basic earnings per share (EPS) is 0.021, and the minimum value is -0.007, indicating that after different corporate taxes There are obvious differences in profits.

**Table 2.** Descriptive statistics of the main variables

Name	ROE	MP	R&D	NUMBERS	SIZE	LEV	EPS
MAX	0.402	1.036	0.354	31703	23.634	0.911	0.021
MIN	-0.7	-8.11	0.008	11	10.929	0.041	-0.007
Mean	0.059	0.014	0.07	1195	18.406	0.374	0.003
Standard deviation	0.102	0.66	0.046	3847	1.753	0.184	0.004
Total sample	441	441	441	441	441	441	441

(B). Correlation analysis

Table 3 shows the Spearman coefficients of the relevant variables and the corresponding significance levels. It can be seen from Table 2 that the R&D investment intensity (R&D), financial performance (ROE), and market performance (MP) are significantly positively correlated at the levels of 5% and 1%, respectively; the size of R&D personnel (NUMBERS) and financial performance (ROE) , Market performance (MP) are significantly positively correlated at the 1% level; company size (SIZE) and basic earnings per share (EPS) are significantly positively correlated with financial performance (ROE) and market performance (MP) at the 1% level ; Asset-liability ratio (LEV) and market performance (MP) are significantly negatively correlated at the 1% level.

**Table 3.** Correlation analysis of main variables

Name	ROE	MP	R&D	NUMBERS	SIZE	LEV	EPS
ROE	1						
MP	0.750*** (0.000)	1					
R&D	0.146** (0.044)	0.149*** (0.007)	1				
NUMBERS	0.446*** (0.000)	0.245*** (0.003)	0.364*** (0.004)	1			
SIZE	0.693*** (0.000)	0.402*** (0.001)	0.237 (0.063)	0.661*** (0.000)	1		
LEV	-0.100 (0.440)	-0.457*** (0.000)	-0.204 (0.112)	0.325*** (0.010)	0.264*** (0.008)	1	
EPS	0.929*** (0.000)	0.727*** (0.000)	0.118 (0.359)	0.436*** (0.000)	0.695*** (0.000)	-0.088 (0.496)	1

(Note: \*\*\*, \*\*, \* represent significant levels at 1%, 5%, and 10%, respectively)

(C). Multiple collinearity test

The article uses the variance expansion factor method and SPSS23.0 software to carry out multicollinearity analysis on the model. When the tolerance is greater than 0.1 and the VIF value is between 0-10, it can be considered that there is no multicollinearity problem between the explanatory variables.

As shown in Table 3, the tolerances of the explanatory variables in models 1 and 2 are greater than 0.1, the maximum value is 0.811, the minimum value is 0.472, and the VIF value is between 0-10. Both are greater than 0.1, the maximum value is 0.807, the minimum value is 0.492, and the VIF value is between 0-10. According to the tolerance and VIF values, there is no multicollinearity between the variables, and the model meets the requirements in terms of variable selection.

**Table 4.** Multicollinearity Test Table

Models 1 and 2		Collinear statistics		Models 3 and 4		Collinear statistics	
		Tolerance	VIF			Tolerance	VIF
Explanatory variables	RD	0.811	1.232	Explanatory variables	NUMBERS	0.762	1.312
	SIZE	0.472	2.121		SIZE	0.492	2.033
	LEV	0.752	1.331		LEV	0.807	1.239
	EPS	0.596	1.679		EPS	0.621	1.611

#### (D). Regression analysis test

Table 4 shows the results of the regression analysis between R&D investment intensity (R&D), R&D staff size (NUMBERS), and company financial performance (ROE) and market performance (MP). It shows that there is a significant positive correlation between R&D funding expenditures and corporate financial performance of communications listed companies, which verifies that the H1a assumption is reasonable; a significant positive correlation between R&D funding expenditures and company market performance, which verifies that the H1b assumption is reasonable; between the size of R&D personnel and the company's financial performance Significant positive correlation, verifying that the H2a hypothesis is reasonable; significant positive correlation between the size of R&D personnel and the company's market performance, verifying that the H2b assumption is reasonable; the impact of R&D investment intensity on corporate performance is significantly better than the size of the R&D personnel, verifying that the H3 hypothesis is not valid. The main reason for the opposite of the H3 hypothesis is that communication companies are R&D-intensive companies, R&D activities are an important part of corporate innovation, whether R&D success is an important factor in determining whether such companies can survive, and communications company products are outdated Quickly, in order to enhance the company's competitive advantage, it is necessary to continuously increase R&D investment instead of blindly expanding the size of R&D personnel. It can be seen that high-tech enterprises represented by communication companies should continuously increase R&D investment instead of blindly expanding the size of R&D personnel in order to improve corporate performance.

The regression results of R&D investment and company performance also show that there is a significant positive impact on the company size and company performance in the control variables, indicating that expanding the size of the company is conducive to improving the performance of communications companies; the asset-liability ratio in the control variables is significantly negatively related to the company's performance. It shows that higher debt risk will cause the performance of listed communication companies to decrease.

**Table 5.** Results of regression analysis on R&D investment and corporate performance

	Model (1)	Model (2)	Model (3)	Model (4)
Name	ROE	MP	ROE	MP
R&D	0.336*** (1.530)	0.621*** (1.818)		
NUMBERS			0.131*** (0.971)	0.074** (0.497)
SIZE	0.097*** (1.689)	0.932*** (0.085)	0.160*** (1.423)	0.402*** (0.845)
LEV	-0.166*** (-1.403)	-0.152** (-1.451)	-0.425*** (-0.804)	-0.328*** (-0.986)
EPS	0.013*** (7.376)	0.026*** (2.293)	0.001*** (7.690)	0.009*** (2.724)
Sample size	441	441	441	441
$R^2$	0.684	0.205	0.676	0.263
F	30.805***	3.680***	29.743***	2.771***

(Note: \*\*\*, \*\*, \* represent significant levels at 1%, 5%, and 10%, respectively)

#### (E). Robustness test

In order to further verify the stability of the conclusions, this article uses the return on total assets (ROA) and net sales margin (TTM) of communication-type listed companies to replace the return on net assets and operating profit margin as the indicators of company performance, in turn with explanatory variables. The regression analysis test was performed, and the reconstructed robustness test model was as follows:

$$ROA_{it} = \partial_0 + \partial_1 RD + \partial_2 SIZE + \partial_3 LEV + \partial_4 EPS + \beta_{it} \quad (5)$$

$$TTM_{it} = \partial_0 + \partial_1 RD + \partial_2 SIZE + \partial_3 LEV + \partial_4 EPS + \beta_{it} \quad (6)$$

$$ROA_{it} = \partial_0 + \partial_1 NUMBERS + \partial_2 SIZE + \partial_3 LEV + \partial_4 EPS + \beta_{it} \quad (7)$$

$$TTM_{it} = \partial_0 + \partial_1 NUMBERS + \partial_2 SIZE + \partial_3 LEV + \partial_4 EPS + \beta_{it} \quad (8)$$

Among them, formula (5) contrasts with formula (1) to test the robustness of the relationship between the company's R&D expenditure and financial performance; formula (6) contrasts with formula (2) to test the robustness of the relationship between the company's R&D expenditure and market performance Formula (7) contrasts with formula (3) to test the robustness of the relationship between the size of the company's R&D personnel and financial performance; formula (8) contrasts with the formula (4) to verify the robustness of the relationship between the size of the company's R&D personnel and market performance The analysis results of formula (5), formula (6) and formula (7), formula (8) are compared with the analysis results of formula (1), formula (2), formula (3), and formula (4) to verify communication The impact of increased investment in R&D funds on corporate performance of such enterprises is significantly better than the robustness of the conclusion on the size of R&D

personnel. The regression analysis results of R&D investment and company performance robustness test are shown in Table 5:

**Table 6.** Regression analysis results of R&D investment and company performance robustness test

	Model (5)	Model (6)	Model (7)	Model (8)
Name	ROA	TTM	ROA	TTM
R&D	0.473*** (1.300)	0.661* (1.606)		
NUMBERS			0.199** (0.722)	0.114 (0.441)
SIZE	0.086*** (1.748)	0.874*** (0.160)	0.142*** (1.489)	0.508*** (0.666)
LEV	-0.190** (-1.328)	-0.152*** (-1.453)	-0.405** (-0.840)	-0.298*** (-1.050)
EPS	0.002*** (7.043)	0.036*** (2.150)	0.009*** (7.340)	0.014*** (2.543)
Sample size	441	441	441	441
$R^2$	0.668	0.187	0.662	0.153
F	28.730***	3.278***	27.874***	2.576***

(Note: \*\*\*, \*\*, \* represent significant levels at 1%, 5%, and 10%, respectively)

Table 5 shows the results of the robustness test regression analysis on the strength of R&D investment (R&D), the number of R&D personnel (NUMBERS), financial performance (ROA), and market performance (TTM). From the results of model (5) verifying the robustness of the R&D investment intensity and financial performance of communication enterprises, the regression coefficient of R&D investment intensity is 0.473, which is significantly positive at the 1% level. From the results of model (6) testing the robustness of the R&D funding strength and market performance of communications companies, the regression coefficient of R&D funding strength is 0.661, which is significantly positive at the 10% level. From the results of model (7) verifying the robustness between the size of R&D personnel and financial performance of communication enterprises, the regression coefficient of R&D personnel size is 0.199, which is significantly positive at the 5% level. From the results of model (8) testing the robustness between the scale of R&D personnel and market performance of communication enterprises, the regression coefficient of R&D personnel size is 0.114, and the regression coefficient is positive but not significant. It can also be seen from Table 5 that the regression coefficients of R&D investment intensity, financial performance, and market performance of communications listed companies are 0.473 and 0.661, respectively, which are significantly positive at the levels of 1% and 10%, respectively. R&D personnel of communications listed companies The regression coefficients of scale, financial performance, and market performance are 0.199 and 0.114, respectively. Among them, the impact on market performance is not significant, indicating that the impact of R&D funding strength on the performance of communications listed companies is significantly better than the size of R&D personnel. From the results of robustness regression analysis, it can be seen that in the empirical research model, ROA and TTM are used to replace ROE and MP as the indicators of company performance, and the significance of the model fit and the variables have not changed significantly. The set model is relatively stable, the original hypothesis is correct, and the conclusion is more reliable.

## 5. Conclusion

The study found that communication-based listed companies have insufficient R&D funding and large gaps in R&D staff size, and overall financial and market performance needs to be improved. There is a significant positive impact between the strength of the company's R&D investment and the company's performance, that is, the company's increased R&D investment is conducive to improving the company's performance; the company's R&D personnel scale has a significant positive correlation with the company's performance, that is, the company's expansion of R&D personnel has Conducive to improving company performance; the impact of the size of R&D personnel of communications companies on corporate performance is significantly weaker than the strength of R&D investment, that is, the continuous increase of R&D investment of communications listed companies is more conducive to improving company performance.

According to the research conclusions, the author puts forward the following suggestions: R&D is a key link for listed companies to gain competitive advantage. Therefore, managers of such enterprises must establish a long-term perspective, continuously expand financing channels, increase investment in basic research funds, and build Core competitive advantages of enterprises; Communication listed companies should revise and improve relevant reward systems, fully mobilize the innovation enthusiasm of R&D personnel, continuously introduce high-tech talents, rationally build and optimize corporate R&D teams, and strive to improve the quality of R&D teams; communications listed companies We should strengthen the construction of R&D culture, cultivate the sense of mission and responsibility of R&D personnel, and form a good atmosphere of R&D culture.

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## References

- [1] Sougiannis T. The Accounting Based Valuation of Corporate R&D[J].The Accounting Review,1994,69(1):44-68.
- [2] Roberts EB.Bench marking Global Strategic Management of Technology[J].Research Technology Management, 2001, 44(2):25.
- [3] Hsieh P.H.,Mishra C.S.,Gobeli D.H.The return on R&D versus capital expenditures in pharmaceutical and chemical industries[J]. IEEE Transactions on Engineering Management, 2003, 50(2): 141-149.
- [4] Anagnostopoulou SC, Levis M. R&D and Performance Persistence:Evidence from the United Kingdom[J]. The International Journal of Accounting, 2008, 43(3):293-320.
- [5] Yin Kaiguo, Liu Xiaoqin, Chen Huadong. Research on the relationship between endogenous corporate social responsibility and financial performance: empirical evidence from Chinese listed companies [J]. China Soft Science, 2014 (06): 98-108.
- [6] Zhuang Bochao, Yu Shiqing, Zhang Hong. Supply chain concentration, capital operation and operating performance: an empirical study based on listed companies in Chinese manufacturing industry [J]. Soft Science, 2015 (03): 9-14.
- [7] Dai Xiaoyong, Cheng Liwei. Research on the Threshold Effect of the Impact of R&D Investment Intensity on Enterprise Performance [J]. Studies in Science of Science, 2013 (11): 1708-1716 + 1735.

- [8] Zhao Xicang, Wu Junxiang. A Comparative Study on the Relationship between R&D Investment and Corporate Performance of Small and Medium-sized Listed Companies [J]. Science and Technology Management Research, 2013 (12): 104-108.
- [9] Wang Yiyang. Research on the correlation between high-tech enterprises' R&D investment and corporate performance: an empirical analysis based on innovation output and corporate heterogeneity [D]. Liaoning University, 2018.
- [10] Zhou Jiangyan. Research on the correlation between R&D investment and corporate performance: an empirical analysis based on listed companies in Chinese manufacturing industry [J]. Industrial Technology & Economy, 2012 (01), 49-57.
- [11] Zhu Zheng, Zhang Mengchang. Empirical Research on Human Capital, R&D Investment and Enterprise Performance of Enterprise Management Team [J]. Accounting Research, 2013 (11), 45-52 + 96.