

Nature of Controlling Stake, R&D Investment and Corporate Performance-Based on Empirical Data of Listed Companies in China

Zhang Guiling

*Accounting and Finance Research Center, Zhengzhou Institute
of Aeronautical Industry Management, Zhengzhou, 450046, China
financepaperzhang@126.com*

Abstract

This article makes an empirical analysis on influence of R&D investment on corporate performance under different nature of controlling stake by applying multivariate regression analysis and ordinary least square and taking China A-share listed companies as samples. The study finds that for the whole sample enterprises and non-state-controlled enterprises, current and last R&D investment have significant positive influence on corporate performance; for state-controlled enterprises, current and last R&D investment have positive influence on corporate performance but not significant.

Keywords: *Nature of controlling stake; R&D investment intensity; corporate performance; China*

1. Introduction

R&D investment is not only an important source for enterprises to promote competitiveness and create value(Schumpeter, 1934)[1], but also a key condition to realize sustainable development(Hamel and Prahalad, 1994)[2]. Whether R&D investment can improve corporate performance receives great attention from academic world. However, there are controversies in existent research conclusions in academic world: Morby(1988) [3], Morbey(1989) [4], Hall(1993) [5], Hirschey(1985) [6], Ren and Shi(2009)[7]、Luo *et al.* (2011)[8]、Jiao *et al.*(2010)[9] and Li *et al.*(2007)[10]*etc.* found that R&D investment has significant positive influence on corporate performance through empirical study; Guo(2006), Lu andWang(2011)[12] *etc.* found that R&D investment has significant negative influence on corporate performance through empirical study; Gerard Ballot (2001) [13] *etc.* found that R&D investment has non-significant influence on corporate performance through empirical study.

The main reason of lots controversies in existent research conclusions is that difference in enterprise R&D investment performance under different nature of controlling stake is ignored in addition to the different nationality, time window and analytical method selected by study sample. Based on this, in order to make up the deficiency in existing research literature, this paper divides China A-share listed companies as state-controlled enterprises and non-state-controlled enterprises based on nature of controlling stake and makes an empirical analysis by applying multivariate regression analysis and ordinary least square. The conclusion in this article can both further expand relevant theory on enterprises R&D investment performance and provide theoretical support and decision reference for modern enterprises to promote R&D investment performance. The paper contains theoretical analysis and research hypothesis, study design, empirical result and analysis, robustness test and research conclusion, *etc.*

2. Theoretical Analysis and Research Hypothesis

Technological innovation theory believes that R&D investment is able to improve enterprises' innovation ability and competitiveness and drive corporate performance to keep growing by increasing new products and improving enterprise technological process; however, there are disagreements over empirical study conclusion. Technological innovation theory believes that R&D investment is an important factor to improve corporate technological innovative ability (Tsai, 2004)[14] and maintain corporate competitiveness(Chan *et al.*, 1990)[15] as well as a key element for companies to gain profit in market competition(Amit and Schoemaker,1993)[16]. This can form blocking mechanism with market competition obstacle (Srivastavae *et al.* ,1998)[17], obtain advantages different from other competitors (Johnson and Pazderka,1993)[18]and improve enterprises' profitability(Calantone *et al.*,2002)[19]. Morby (1988), Morbey(1989) [4], Hall(1993) [5], Hirschey(1985) [6], Cao *et al.* (2010) [20]、 Wang and Zhang(2011)[21]、 Zhang *et al.*(2012)[22]*etc.* found that R&D investment is significantly positively correlated with corporate performance through empirical research.

Besides high profitability feature of R&D investment, income from R&D investment has hysteric nature, because it takes a long time from research to development and then to commercialization of technological achievements. The time is affected and restrained by industrial technological reform speed and the company's innovative ability. Regarding to financial accounting of R&D expenditure, *No. Six Accounting Standards for Business Enterprises - Intangible Assets* issued by China in 2006 provides that all expenses in research stage should be recorded into current profit and loss when they occur; expenses in development phase cannot be capitalized and recognized as intangible assets unless they meet five conditions at the same time. This shows that R&D investment can not bring current profit for the company, and even reduce company current profit. For companies, R&D investment is a selection process in which the company exchanges current performance for future performance (Liu 2014) [23]. Based on above analysis, this paper proposes the following hypothesis.

H1: Current R&D investment is negatively correlated with current corporate performance.

H2: Last R&D investment is positively correlated with current corporate performance.

3. Study Design

3.1 Model Design

According to research hypothesis, build the following regression model to show influence relation of R&D investment on corporate performance based on different nature of controlling stake.

$$\begin{aligned}
 ROA_t = & \alpha_0 + \alpha_1 RDasset_t + \alpha_2 RDasset_{t-1} + \alpha_3 CEO_share_t + \alpha_4 CEO_share_t^2 \\
 & + \alpha_5 CEO_share_t^3 + \alpha_6 lever_t + \alpha_7 Lnasset_t + \alpha_8 Lnrevenue_t \\
 & + \alpha_8 Lnemployee_t + \sum Indu_m + \sum Year_j + \varepsilon
 \end{aligned} \tag{1}$$

In model (1), the explained variable is ROA_t , test variables are $RDasset_t$ and $RDasset_{t-1}$, control variables are CEO_share_t , $CEO_share_t^2$, $CEO_share_t^3$, $lever_t$, $Lnasset_t$, $Lnrevenue_t$, $Lnemployee_t$, $Indu_m$, $Year_j$. α_0 is the constant term, $\alpha_1 - \alpha_8$ are regression coefficient, ε is the residual term.

Name, symbol and definition of each variable are shown in Table 1:

Table 1. Name, Symbol and Definition of Variables

	Name	Symbol	Definition
Explained variable	Rate of return on total assets in current period	ROA_t	Current net profit \div average balance of total assets in current period, in which, average balance of total assets in current period = (closing balance of asset in current period + opening balance of asset in current period) \div 2
Test variable	R&D investment intensity in current period	RD_{asset_t}	R&D expenditure in current period \div total assets at the end of current period
	R&D investment intensity in last period	$RD_{asset_{t-1}}$	R&D expenditure in last period \div total assets at the end of last period
Control variable	CEO shareholding ratio in current period	CEO_share_t	Number of shares held by CEO in current period \div total shares of the company in current period
	CEO shareholding ratio square in current period	$CEO_share_t^2$	(Number of shares held by CEO in current period \div total shares of the company in current period) ²
	CEO shareholding ratio cube in current period	$CEO_share_t^3$	(Number of shares held by CEO in current period \div total shares of the company in current period) ³
	Debt ratio in current period	Lever _t	Total liabilities at the end of current period \div total assets in current period
	Asset size of the company in current period	Ln_{asset_t}	Natural logarithm of total assets at the end of current period
	Revenue size of the company in current period	$Ln_{revenue_t}$	Natural logarithm of current operating income
	Employee number of the company in current period	$Ln_{employee_t}$	Natural logarithm of total employees number in current period
	Annual variable	Year _j	Dummy variable, take value 1 in the jth year; or take value 0
	Industrial variable	Indu _m	Dummy variable, take value 1 in the mth industry; or take value 0

In selecting explained variable, this paper uses indicator design of Chen (2011) [24] and Liu (2014) [23] *etc.* and chooses rate of return on total assets (ROA t) in current period to measure corporate performance.

In selecting test variable, this paper uses indicator design of Chen & Huang (2006) [25], Liu and Liu(2007[26] *etc.*, applies proportion of current R&D expenditure in total assets (RDasset); uses indicator design of Liu (2014) [23] *etc.*, and applies proportion of last R&D expenditure in total assets(RDasset-1); in robustness test, R&D investment intensity variable uses indicator design of Liu and Liu (2007) [27] *etc.* and selects proportion of current R&D expenditure in current operating income (RDrevenue); uses indicator design of Liu (2014) [23] *etc.*, and applies proportion of last R&D expenditure in last operating income(RDrevenue-1);

In selecting control variable, based on the executive incentive theory that CEO holds shares can stimulate CEO to promote corporate performance, and in order to test the nonlinear influence relation of CEO shareholding on corporate performance, this paper selects CEO shareholding ratio(CEO_sharet), CEO shareholding ratio square(CEO_sharet2) and CEO shareholding ratio cube (CEO_sharet3)variables; financial theory believes that corporate liabilities have lever effect on corporate performance and reasonable capital structure is able to amplify earnings per ordinary share, thus this paper introduces financial leverage variable (Financial_lev) in the model; economics believe that company size has progressive increase, invariability and progressive decrease effects on corporate performance and in order to comprehensively uncover the influence relation of company size on corporate performance, we introduce three variables including company asset size(LnAsset), Revenue size(LnRevenue) and employee number(LnEmployee) in the model at the same time; in order to discover the influence relation of economic condition in different years and profitability in different industries on corporate performance, we control the year (Yearj)and industry (Induk) in the model.

3.2 Sample Selection and Data Source

The samples in this paper come from Shanghai and Shenzhen A-share listed companies of China during 2008-2013, based on which we make a rational screening. The procedures are listed as follows: (1) get rid of financial companies; (2) get rid of ST company and *ST company as business activities and financial activities of ST company and *ST company may have abnormal variation; (3) in order to inspect the hysteresis effect of R&D investment, select listed companies that disclosed R&D for two consecutive years and get rid of listed companies with data missed; (4) for major continuous variables, use box plots to detect whether they have abnormal values and Winsorize the variables with abnormal values. Finally, there are 1705 samples in total; classify them by enterprise nature of controlling stake into 778 non-state-controlled enterprises and 927 state-controlled enterprises. Other data come from CSMAR database and WIND database as well as the websites designated by CSRC, Sina Finance, CNINFO and China Securities Journal, *etc.* We draw part of the sample data to check with the annual report of listed companies and correct wrong data.

4. Empirical Result and Analysis

4.1 Descriptive Statistics

Table 2. The Descriptive Statistics of Main Variables

Variable	The Whole Sample Enterprises				State-controlled Enterprises				Non-State-controlled Enterprises			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
ROA _t	0.048	0.045	-0.035	0.146	0.038	0.044	-0.035	0.146	0.056	0.045	-0.035	0.146
RDasset _t	0.012	0.013	0.000	0.046	0.011	0.013	-0.002	0.046	0.014	0.013	0.000	0.046
RDasset _{t-1}	0.011	0.012	0.000	0.039	0.009	0.011	-0.002	0.039	0.012	0.012	0.000	0.039
CEO_share _t	0.048	0.113	0.000	0.558	0.003	0.022	0.000	0.287	0.086	0.141	0.000	0.558
Lever _t	0.408	0.212	0.015	0.779	0.506	0.191	0.022	0.779	0.326	0.193	0.015	0.779
Lnasset _t	21.711	1.119	18.685	24.182	22.157	1.151	18.685	24.182	21.336	0.940	19.237	24.182
Lnrevenue _t	21.128	1.349	19.158	24.127	21.750	1.346	19.158	24.127	20.606	1.108	19.158	24.127
Lnemployee _t	7.620	1.055	5.930	9.669	8.008	1.070	5.930	9.669	7.293	0.924	5.930	9.669

As shown in Table 2, among whole sample enterprises, the current rate of return on total assets (ROA_t) has an average value of 0.048, standard deviation of 0.045, minimum value of -0.035 and maximum value of 0.146; average value of current rate of return on total assets of non-state-controlled enterprises is 0.056, greater than 0.038, average value of current rate of return on total assets of state-controlled enterprises, which means that performance of non-state-controlled enterprises is better than that of state-controlled enterprises; as seen from current R&D investment intensity (RDasset_t), proportion of current R&D expenditure in total assets of whole sample enterprises has an average value of 0.012, standard deviation of 0.013, minimum value of 0.0000 and maximum value of 0.046, and the average value of current R&D intensity of non-state-controlled enterprises is 0.014, greater than 0.011, average value of current R&D intensity of state-controlled enterprises, which means that current R&D intensity of non-state-controlled enterprises is higher than that of state-controlled enterprises; as seen from R&D investment intensity in last period (RDasset_{t-1}), proportion of last R&D expenditure in total assets of whole sample enterprises has an average value of 0.011, standard deviation of 0.012, minimum value of 0.000 and maximum value of 0.039, and the average value of last R&D intensity of non-state-controlled enterprises is 0.012, greater than 0.009, average value of last R&D intensity of state-controlled enterprises,

which means that last R&D intensity of non-state-controlled enterprises is higher than that of state-controlled enterprises. In addition, the average value of current CEO shareholding ratio of non-state-controlled enterprises is 0.086 which is far greater than that of state-controlled enterprises (0.003); average debt ratio of state-controlled enterprises (0.506) is higher than that of non-state-controlled enterprises (0.326); the average natural logarithm of asset size (22.157), operating income size (21.750) and employee number(8.008) of state-controlled enterprises are all higher than those of non-state-controlled enterprises (21.336, 20.606, 7.293). As a whole, among China A-share listed companies, performance of state-controlled enterprises and non-state-controlled enterprises varies a lot because of different impact of capital structure, company size and CEO shareholding ratio in enterprises of different controlling stake nature, and probably also because of the influence of R&D investment intensity in different controlling stake nature enterprises on corporate performance.

4.2 Regression Analysis

Apply Stata12.1 analysis software, multivariate regression analysis model and ordinary least square. For regression result, see Table 3.

Table 3. Regression Result of Influence Relation of R&D Investment on Corporate Performance

Variables	The Whole Sample Enterprises		State-Controlled Enterprises		Non-State-Controlled Enterprises	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
RDasset _t	0.206*** (2.66)		0.134 (1.12)		0.343*** (3.37)	
RDasset _{t-1}		0.194** (2.25)		0.210 (1.58)		0.243** (2.12)
CEO_share _t	0.205*** (3.72)	0.206*** (3.73)	0.814** (2.15)	0.801** (2.12)	0.0723 (1.24)	0.0814 (1.39)
CEO_share _t ³	-0.973*** (-3.17)	-0.966*** (-3.15)	-2.694 (-0.62)	-2.583 (-0.60)	-0.373 (-1.18)	-0.393 (-1.24)
CEO_share _t ²	1.210*** (2.98)	1.190*** (2.93)	0.146 (0.01)	-0.0603 (-0.01)	0.543 (1.31)	0.541 (1.30)
Lever _t	-0.125*** (-20.29)	-0.126*** (-20.56)	-0.120*** (-13.79)	-0.120*** (-13.81)	-0.118*** (-12.89)	-0.121*** (-13.27)
Lnasset _t	-0.0081*** (-3.71)	-0.0083*** (-3.81)	-0.0022 (-0.64)	-0.0021 (-0.63)	-0.0135*** (-4.34)	-0.0143*** (-4.57)
Lnrevenue _t	0.0222*** (10.75)	0.0224*** (10.87)	0.0145*** (4.75)	0.0145*** (4.78)	0.0349*** (11.48)	0.0354*** (11.61)
Lnemployee _t	-0.0023 (-1.49)	-0.0023 (-1.48)	-0.0013 (-0.56)	-0.0014 (-0.61)	-0.0069*** (-2.97)	-0.0067*** (-2.87)
Yea _{ij}	control	control	control	control	control	control
Indu _m	control	control	control	control	control	control
_cons	-0.133*** (-4.95)	-0.132*** (-4.93)	-0.168*** (-3.53)	-0.169*** (-3.56)	-0.247*** (-6.08)	-0.241*** (-5.89)
N	1705	1705	778	778	927	927
R ²	0.404	0.403	0.413	0.414	0.444	0.440

Note: (1) t statistics in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01. (2) Model 1, model 3 and model 5 are influence relation models of current R&D investment intensity on current corporate performance. (3) Model 2, model 4 and model 6 are influence relation models of last R&D investment intensity on current corporate performance.

4.2.1 Influence Test of Current R&D Investment Intensity on Corporate Performance: In Table 3, model 1, model 3 and model 5 test the influence relation of current R&D investment intensity (RDasset_t) on current corporate performance (ROA_t). For the whole sample enterprises, regression coefficient of current R&D

investment intensity on current corporate performance is 0.206 and significant at 1% level, which means that current R&D investment intensity has positive influence on current corporate performance. Hypothesis 1 fails the test, the study conclusion is basically in line with the conclusion of Morby (1988) [3], Morbey(1989) [4], Hall(1993) [5], Hirschey(1985) [6], Cao *et al.*(2010) [20], Wang and Zhang(2011)[21], Zhang *et al.*(2012)[22]. For state-controlled enterprises, regression coefficient of current R&D investment intensity on current corporate performance is 0.134, but the relation is not significant. Hypothesis 1 fails the test, the study conclusion is basically in line with the conclusion of Gerard Ballot (2001) [13] *etc.* For non-state-controlled enterprises, regression coefficient of current R&D investment intensity on current corporate performance is 0.343 and significant at 1% level. Hypothesis 1 fails the test, the study conclusion in non-state-controlled enterprises further justifies the conclusion of Morby (1988) [18] *etc.* In all, in the whole sample enterprises, state-controlled enterprises and non-state-controlled enterprises, the hypothesis 1 all fails the test, that is current R&D investment intensity has positive influence rather than negative influence on current corporate performance, it may be because the positive impact of technological achievement on current performance is largely greater than the negative impact produced by current R&D investment cost as modern technology has a rapid development, technological updating speeds up and technological transformation quickens; compared to state-controlled enterprises, non-state-controlled enterprises have more sound governance mechanisms and their current R&D investment intensity has significant positive influence on corporate performance while significance of influence relation of state-controlled enterprises is weaker.

4.2.2. Influence Test of Last R&D Investment Intensity on Corporate Performance: In Table 3, model 2, model 4 and model 6 test the influence relation of last R&D investment intensity ($RD_{asset,t-1}$) on current corporate performance (ROA_t). For the whole sample enterprises, regression coefficient of last R&D investment intensity on current corporate performance is 0.194 and significant at 5% level, which means that last R&D investment intensity has positive influence on current corporate performance. Hypothesis 2 passes the test. For state-controlled enterprises, regression coefficient of last R&D investment intensity on current corporate performance is 0.210, but the relation is not significant. Hypothesis 2 fails the test. For non-state-controlled enterprises, regression coefficient of last R&D investment intensity on current corporate performance is 0.243 and significant at 5% level. Hypothesis 2 passes the test. In all, in the whole sample enterprises, state-controlled enterprises and non-state-controlled enterprises, last R&D investment intensity has positive influence on current corporate performance, which means R&D investment intensity has hysteresis effect on corporate performance. Likewise, compared to state-controlled enterprises, last R&D investment intensity of non-state-controlled enterprises has significant positive influence on current corporate performance while state-controlled enterprises have weak significance of influence relation.

5. Robustness Test

To test reliability of above study conclusion, this paper conducts the following robustness test: based on above regression model, replace ratio of current R&D expenditure in total assets at the end of current period ($RD_{asset,t}$) indicator with ratio of current R&D expenditure in current operating revenue ($RD_{revenue,t}$) indicator and replace last R&D expenditure in total assets at the end of current period

(RDasset_{t-1})indicator with ratio of last R&D expenditure in current operating revenue (RDrevenue_{t-1}) indicator. Similarly, apply ordinary least square to make econometric regression for whole sample enterprise data, state-controlled enterprise data and non-state-controlled enterprise data of China A-share listed companies during 2008-2013. For regression result, see Table 4. Regression result is basically consistent with the above study conclusion, which means that above study conclusion has strong robustness.

Table 4. Regression Result of Influence Relation of R&D Investment on Corporate Performance

Variables	The Whole Sample Enterprises		State-Controlled Enterprises		Non-State-Controlled Enterprises	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
RDrevenue _t	0.0526* (1.84)		0.0464 (0.73)		0.101** (2.25)	
RDrevenue _{t-1}		0.0639* (1.72)		0.0974 (1.19)		0.0840* (1.69)
CEO_share _t	0.211*** (3.82)	0.211*** (3.81)	0.816** (2.12)	0.802** (2.11)	0.0846 (1.45)	0.0885 (1.51)
CEO_share _t ³	-0.990*** (-3.22)	-0.989*** (-3.22)	-2.716 (-0.62)	-2.585 (-0.60)	-0.413 (-1.30)	-0.425 (-1.34)
CEO_share _t ²	1.219*** (3.00)	1.214*** (2.99)	0.163 (0.01)	-0.139 (-0.01)	0.572 (1.38)	0.574 (1.38)
Lever _t	-0.126*** (-20.42)	-0.127*** (-20.63)	-0.121*** (-13.96)	-0.121*** (-13.97)	-0.119*** (-12.91)	-0.122*** (-13.28)
Lnasset _t	-0.00953*** (-4.35)	-0.00936*** (-4.30)	-0.00293 (-0.87)	-0.00312 (-0.93)	-0.0166*** (-5.38)	-0.0159*** (-5.18)
Lnrevenue _t	0.0234*** (11.14)	0.0233*** (11.14)	0.0152*** (4.88)	0.0155*** (4.98)	0.0375*** (12.14)	0.0367*** (11.99)
Lnemployee _t	-0.00217 (-1.38)	-0.00216 (-1.38)	-0.00120 (-0.54)	-0.00124 (-0.56)	-0.00657*** (-2.84)	-0.00646*** (-2.79)
Yea _{ij}	control	control	control	control	control	control
Indu _m	control	control	control	control	control	control
_cons	-0.128*** (-4.79)	-0.129*** (-4.81)	-0.166*** (-3.50)	-0.167*** (-3.53)	-0.236*** (-5.82)	-0.235*** (-5.76)
N	1705	1705	778	778	927	927
R ²	0.376	0.376	0.368	0.369	0.401	0.399

Note: (1) t statistics in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01. (2) Model 1, model 3 and model 5 are influence relation models of current R&D investment intensity and current corporate performance. (3) Model 2, model 4 and model 6 are influence relation models of last R&D investment intensity and current corporate performance.

6. Conclusion and Suggestions

The study samples in this paper come from Shanghai and Shenzhen A-share listed companies of China during 2008-2013. With multivariate regression analysis and ordinary least square, it makes econometric regression for whole sample enterprises, state-controlled enterprises and non-state-controlled enterprises and conducts empirical study on influence of R&D investment on corporate performance. The study finds that for whole sample enterprises, current and last R&D investment intensity have significant positive influence on corporate performance; for state-controlled enterprises, current and last R&D investment intensity have positive influence on corporate performance but not significant; for non-state-controlled enterprises, current and last R&D investment intensity have significant positive influence on corporate performance.

Based on above conclusion, it's not difficult to find that for non-state-controlled enterprises, current and last R&D investment intensity have significant positive influence on current corporate performance, which means that non-state-controlled

enterprises have high R&D investment efficiency mainly, which is mainly because of the well-established governance mechanisms in non-state-controlled enterprises; however, in state-controlled enterprises, current and last R&D investment intensity have positive influence on current corporate performance but not significant, which means that state-controlled enterprises have low R&D investment efficiency, mainly because the unsound governance mechanisms in state-controlled enterprises which makes them difficult to effectively allocate R&D resource. Therefore, to improve R&D allocation efficiency in state-controlled enterprises and corporate performance, we have to make breakthroughs in improving corporate governance mechanism in addition to seeking solutions to R&D investment intensity.

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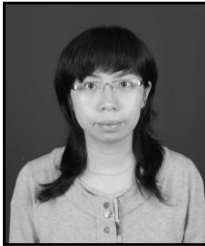
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Authors



Zhang Guiling, She was born in 1983, Henan China. CIMA Advanced Diploma in Management Accounting. She received the Master degree of management in Nankai University in 2006. Now she is a lecture in Zhengzhou Institute of Aeronautical Industry Management. Her current research interests include R&D investment and investment efficiency.

