International Journal of Business and Management Review
Vol.6, No.3, pp.72-90, April 2018
Published by European Centre for Research Training and Development UK (www.eajournals.org)

RESEARCH ON THE RELATIONSHIP BETWEEN INTERNAL CONTROL AND R&D INVESTMENT (BASED ON THE EMPIRICAL STUDY OF GEM LISTED COMPANIES)

Yun Xia and Liu Yang

International Business School, Zhuhai campus, Jinan University, Guangdong, China.

ABSTRACT: *Based on the data of GEM listed companies from 2010 to 2015, this paper analyzes the relationship between the internal control and R&D investment of enterprise. The results show that, the internal control quality of the enterprise is positively correlated with the enterprise's R&D investment intensity; in addition, we also find that the internal control quality of non-state-owned enterprises has a more significant effect on the enterprise'R&D investment intensity than that of state-owned enterprises; the internal control of high-tech enterprises plays a more significant role in promoting the R&D investment intensity than that of non-high-tech enterprises. On the one hand, this paper has certain theoretical meaning on enriching the academic research of the economic consequences of internal control and of the influential factors of R&D investment. On the other hand, it provides some ways for enterprises to improve R&D investment from the internal mechanism aspect.*

KEYWORDS: R&D, investment, internal control, GEM listed companies

INTRODUCTION

The innovation ability of Chinese enterprises has increased gradually in recent years, while there is still a gap compared with the developed countries. The insufficient R&D investment is an important factor restricting the improvement of innovation ability. China's R&D expenditure intensity reached 2.07% in 2015, while the developed countries are 2.5% to 4%. How to effectively improve the R&D investment of Chinese enterprises has become one of the main problems to be solved. Some scholars believe that large enterprises have sufficient funds to invest in R&D due to the advantages of scale production and various resources (Roy et al., 1994;Fisherman, 1999).In addition, the ownership concentration ratio and the higher proportion of CEO's shareholding ratio will also positively promote the R&D investment of enterprises (Marta, 2011).Considering the particularity of China's market system, the impact of different ownership of enterprises on R&D investment will be different (Tongliang An, 2009;Qian Shu et al., 2013).The study of the relationship between the internal control and R&D investment of enterprise mostly focus on internal control in the process of R&D activities and the influence of internal control on R&D investment efficiency (Billett et al., 2005).Research on the direct correlation between R&D investment and internal control are not enough, thus we start our research on the relationship between these two in view of the importance of internal control and innovation.

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

By finding empirical support for our arguments, this study contributes to theory in important ways. First, we study the relationship between R&D and internal control from different perspectives. Based on the internal control perspective which is relatively new to study, we provide a different starting point for the enterprise to increase R&D investment effectively. Secondly, we find ways to promote R&D investment in enterprises from different aspects. Using internal control to research the R&D activities is still not common. Our third contribution is to supplement the research on economic consequences of internal control from different points. In this paper, the enterprise's R&D investment is studied as an economic consequence of internal control, which is partly a supplement to the research on R&D activities and internal control.

THEORETICAL UNDERPINNING AND HYPOTHESES

We study the relationship between internal control and enterprise R&D research, In relation to R&D activity research, some scholars show that the larger the size of the enterprise, the more advanced basic resources will be provided to the R&D department (Fisherman, etc., 1999).The higher shareholding ratio of CEOs also helps to promote R&D investment (Marta, 2011).However, it is not significant that increasing the shareholding ratio of senior executives to stimulate management to increase R&D investment in the condition where firms controlled by the manager and with dispersed ownership (Yun Xia, 2014).In addition, the smaller scale of board of directors can respond more quickly and effectively to the activities of uncertainty, which is conducive to the decision-making of R&D investment (Boyd, 1998). Management's tenure and age will also have an impact on corporate R&D investment (Baker and Mueller, 2002). Take the corporate finance factor into consideration, The sales revenue of new products is positively correlated with the R&D investment of enterprises (Grabowski et al., 2003).In addition, internal control has always been a hot topic in academic research. The elements of internal control are: internal environment, risk assessment, control activities, information communication and supervision. The main factors influencing R&D investment are closely related to the five elements in internal control, which is one of the main reasons why there are many research associate the internal control with R&D activity, some scholars find that the effective internal control can restrain and reduce the enterprise fundamentally inefficient investment, and improve the efficiency of enterprise each project overall funding (Hongxing Fang et al., 2013; Hanwen Chen et al.,2014).Strengthening the internal control of the enterprise's R&D projects is conducive to improving the risk prevention ability in the enterprise's R&D process and ensuring the quality of the enterprise financial report. Internal control makes investors have a full understanding of the enterprises' management and financial conditions before the investment, which effectively solve the problem of "adverse selection". At the same time, for companies with good internal control quality, Banks tend to charge lower financing interest and other fees. Obviously, companies with good internal control are more likely to obtain external investments and abundant capital to invest in all kinds of projects. With the improvement of the importance of R&D innovation, R&D projects ought to be the

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

focus of enterprise investment. Based on the above analysis, this paper proposes the following hypothesis:

H1: With other conditions unchanged, the internal control quality of the enterprise is positively correlated with the R&D investment of the enterprise.

The ownership of the state-owned enterprises in China are owned by the state, with two types of agency problem which are between large and small investors and among the management levels within the enterprise that is different from non-state enterprises. In this case, compared with non-state-owned enterprises, the state-owned listed enterprises' internal control effectiveness is more weaken (Hao wang, 2014). In china, the enterprise strategy and business policy in state-owned enterprise is largely affected by the government decision-making. The state-owned nature of enterprises will weaken the role of internal control in the management and operation of enterprises (Zuji liu, 2013).Government intervention will also have a negative impact on the effectiveness of the internal control of state-owned enterprises (Huifang zhao, Xiaoli wang, 2015). In this paper, we regard R&D investment as one of the economic consequences of effective internal control. Thus we assume that:

H2: The internal control quality of non-state-owned enterprises has a more significant effect on the enterprise' R&D investment intensity than that of state-owned enterprises.

Generally speaking, as technology-intensive and capital-intensive enterprises, the high technology enterprises rely heavily on R&D activities. Based on the R&D activities of the characteristics of high risk, high investment, long cycle, high-tech enterprise are more risk-conscious, and the control of the risk in the process of R&D is particularly valued. The effective evaluation and control of risk is one of the main functions of internal control. Therefore, high-tech enterprises will pay more attention to the improvement of internal control construction and internal control effectiveness. In addition, the declaration of high technology enterprise in Chinese are very stringent, therefore, enterprises which want to declare successfully should pay more attention to the construction and promotion of their own internal control. At the same time, preferential policy from the government also make high-tech enterprises have more resources to improve its internal control level. In this paper, we regard R&D investment as one of the economic consequences of effective internal control. Thus we assume that:

H3: The internal control quality of high-tech enterprises has a more significant effect on the enterprise' R&D investment intensity that of non-high-tech enterprises.

METHODS

Sample

The research object we choose is the listed companies on ChiNext from 2010 to 2015. The relevant data are mainly from the DIB internal control information disclosure index database, CSMAR database, WIND database, enterprises and official website. 1,545 observations from

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

2010 to 2015 were selected after processing and screening, which were 33 in 2010, 148 in 2011, 275 in 2012, 347 in 2013, 349 in 2014 and 393 in 2015.

Dependent variable (R&D investment)

The R&D investment is the dependent variable in our analysis. In order to eliminate the influence of enterprise scale, scholars generally choose R&D investment/total assets, R&D investment/ enterprise value, R&D investment/net income or other indicators to measure the R&D investments. According to the existing literature, we select R&D investment/total assets (initial amount on the balance sheet) as dependent variable. Meanwhile, we use R&D investment/total assets as the alternative dependent variable in robustness check. The data of R&D investment in this paper is derived from the WIND database.

Independent variable (Internal control)

Some scholars use internal control defects disclosed by the enterprise to measure internal control (Tang et al., 2015). Some scholars classify the perceived internal control quality of enterprise at different levels, then evaluate for each level to define the index (Hongxing Fang et al., 2013). At present, the most commonly used index to measure the internal control is from "DIB - China's listed company internal control index", which is widely adopted by the academia since its launch in 2011.In this paper, we use the "DIB internal control index" to measure the level and quality of the enterprises' internal control. Meanwhile, we use" if there are internal control defects "as the alternative independent variable in robustness check.

Control variables

Our regression analysis also includes several Control variables as follows:Growth rate of total assets , growth rate of main business income, financial leverage, Tobin ' s Q, selling cost ,proportion of intangible assets , managerial power, firm size, Ownership types, proportion of independent directors, industry, firm age. The main variables in our model are shown in Table 1.

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Table 1 Variable definition and explanation

name	label	definition and explanation
R&D investment	RDI_0	Present R&D investment/ total assets in the beginning of the year
	RDI_1	1 period lag R&D investment/ total assetsin in the beginning of the year
	RDI_2	2 period lag R&D investment/total assets in the beginning of the year
	$RDIT_0$	Present R&D investment/total assets
	$RDIT_1$	1 period lag R&D investment/ total assets
	$RDIT_2$	2 period lag R&D investment/ total assets
Internal Control	IC	Internal control quality index
	ICD	There is no internal control equals to 1, otherwise equals to 0.
Growth rate of Total Assets	GrowthA	(Total assets in the present year- total assets in last year)/ total assets in last present year
Growth rate of Main Business Income	GrowthM	(Main business income in the present year- main business income in last year)/ main business income in last present year
Tobin ' s Q	Tobin's q	(Market value of common equity in the end of the year+total liabilities in the end of the year)/total assets in the end of the year
Selling Cost	SC	Selling cost/main business income
Proportion of Intangible Assets	Tint	Intangible assets/total assets
Managerial Power	Dual	If the chairman and the CEO are the same person equals to 1,otherwise equals to 0
Firm Size	Lnsize	The logarithm of total assets.
	LnMBI	The logarithm of main business income
Ownership Types	Own	State-owned enterprises equals to 1,otherwise equals to 0
Financial Leverage	Lev	Asset-liability ratio
Proportion of Independent Directors	Dirp	The number of independent directors/the total number of board members
Industry	Ind	High-tegh enterprises equals to 1,otherwise equals to 0
Firm Age	Year	This paper selects data from 2010 to 2015 and sets 5 dummy variables.

Model

Based on previous researches and relevant literatures, this paper establishes the following

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

models to verify the hypothesis of this paper. In consideration of the influence of internal control to R&D investment may not be emerged immediately, which means there may be a certain degree of hysteresis. Therefore, the models established for the present，1 period lag and 2 period lag R&D investment.

$$RDI_0=\beta_0+\beta_1 IC+\beta_2 LEV+\beta_3 GrowthA+\beta_4 SC+\beta_5 Tint+\beta_6 Dual+\beta_7 Dirp+\beta_8 Lnsize+\beta_9 Year+\beta_{10} Own+\beta_{11} Ind+\varepsilon_0 \quad (1)$$

$$RDI_1=\beta_0+\beta_1 IC+\beta_2 LEV+\beta_3 GrowthA+\beta_4 SC+\beta_5 Tint+\beta_6 Dual+\beta_7 Dirp+\beta_8 Lnsize+\beta_9 Year+\beta_{10} Own+\beta_{11} Ind+\varepsilon_0 \quad (2)$$

$$RDI_2=\beta_0+\beta_1 IC+\beta_2 LEV+\beta_3 GrowthA+\beta_4 SC+\beta_5 Tint+\beta_6 Dual+\beta_7 Dirp+\beta_8 Lnsize+\beta_9 Year+\beta_{10} Own+\beta_{11} Ind+\varepsilon_0 \quad (3)$$

RESULTS

Descriptive statistics

The descriptive statistics are reported in Table 2. The mean and median of R&D investment are 0.027 and 0.021 respectively, indicating that the R&D investment of most of the enterprises in China is below the average. The maximum and minimum values are 0.186 and 0.000 respectively, which shows that there is a large gap among the enterprises' R&D investment level. The mean and median of internal control index are 663.523 and 677.74 respectively, which shows that most of the internal control of enterprise level has reached the average level, however, there is still a large gap among the enterprises' internal control according to the maximum and the minimum values. The mean of the asset-liability ratio is 0.253, which is at a low level and shows a lot of room for financing. The mean and median of growth rate of total assets are 0.254 and 0.128 respectively, which indicates that the growth rate of total assets of most enterprises is below the average level. The mean value of the Selling Cost is 0.098, indicating that the sales cost of the sample enterprise is controlled at a lower level. The mean value of the proportion of intangible assets is only 0.055, indicating the proportion of intangible assets of the sample enterprises is low and the investment in technology transformation and scientific innovation is not enough. The average value of the managerial power is 0.432, indicating that nearly half of the sample enterprises are Chairman and General Manager of the two level-one. The average value of the proportion of independent directors is 0.38, which is

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

close to the median 0.364, indicating that the proportion of independent directors is more than one-third of the board's size in most of the enterprises. The mean value of firm size(Lnsize) which represents the total assets scale of the company is 21.04, and the median is 20.95, indicating that most enterprises' firm size are on average level. The mean value of the ownership types is 0.0254 indicating that most of the sample enterprises are non-state-owned enterprises. The mean value of industry is 0.674, indicating that most of the sample enterprises are high-tech enterprises.

Table 2 Descriptive statistics of Variables.

Variables	Sample	Min	Mean	Median	Max	S.D.
RDI	1545	0.000	0.027	0.021	0.186	0.020
IC	1555	234.0	663.5	677.7	779.0	60.62
ICD	1550	0	0.92	1	1	0.265
Lev	1555	0.011	0.253	0.224	0.843	0.156
GrowthA	1554	-0.488	0.254	0.128	8.096	0.497
SC	1555	0	0.098	0.068	0.730	0.095
Tint	1555	0	0.055	0.039	0.987	0.067
Dual	1547	0	0.432	0	1	0.495
Dirp	1550	0.286	0.380	0.364	0.600	0.056
Lnsize	1555	19.54	21.04	20.95	23.89	0.65
Own	1535	0	0.025	0	1	0.157
Ind	1555	0	0.674	1	1	0.469

Correlation analysis

Correlation analysis was also performed in this paper. We have Pearson correlation values between the main variables, table 3 shows the current R&D investment is positively correlated with the internal control at 5% significance level, which verifies the H1 preliminarily. At the same time, we analysis the correlation between the 1 period lag R&D investment and internal control, and 2 period lag R&D investment and internal control (table 4 and table 5), and find that the correlations are significant positive at 1% level, showing a certain lag in the positive correlation between internal control and R&D investment. In addition, R&D investment is insignificantly correlated with the asset-liability ratio, the logarithm of the asset size. and state-owned enterprises, while is significantly correlate with the growth rate of total assets, selling cost, intangible assets ratio, managerial power, the proportion of independent directors and the industry.

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Table 3 Correlation Matrix of Variables (R&D investment is the present value)

	RDI_0	IC	Lev	GrowthA	SC	Tint	Dual	Dirp	Lnsize	Own	IND
RDI_0	1										
IC	0.052**	1									
Lev	-0.037	-0.076***	1								
GrowthA	0.124***	0.088***	0.261***	1							
SC	0.159***	-0.028	-0.255***	-0.080***	1						
Tint	0.182***	0.005	0.144***	0.233***	-0.018	1					
Dual	0.051**	0.006	-0.022	0.028	-0.018	0.009	1				
Dirp	0.070***	-0.072***	-0.001	-0.007	0.039	0.035	0.056**	1			
Lnsize	-0.009	0.013	0.452***	0.342***	-0.120***	0.186***	-0.089***	-0.114***	1		
Own	0.023	-0.03	0.013	-0.034	-0.062*	-0.037	-0.133***	-0.076***	0.036	1	
Ind	0.184***	-0.050**	-0.070***	0.015	0.080***	0.016	0.003	0.113***	-0.149***	-0.001	1

*** p < 0.001, ** p < 0.01, * p < 0.05

Table 4 Correlation Matrix of Variables (R&D investment is the 1 period lag value)

	RDI_1	IC	Lev	GrowthA	SC	Tint	Dual	Dirp	Lnsize	Own	IND
RDI_1	1										
IC	0.086***	1									
Lev	0.01	-0.076***	1								
GrowthA	0.257***	0.088***	0.261***	1							
SC	0.123***	-0.028	-0.255***	-0.080***	1						
Tint	0.281***	0.005	0.144***	0.233***	-0.018	1					
Dual	0.072***	0.006	-0.022	0.028	-0.018	0.009	1				
Dirp	0.079***	-0.072***	-0.001	-0.007	0.039	0.035	0.056***	1			
Lnsize	0.037	0.013	0.452***	0.342***	-0.120***	0.186***	-0.089***	-0.114***	1		
Own	0.011	-0.03	0.013	-0.034	-0.062**	-0.037	-0.133***	-0.076***	0.036	1	
Ind	0.178***	-0.050**	-0.070***	0.015	0.080***	0.016	0.003	0.113***	-0.149***	-0.001	1

*** p < 0.001, ** p < 0.01, * p < 0.05

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Table 5 Correlation Matrix of Variables (R&D investment is the 2 period lag value)

	RDI_2	IC	Lev	GrowthA	SC	Tint	Dual	Dirp	Lnsize	Own	IND
RDI_2	1										
IC	0.107***	1									
Lev	0.046	-0.076***	1								
GrowthA	0.293***	0.088***	0.261***	1							
SC	0.109***	-0.028	-0.255***	-0.080***	1						
Tint	0.383***	0.005	0.144***	0.233***	-0.018	1					
Dual	0.089***	0.006	-0.022	0.028	-0.018	0.009	1				
Dirp	0.084***	-0.071***	-0.001	-0.007	0.039	0.035	0.056**	1			
Lnsize	0.025	0.013	0.452***	0.342***	-0.120***	0.186***	-0.089***	-0.114***	1		
Own	0.01	-0.03	0.013	-0.034	-0.062**	-0.037	-0.133***	-0.076***	0.036	1	
Ind	0.167***	-0.050**	-0.070***	0.015	0.080***	0.016	0.003	0.113***	-0.149***	-0.001	1

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Multivariate regression analysis

Our hypotheses were tested using multivariate regression analysis, Table 6 shows that the internal control is positively and significantly correlated with the present R&D investment ($r=0.0000263, p<0.05$), 1 period lag R&D investment ($r=0.0000454, p<0.01$)and 2 period lag R&D investment($r=0.0000834, p<0.01$) ,and the correlation coefficient increased significantly year by year. It indicates that the internal control quality of the sample enterprise has a significant positive effect on the R&D investment, which confirmed H1. In terms of control variables, the asset-liability ratio is negatively and significantly correlated with present R&D investment and 2 period lag R&D investment at 10% significance level, and with the lag issue that there was no significant correlation between R&D investment, to a certain extent, the higher the asset-liability ratio, the more cautious the investment in R&D activity. The growth rate of total assets is positively and significantly correlated with the R&D investment, indicating that the faster the enterprise's assets grows, the more capital it spends on R&D investment. The sales cost and the intangible assets ratio also showed a significant positive correlation with R&D investment at 1% significance level. CEO duality is positively and significantly correlated with the present R&D investment at 10% significance level and the 1 period lag and 2 period lag R&D investment at 5% significance level. The proportion of independent directors is insignificantly correlated with the present and 1 period lag R&D investment, while is positively and significantly correlated with the 2 period lag R&D investment at 10% significance level. The logarithm of the asset size is negatively and significantly correlated with present R&D investment at 10% significance level and with the 1 period lag and 2 period lag R&D investment at 5% significance level, indicating that the oversize asset scale will increase the enterprise internal friction, the investment intensity of R&D will be reduced in the meantime.

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Table 6 Regression results.

Variables	RDI0	RDI1	RDI2
IC	2.63E-05**	4.54E-05***	8.34E-05***
	(2.58)	(3.36)	(3.68)
Lev	-0.009*	-0.011	-0.019*
	(-1.97)	(-1.91)	(-2.06)
GrowthA	0.011***	0.026***	0.047***
	(5.23)	(9.78)	(8.96)
SC	0.038***	0.043***	0.055***
	(5.98)	(5.14)	(4.47)
Tint	0.055***	0.107***	0.218***
	(5.82)	(9.08)	(12.37)
Dual	0.003*	0.005**	0.007**
	(2.17)	(2.97)	(3.05)
Dirp	0.015	0.027	0.047*
	(1.38)	(1.94)	(2.22)
Lnsize	-0.002*	-0.004**	-0.006**
	(-2.21)	(-2.70)	(-2.63)
Own	0.011**	0.014**	0.018*
	(2.86)	(2.73)	(2.57)
Ind	control	control	control
year	control	control	control
N	1515	1511	1130
F	14.90	25.91	30.14
Prob	0.0000	0.0000	0.0000
adj. R2	0.121	0.198	0.265

*** p < 0.001, ** p < 0.01, * p < 0.05

In state-owned enterprises, the influence of internal control quality on R&D investment intensity is weaker than that of non-state-owned enterprises. Due to the influence of internal control on R&D investment has a certain lag, the correlation coefficient between those two variables increased year by year (Table 7). In state-owned enterprises, the internal control is insignificantly correlated with the present and 1 period lag R&D investment, while is positively and significantly correlated with the 2 period lag R&D investment(r=0.000303 p=10%) In non-state-owned enterprise, the internal control is positively and significantly correlated with the present R&D investment (r=0.000031 p=5%), 1 period lag R&D investment (r=0.0000511 p=1%), 2 period lag R&D investment (r=0.0000837 p=1%).

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Table 7 Regression results. (Comparing state-owned with non-state-owned enterprises)

	state-owned	non-state-owned	state-owned	non-state-owned	state-owned	non-state-owned
Variables	RDI0	RDI0	RDI1	RDI1	RDI2	RDI2
IC	-2.54E-05	3.10E-05**	2.50E-05	5.11E-05***	3.03E-04*	8.37E-05***
	(-0.64)	(2.96)	(0.50)	(3.68)	(2.68)	(3.63)
Lev	-0.015	-0.009	-0.002	-0.011	0.059	-0.021*
	(-0.51)	(-1.93)	(-0.05)	(-1.92)	(1.18)	(-2.19)
GrowthA	0.011	0.010***	0.023	0.026***	-0.021	0.047***
	(0.37)	(5.10)	(0.61)	(9.62)	(-0.43)	(9.02)
SC	0.198**	0.037***	0.282**	0.041***	0.303**	0.052***
	(3.12)	(5.75)	(3.49)	(4.90)	(2.90)	(4.20)
Tint	0.067	0.055***	0.037	0.108***	0.035	0.221***
	(0.61)	(5.80)	(0.26)	(9.11)	(0.20)	(12.41)
Dual	0.036	0.002*	0.069**	0.004**	0.089*	0.007**
	(1.99)	(2.04)	(3.03)	(2.80)	(2.85)	(2.89)
Dirp	-0.105	0.015	-0.023	0.027	0.133	0.047*
	(-1.05)	(1.44)	(-0.18)	(1.93)	(0.79)	(2.20)
Lnsize	0.004	-0.003*	-9.12E-05	-0.004**	-0.002	-0.006*
	(0.61)	(-2.32)	(-0.01)	(-2.71)	(-0.15)	(-2.53)
_cons	-0.018	0.050*	-0.008	0.062	-0.197	0.057
	(-0.13)	(2.00)	(-0.04)	(1.88)	(-0.78)	(1.13)
Ind	control	control	control	control	control	control
Year	control	control	control	control	control	control
N	38	1477	38	1473	33	1097
F	2.737	15.50	3.272	27.36	3.123	32.05
Prob	0.016	0.0000	0.006	0.0000	0.012	0.0000
adj. R2	0.397	0.121	0.462	0.200	0.463	0.269

*** p < 0.001, ** p < 0.01, * p < 0.05

In high-tech enterprises, the influence of internal control quality on enterprise R&D investment intensity is stronger than that of non-high-tech enterprises. Table 8 shows the regression analysis of internal control and enterprise R&D investment in high-tech enterprises and non-high-tech enterprises. In high-tech enterprises, the internal control is positively and significantly correlated with the present R&D investment (r= 0.0000276 p=10%), 1 period lag R&D investment(r=0.0000449 p=5%), 2 period lag R&D investment(r= 0.000118 p=1%).However, there is no significant correlation between the internal control and R&D investment in non-high-tech enterprises.

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Table 8 Regression results. (Comparing high-tech with non-high-tech enterprises.)

	high-tech	non-high-tech	high-tech	non-high-tech	high-tech	non-high-tech
Variables	RDI0	RDI0	RDI1	RDI1	RDI2	RDI2
IC	2.76E-05*	1.10E-05	4.49E-05**	2.96E-05	1.18E-04***	-4.31E-06
	(2.17)	(0.69)	(2.69)	(1.42)	(4.06)	(-0.14)
Lev	-0.009	-0.011	-0.013	-0.013	-0.030*	-0.009
	(-1.55)	(-1.76)	(-1.72)	(-1.50)	(-2.47)	(-0.73)
GrowthA	0.012***	0.006*	0.030***	0.016***	0.057***	0.028***
	(4.59)	(2.22)	(8.64)	(4.38)	(7.75)	(4.80)
SC	0.028***	0.069***	0.031**	0.078***	0.039**	0.098***
	(3.66)	(6.20)	(3.05)	(5.49)	(2.64)	(5.00)
Tint	0.001	0.005**	0.002	0.008***	0.003	0.010***
	(0.51)	(3.29)	(1.22)	(3.61)	(1.01)	(3.44)
Dual	0.078***	-0.014	0.147***	-0.026	0.283***	-0.047
	(6.56)	(-0.92)	(10.05)	(-1.37)	(13.01)	(-1.69)
Dirp	0.010	0.017	0.014	0.039	0.036	0.037
	(0.73)	(1.00)	(0.80)	(1.83)	(1.33)	(1.24)
Lnsize	-0.003	-0.001	-0.005*	-0.002	-0.007*	-0.003
	(-1.77)	(-0.94)	(-2.37)	(-1.03)	(-2.31)	(-1.31)
Own	0.010*	0.011*	0.012	0.016*	0.013	0.020*
	(1.98)	(2.12)	(1.77)	(2.46)	(1.40)	(2.48)
_cons	0.064	0.037	0.097*	0.031	0.084	0.068
	(1.90)	(1.18)	(2.19)	(0.77)	(1.20)	(1.23)
year	control	control	control	control	control	control
N	1019	496	1015	496	740	390
F	8.938	6.454	20.65	7.277	28.41	6.730
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
adj. R2	0.098	0.134	0.213	0.151	0.325	0.161

*** p < 0.001, ** p < 0.01, * p < 0.05

Robustness check

To check the validity of our findings, we run the analyses again by using different variables. First, we use the ratio of R&D investment to total assets (RDIT) as the alternative dependent variables. Table 9 shows the regression results. The internal control is positively and significantly correlated with $RDIT_0$ (r=0.0000187 p=10%), $RDIT_1$ (r=0.0000377 p=1%), and $RDIT_2$ (r= 0.0000694 p=1%). Then we use the internal control defects index to replace the internal control index. Table 10 shows the results obtained when using alternative independent variables. The internal control defects index is positively and significantly correlated with the

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

present R&D investment(r= 0.006 p=5%), 1 period lag R&D investment(r=0.009 p=5%) and 2 period lag R&D investment(r= 0.015 p=1%).Then we use Tobin's Q to replace the growth rate of total assets. Regression results is shown in table 11, the internal control index is positively and significantly correlated with the present R&D investment(r= 0.00002 p=10%), 1 period lag R&D investment(r=0.0000471 p=1%) and 2 period lag R&D investment(r= 0.0000843 p=1%). As we can see, the robustness checks strongly supported our hypotheses.

Table 9 Robustness check of alternative dependent variables.

Variables	RDIT0	RDIT1	RDIT2
IC	1.87E-05*	3.77E-05***	6.94E-05***
	(2.21)	(3.54)	(3.85)
Lev	-0.009*	-0.010*	-0.016*
	(-2.37)	(-2.07)	(-2.14)
GrowthA	-0.007***	-0.002	0.007
	(-4.00)	(-0.90)	(1.60)
SC	0.034***	0.039***	0.051***
	(6.49)	(5.98)	(5.19)
Tint	0.030***	0.057***	0.125***
	(3.81)	(6.09)	(8.87)
Dual	0.001	0.003*	0.005**
	(1.53)	(2.44)	(2.85)
Dirp	0.010	0.018	0.033
	(1.16)	(1.63)	(1.94)
Lnsize	-0.002*	-0.003**	-0.006**
	(-2.55)	(-2.96)	(-3.14)
Own	0.008**	0.011**	0.015**
	(2.71)	(2.73)	(2.72)
Ind	control	control	control
year	control	control	control
N	1515	1511	1130
F	12.62	12.10	15.13
Prob	0.0000	0.0000	0.0000
adj. R2	0.103	0.099	0.149

*** p < 0.001, ** p < 0.01, * p < 0.05

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Table 10 Robustness check of alternative independent variables.

Variables	RDI0	RDI1	RDI2
ICD	0.006**	0.009**	0.015***
	(2.89)	(3.13)	(3.41)
Lev	-0.010*	-0.013*	-0.023*
	(-2.25)	(-2.28)	(-2.47)
GrowthA	0.011***	0.028***	0.049***
	(5.58)	(10.33)	(9.48)
SC	0.038***	0.043***	0.055***
	(6.04)	(5.17)	(4.48)
Tint	0.054***	0.107***	0.217***
	(5.76)	(9.01)	(12.28)
Dual	0.003*	0.005**	0.007**
	(2.23)	(2.98)	(3.09)
Dirp	0.013	0.024	0.042*
	(1.21)	(1.68)	(1.98)
Lnsize	-0.002*	-0.003*	-0.005*
	(-1.97)	(-2.40)	(-2.35)
Own	0.011**	0.013**	0.017*
	(2.81)	(2.64)	(2.53)
Ind	control	control	control
year	control	control	control
N	1510	1506	1125
F	14.98	25.77	30.02
Prob	0.0000	0.0000	0.0000
adj. R2	0.122	0.198	0.266

*** p < 0.001, ** p < 0.01, * p < 0.05

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Table 11 Robustness check of Alternative Control Variables.

Variables	RDI_0 Coef.	RDI_1 Coef.	RDI_2 Coef.
IC	2.00E-05*	4.71E-05***	8.43E-05***
	(1.99)	(3.54)	(3.81)
Lev	0.006	0.014*	0.024**
	(1.38)	(2.41)	(2.64)
Tobin's q	0.003***	0.005***	0.008***
	(11.94)	(13.81)	(10.81)
SC	0.028***	0.029***	0.032**
	(4.50)	(3.49)	(2.63)
Tint	0.06***	0.130***	0.246***
	(7.11)	(11.48)	(14.56)
Dual	0.003*	0.005**	0.007**
	(2.25)	(3.14)	(3.18)
Dirp	0.019	0.033*	0.044*
	(1.78)	(2.38)	(2.09)
Lnsize	0.001	0.003*	-2.710E-04
	(1.22)	(2.39)	(-0.12)
Own	0.008*	0.010*	0.013
	(2.31)	(2.03)	(1.92)
Ind	control	control	control
year	control	control	control
N	1449	1445	1088
F	23.46	33.35	33.85
Prob	0.0000	0.0000	0.0000
adj. R2	0.189	0.252	0.297

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

DISCUSSION

Using the data of listed companies on ChiNext from 2010 to 2015, this paper analyzes the relationship between the internal control and R&D investment of enterprise. Firstly, we find that the internal control quality of the enterprise is positively correlated with the R&D investment, in other words, the better the internal control, the more funds invested in R&D investment. Enterprises with good internal control will have a better internal environment, and the evaluation of the risk of R&D activity would be more reasonable. In addition, with the characteristic of perfect information and communication system and effective supervision measures, internal control would have positive influence on R&D investment.

Compared with the internal control of state-owned enterprises, the internal control of non-state-owned enterprises has a more significant effect on the R&D investment intensity. In our

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

national economy, the agency problem in state-owned enterprises is complex, which makes the internal control effectiveness of state-owned enterprises weaker than non-state-owned enterprises. State-owned enterprises are closely related to the development of national politics and economy, so there are significant differences between state-owned enterprises and non-state-owned enterprises in terms of ownership. As a result, the R&D investment in state-owned enterprises is more susceptible to the political environment, government subsidies and the related preferential policies. Due to those characteristics of state-owned enterprises, the influence of internal control on R&D investment has been weakened in state-owned enterprises.

The internal control of high-tech enterprises plays a more significant role in promoting the R&D investment intensity than that of non-high-tech enterprises. Owing to the high dependence on the R&D activities, the high-tech enterprises need to place emphasis on the internal control quality to ensure its R&D activities going on smoothly. At the same time, the government has higher requirements for R&D activities and internal control on high-tech enterprises. Therefore, the positive effect of internal control on R&D investment is more obvious in high-tech enterprises.

IMPLICATION TO RESEARCH AND PRACTICE

Our results have some implications for practice. To beginning with, enterprises should realize the importance of internal control. By enhancing the quality of internal control, they can improve the effectiveness R&D investment, optimize the internal structure of management and achieve the strategic objectives of enterprises. In order to improve the internal control level, enterprises should establish a good internal environment, evaluate the risks in the production and operation process comprehensively, reduce the risks to a manageable level, and enhance the information sharing and the monitoring measures. Secondly, in order to strengthen sustainable development ability and occupy advantageous competitive position in global economy market. State-owned enterprises must attach importance to internal control, enhance the quality of internal control, promote the reform of its state-owned system and keep the healthy development of the enterprises. Last but not least, the internal control construction of non-high-tech enterprises should receive more attention and support from government policy. The government needs to keep close eye on the encouragement on the R&D investment of non-high-tech enterprises. Meanwhile, the corresponding internal control policies and measures for non-high-tech enterprises should be issued to promote the improvement of internal control construction.

CONCLUSION

Based on the analysis in the study, we find that the internal control quality of enterprise is positively correlated with the enterprise's R&D investment intensity; in addition, we also find that the internal control quality of non-state-owned enterprises has a more significant effect on

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

the enterprise' R&D investment intensity than that of state-owned enterprises; the internal control of high-tech enterprises plays a more significant role in promoting the R&D investment intensity than that of non-high-tech enterprises. This paper not only has certain theoretical meaning on enriching the academic research of the economic consequences of internal control and of the influential factors of R&D investment, but also provides some ways for enterprises to improve R&D investment from the internal mechanism aspect.

FUTURE RESEARCH

As outlined in the previous section, our study offers important and novel contributions to the relationship between internal control and R&D investment. However, it also has some limitations, which can be used as the starting point for future research work in this area. First, we only obtained the data of listed companies, the data of non-listed enterprises is missing. Therefore, the universality of the research conclusion needs further verification. Second, the data of internal control mainly come from "DIB database", which was established since 2011. After screen out the companies that disclosed both internal control index and R&D expenses, there is a certain reduction in the sample size that meets the requirements. Thus the effectiveness of the research results may be affected. Further research should be carried out from different stock markets and even global stock markets. Finally, the number of state-owned and non-high-tech enterprises is small on ChiNext. The available samples are limited when we compared the relationship between internal control and R&D investment among the enterprises. Our results need to be verified with a larger sample size.

REFERENCES

Altamuro J., Beatty.A.(2010) How does Internal Control regulation affect Financial Reporting? [J].Journal of Accounting and Economics, 49(1): 58-74.

Barker, V., G.Mueller (2002) CEO Characteristics and Firm R&D Spending[J].Management Science,（48）:782-801.

Billett, M.T,Qian,Y (2005) Are Overconfident Managers Born or Made? Evidence of Self-Attribution Bias from Frequent Acquirers. Management Science [J]. 19(11), 77-84.

Boyd B. K，Frikelstein S.(1998)How much does the CEO matter? The role of managerial discretion in the setting of CEO compensation[J].The Academy of Management Journal, 55(5):89-92.

Cheng, Mei., D. Dhaliwal, and Y. Zhang.(2012)Does Internal Control over Financial Reporting? [J].The Journal of Finance, 2012, 67(4): 1457-1498 .

Cole Matthew A., Robert J.R. Elliott.(2003)Determining the trade–environment composition effect: the role of capital, labor and environmental regulations [J]. Journal of Environmental Economics and Management. 32 (3):25-43.

Doyle, J., W. Ge, and S. Mcvay.(2007)Determinants of Weakness in Internal Control over Financial Reporting[J].Journal of Accounting and Economics, 21(44):193-223.

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

Dvid M. Willis and Susan S. Lightle.(2000)Management reports on internal control. [J] Journal of Ac-countancy. 67(15):56-67.

Federico M., Raffaele O., Maurizio S.(2010)The effects of owner identity and external governance systems on R&D investments: A study of Western European Firms[J].Research Policy, 39(8): 1093-1104.

Feng M., Li C., McVay S. E.(2015)Does Ineffectively Internal Control over Financial Reporting affect a Firm's Operations? Evidence from Firms' Inventory Management[J].Accounting Review, 90(2):529-557.

Fisherman A., Rob R.(1999)The Size of firms and R&D investment[J].International Economic Review, (40): 915-931.

Gneva M, Subramanyam KR, Raghunandan K.(2007)Internal Control Weakness and Cost of Equity: Evidence from SOX Section 404 Disclosures [J].The Accounting Review 82(5):1255-1297.

Grabowski H. G., DiMasi J. A., Hansen R. W.(2003)The price of innovation: new estimates of drug development costs[J].Journal of Health Economics, 22(2): 151-185.

Hanwen Chen, Zhongsheng Zhou,.(2014) Internal control quality and corporate bank credit loan cost [J]. Nankai Business Review（3）：103-111

Henry Theresa F., Shon,Renee E., John J. Weiss.(2011)Does executive compensation incentivize managers to create effective internal control systems?[J].Research in Accounting Regulation, (1):55-67.

Hongxing Fang, Yuna Jin (2013). Corporate Governance，Internal Control and Inefficient Investment: Theoretical Analysis and Empirical Evidences. [J]. Accounting Research，（7）:60-68.

Hongxing Fang, Yuna Jin (2013). Perceived internal control quality: measurement method and preliminary test. [J]. Research on Financial and Economic Issues，（10）：18-25.

Jensen M.C., Meckling W.H.(1976)Theory of firm: managerial behavior, agency costs and ownership structure[J].The Journal of Finance, (20): 59-64.

Kor Y. Y.(2006)Direct and Interaction Effects of top Management Team and Boarding Composition on R&D Investment Strategy[J].Strategic Management Journal 27(11): 1081-1099.

Marta A. Geletka.(2011)CEO outside directorships and firm performance.[J]. Academy of Management Journal, (54): 335–352.

Paul Healy M, Krishna Palepu G.(2001)Information asymmetry, corporate disclosure, and the capital markets: A review of the empirical disclosure literature[J].Journal of Accountancy,31(1-3): 405-440.

Qian Shu, Zhiya Chen (2013). Effects of Governance Structure on Chinese Manufacturing Companies' R&D Investment [J]. Science of Science and Management of S.& T.（09）：97-106.

Roy Rothwell.(1994)Towards fifth–generation innovation process[J].International Marketing Review， 11(1)：7–31.

Tongliang An , Hao Shi, Ludovico Alcorta..(2006)An observation and empirical study of R&D behavior of chinese manufacturing firms: based on a survey of the manufacturing firms

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)

in Jiangsu province [J]. Economic Research Journal（02）：21-30.

Yun Xia.(2014) Manager Power，Equity Incentive and R＆D Investments—An Empirical Research on Chinese Listed Companies [J]. R&D Management. 26(4):12-22

Zeff,S.A.The rise of economic consequences[J].The Journal of Accountancy, 1978, December.

ISSN: 2052-6393(Print), ISSN: 2052-6407(Online)