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An Empirical Study of R&D Intensity in Chinese Firms

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Abstract

This study examines how the R&D intensity of Chinese firms relates to their performance. Also, it also explores how the different corporate governance systems moderate this relationship. To address the research question, a multiple-regression model was analyzed. All subsidiaries were excluded from a multi-year (2009-2014) sample to avoid the potential distortion. Pearson correlations indicate a highly significant relation of R&D intensity with firm performance. Thus, Variance Inflation Factors (VIFs) were checked for possible multicollinearity. All VIFs were within the acceptable range, below 10. Thus, we can confirm the absence of multicollinearity. The multiple-regression analysis showed that R&D intensity significantly and positively relates to the performance of Chinese firms. We also found that both CEO stock ownership and the separation between the board chair and CEO strengthen this positive relationship. However, the outsider ratio of the board was found to negatively moderate the R&D intensity-performance relationship of sample firms. The findings imply that the R&D investment of Chinese firms contributes to increasing firm performance. The positive impact of R&D investment on performance is intensified when firms effectively monitor the decisions of their top managers. Thus, this study provides practical guidelines for Chinese companies undertaking R&D management. The findings imply that Chinese firms may achieve more positive outcomes when they effectively use their governance

systems to monitor their top managers' decisions on R&D investments.

Key Words : R&D investment, Agency theory, Corporate governance system, Chinese firms

1 INTRODUCTION

Effective R&D management has been considered a critical factor for firms to gain a sustainable competitive advantage (Hanel et al., 2002). However, the outcome of R&D investment is often uncertain. Such investments are unique and long-term by nature (Bartlett and Ghoshal, 1989). In addition, investment may negatively affect the short-term performance of firms (Holmstrom, 1989). Therefore, the decision regarding the investment on R&D activities is one of the most difficult tasks of top managers (Hoskisson et al., 1993). There have been many researches on the field of innovation management. However, little is known about how investment decisions on R&D activities are practically determined by top managers under various internal and external controlling mechanisms, and their complex impacts on firm performance is unclear (Greve, 2003).

Understanding how corporate governance systems influence the R&D investment is essential. However, the prior research on innovation management has not clarified the various and complex impacts of corporate governance systems on different types of stakeholders including shareholders, board of directors, employees, banks, government, or suppliers (Dosi et al., 2003). As a result, it is not clear how to employ different types of corporate governance systems to effectively minimize a firm's agency costs.

According to agency theorists, there is high possibility managers adopt opportunistic behaviors when there are information asymmetry and different risk profiles between managers and shareholders. Top managers could exhibit opportunistic behaviors when verifying the outcomes of a specific investment is not straightforward. In those settings, incentive mechanisms maybe beneficial to reconcile the interests of executives with the interests of shareholders regarding R&D investment and innovation activities (Hoskission, 1994). Agency theorists argued that incentive mechanisms could function as a monitoring system for the opportunistic behaviors of top managers, inducing top managers to take higher risk on R&D

investment decisions. However, corporate governance systems include various and more complex mechanisms besides compensation systems. It is very likely that strategic decision-making and behavior in R&D investment and creative activities and the influence on firms' outcomes are simultaneously affected by different governance systems. This suggestion has been made by researchers who work on the field of governance mechanisms. They deal with governance systems to suggest the most efficient governance mechanisms depending on environmental situations (Danielsona and Karpoffb, 1998; Gompers et al., 2003). However, researchers did not examine the effects of multiple governance systems on innovation activities. Instead, they focused on analyzing the effects of a specific governance system on strategic outcomes.

The primary goal of present study is to deal with this limitation in the areas of innovation research by investigating the relation of R&D investment of Chinese firms with their performance, as well as the moderating effects of governance systems on the R&D investment-performance relationship. Adopting the 343 largest publicly listed companies in China, we investigate the impact of the CEO stock ownership, the separation of the board chair with CEO, and the proportion of outsider members in the board on the R&D intensity-performance relationship. This study contributes to the development of the theories in corporate governance mechanisms and practices concerning R&D investment and its impact on performance. A set of corporate governance systems was examined in the proposed model, rather than focusing on one single dimension. Thus, the proposed empirical model allows us to analyze the complex and complementary impacts of different governance systems. Emphasizing the relationships between principles and agents allows us to examine the fundamental promises of agency theory regarding R&D investment. This study also provides empirical evidence on Chinese firms. Thus, it complements prior researches, which mostly concentrated on Western developed markets, including the United States (Becker-Blease, 2011), France (Lhuillery, 2011), and the United Kingdom (Driver and Guedes, 2012).

2 LITERATURE REVIEW

A. R&D Intensity and Corporate Governance system

Publicly-held modern corporations are characterized by a separation between management decision making and operational functions characterized by risk bearing. Top managers try to avoid the risk as they are mainly responsible for strategic decision making and operational functions. On the other hand, shareholders, as residual claimants, bear the most part of the risk deriving from the decisions of the top managers (Ross, 1973). While the separation between ownership and management is an efficient tool to guarantee the existence and operation of corporations, it often induces agency problems between decision makers and owners (Eisenhardt, 1989). Thus, since the 1970s, researchers have investigated the relationships between managers and shareholders of publicly-held modern corporations. The existing literature defines this link as an agency relationship and refers to the related issues as agency problems (Dalton et al., 1998). Agency theorists argue that shareholders conflict with shareholders because managers have different needs in comparison with shareholder. Researchers assume that a manager, as an agent, can be motivated by self-interest. They If their own interest motivates both a manager and a shareholder, managers are more likely to pursue less-risky goals than shareholder expects (Fama and Jensen, 1983). Therefore, shareholders should utilize corporate governance systems to prevent the potential adverse effects of self-interested managers (Pratt and Zeckhauser, 1987).

In the agency relationship between managers and shareholders, corporate governance systems are believed as useful tools for protecting the needs and interest of shareholders. A corporate governance system is defined as the group of monitoring systems existed in inside and/or outside the firms. Such conflicts are believed to arise from the separation between ownership and control. Corporate government systems are thought to align the decision-making and behavior of top managers with the interests of shareholders. In particular, effective corporate governance systems may help assure the long-term strategic investment and maximum returns to shareholders. In most cases, they can improve the quality of the decision-making of managers as well as firm valuations in the mar-

ket (Yao and Applebaum, 2009).

Agency theorists argue that the conflict between managers and shareholders has substantial implications for the R&D investment of firms. First, as mentioned above, the objective of shareholders can differ from that of managers. As a result, the degree of risk that managers are willing to bear may not be in line with that of shareholders. Second, because of information asymmetries between managers and shareholders, it is very hard and costly for shareholders to predict the decisions and behaviors of managers in advance. Agency theorists assume that the objective of shareholders is to increase the return as a benefit in return for investment. On the other hand, managers focus on the continuity of their job and higher compensation for their work. In terms of attitude and risk profile, managers are thought to have a risk-averse attitude, while shareholders often reveal a risk-neutral tendency. Managers cannot diversify their risk, while shareholders can do that in the market. Therefore, managers value more short-term, efficiency-seeking strategies. However, the tendency of managers to focus on the short term can be weakened by corporate governance systems. Scholars in the standard agency theory argue that corporate governance systems can induce managers to intensify the investment on R&D activities and maximize the value of shareholders (Agrwal and Chadha, 2005).

However, some scholars have provided alternative perspectives, which highlight the high-pressure exercised by shareholders on managers aimed at focusing more on short-terms investment than on R&D activities (Laverty, 1996). The investment on R&D is risky. The outcomes of R&D activities are also uncertain because R&D activities require lots of tacit knowledge. Managers who monitor R&D activities know the opportunities and potential influence of these activities on long-term performance better than shareholders. Furthermore, due to the above-mentioned reasons, managers will have a difficulty to precisely outline the expected outcomes of R&D activities to the shareholders, particularly minority shareholders. Therefore, shareholders are overall less likely to understand the features of R&D activities and their potential impact on future firm performance. Whereas shareholders are more likely detected on the expenses of R&D activities and their adverse impact on short-term financial performance. This difficulty can lead shareholders

not to comprehend or less concern the impact of R&D activities. Rather, they will more likely focus on value maximization activities of firms in the short-term (Lazonick and O'Sullivan, 2010). As a consequence, shareholders often place a significant burden on top managers to decrease the investment in R&D activities.

According to this perspective, the studies with empirical analysis seem to contradict the standard agency theory. In particular, they showed that implementing governance systems targeted to protecting the interest of shareholders can decrease the investment in R&D activities and innovation (Coelho et al., 2012). For instance, focusing on US companies, some recent studies found that increasing market monitoring and intensifying financial controlling systems may result in decreased R&D activities and innovation-related outcomes (Shadab, 2009). However, the empirical support for this alternative perspective is limited to the US. For instance, a researcher found that the governance systems that have priority on the interest of shareholders have a positive influence on the R&D activities of 110 publicly-held French companies. Compensation systems and voting policies were an exception, as they do not significantly change the R&D investment of sample firms (Becker-Blease, 2011). Another exception is reported by a study of 91 UK corporations (Lhuillery, 2011).

The findings of prior researches imply that the relationship of R&D management with corporate governance systems differ across countries. Thus, the research on this issue should be further expanded, addressing various settings. To address this issue, the present study focuses on a sample of Chinese corporations that achieved a fast development in the recent years.

B. Corporate Governance System of Chinese Corporations

After 1980s, the government of China has carried on several reforms. China was a centrally planned economic system. Most corporate shares were held by the government and state institutions. However, during the last four decades, the Chinese economic system has significantly changed. The ownership structure of both government- and state-owned firms has been rapidly transformed under the guidance of the government. Furthermore, to liberalize the economic system as a whole, the reforms initiated by the Chi-

nese government have been extended to privately-held companies, which changed their ownership structures as well as operational methods (Hussain and Mallin, 2003). As a result, a large share of Chinese firms is owned by private shareholders at present.

Those changes in the market system and ownership structure have led to various transformations in the corporate governance systems of Chinese firms. In particular, several companies began to establish internal governance systems, altered their ownership structure, and transformed it into an internal governance system. Several companies also developed internal governance polices and identified the board of directors as the firm's highest decision-making body (Lin, 2004). The Chinese government gave more autonomy to the management teams and encouraged them to exercise more power in key decision-making and operation of companies. Various types of firms are now allowed to retain and share their profit (Michael et al, 2006). Furthermore, the government assigned ten specific functions to the boards of Chinese firms introducing a new Corporate Law in 1994. Based on this law, the board of directors acquired the authority to make key decisions regarding the corporate management, including decisions about mergers and acquisitions, investment on new product development, etc. As it takes the final decision regarding the corporate management and top manager's compensation, the board of directors also became eligible to punish inappropriate behavior of executives (Wei, 2007).

These changes in the economic systems and policies made the corporate governance systems of Chinese firms similar to those of Western companies. However, there are still some distinct features in the corporate governance mechanisms of Chinese firms. First, the ownership of many firms, especially public enterprises, is still highly concentrated on a small number of parties, despite the Corporate Law of 1994. This is a very distinguished feature compared to the corporate governance systems of Western companies, which are characterized by a very diffused ownership structure. Second, despite the continuous privatization of government- or state-owned firms, many public institutes are still controlling the ownership of various types of firms. They often exercise an unparalleled level of power in the strategic decision-making of top managers. Third, many companies have the power to control other listed firms as they often retain a substantial portion of their shares. This unique

ownership structure allows many Chinese firms to extract various gains, especially a tacit consent from other firms regardless the disagreement of minority owners. Fourth, there was no official market for corporate control in China before 2007. As pointed out earlier, a substantial share of Chinese firms had been held by the government- and state-owned institutions. In the past, corporate control was not tradable on the market, but the situation changed in 2007, when untraded shares formally moved to the open market. Since then, market competition for corporate control as an external governance system prevailed. However, more than half of the larger block of shares in Chinese firms are still owned by government- or state-owned institutions. Unlike private investors, those entities are not just concerned with the maximization of shareholder value. Their concern includes several macroeconomic and political issues, which influence their decision-making regarding the firm management.

3 METHODOLOGY AND RESULTS

This study focuses on the manufacturing and service sectors in China. The importance of R&D investment to achieve an innovation varies across industries. Therefore, we consider firms in various manufacturing and services industries operating in the Chinese market. This sampling method aims at increasing the generalizability of the research findings. In particular, we adopted a multi-year (2009-2014) approach to building a sample of Chinese firms in the chemical, pharmaceutical, industrial machinery and tools, computer, communication equipment, electronic equipment, precision machinery, medical equipment, and chemical appliances industries. In addition, we excluded all subsidiaries from the sample to minimize the distortion potentially caused by corporate governance systems.

The information regarding the R&D investment of the sample firms was obtained from the statistical yearbook of Chinese high-tech firms from 2009 to 2014. The independent variable, R&D intensity, was calculated by the ratio of R&D cost to sales profit. We adopted three different corporate governance mechanisms-the ratio of CEO ownership, the ratio or outside board members, and the separation of the board chair with the CEO- as moderating

variables in the analysis. We measured the ratio of CEO ownership by dividing the CEO stake by the total number of shares and, then, we multiplied this value by 100. To measure the ratio of outside board members, the number of outside board was divided by the total number of board, and, then, we multiplied this value by 100. Finally, the separation between the board chair and the CEO was introduced in the model as a dummy variable. We searched the CSMR and the iFinD database to obtain all information regarding the governance systems. A market-based performance measure is generally assumed to be superior to an accounting-based performance indicator to evaluate the performance implications of governance systems. Thus, in this study, we adapt the Tobin's Q, calculated by the "market value/replacement cost," to assess firm performance.

Table 1 reports the means and standard deviations and the correlation matrix of key variables of study. A review of the correlations indicates a significantly positive relation of the R&D intensity with Tobin's Q. Therefore, Variance Inflation Factors (VIFs) of variables were checked for possible multicollinearity. All of the variance influence factors are within the acceptable range, below 10, indicating no multicollinearity in the regression analysis.

TABLE I
DESCRIPTIVE STATISTICS AND CORRELATIONS

Var.	Mean	S.D.	1	2	3	4	5	6	7	8
1.	2.42	1.94								
2.	4.78	4.68	.46**							
3.	5.61	8.59	.23**	.17**						
4.	36.88	5.43	-.08*	.04	-.03					
5.	0.68	0.47	.26**	.25**	.46**	.10**				
6.	8.51	4.37	-.30**	-.20**	-.43**	.11**	.18**			
7.	40.13	18.26	-.51**	-.36**	-.18**	.05	.13**	.22**		
8.	21.70	0.93	-.39**	-.16**	-.30**	.09**	.23**	.46**	.35**	
9.	0.83	0.37	-.22**	-.26**	-.04	-.03	.02	.06	-.03	-.05

1. Tobin's Q
2. R&D Intensity
3. CEO Ownership
4. Board Outsiders Ratio
5. CEO/Board Chair Duality

6.	Firm Age
7.	Debt Ratio
8.	Firm Size
9.	Type of Industry

*<.05; **<.01, N=343

In this study, we did a multiple-regression model as an empirical examination. We control the effects of the firm age, size, debt ratio, and industry type in the analysis. To measure the debt ratio, we divide the debt by equity amount. Firm size was measured as the logarithm of the value of capital. Finally, the type of industry was introduced in the model as a dummy variable (1= if a firm operates in the manufacturing industry, 0= otherwise). Table 2 represents the findings of the multiple regression analysis.

According to the findings of a multiple-regression analysis, there is significantly positive relationship between the R&D intensity of Chinese companies and their performance. Furthermore, some corporate governance systems have moderating effects on this relation of R&D intensity with firm performance. In particular, the results indicate that CEO stock ownership has positive impact on the relation of R&D intensity with the performance of Chinese firms. The separation of the board chair with the CEO also strengthens the positive relation of R&D intensity with performance. Whereas, the percentage of outside members in the board was found to negatively moderate the R&D intensity-performance relationship in Chinese firms. Regarding to the control variables, firm age presents negatively significant impacts on the performance of Chinese firms. This finding implies that, as a firm become older, it tends to achieve a lower performance level. The debt ratio also shows a negative and significant relationship with the performance of Chinese firms. Furthermore, firm size reveals a significant a negative impact on R&D investment. Finally, the type of industry presents a significantly negative impact on firm performance, meaning that companies in the service industries are characterized by a higher performance level compared to firms in the manufacturing industries in China.

TABLE II
RESULTS OF MULTIPLE REGRESSION ANALYSIS

Variable	Model 1	Model 2	Model 3
Firm Age	-.09 (-2.70)**	-.06 (-1.95)*	-.07 (-2.01)*
Debt Ratio	-.43 (-13.85)**	-.34 (-10.8)**	-.33 (-10)**
Firm Size	-.22 (-6.44)**	-.22 (-6.65)**	-.19 (-5.7)**
Type of Industry	-.25 (-8.61)**	-.18 (-6.28)**	-.13 (-2.1)**
R&D Intensity		.24 (7.68)**	-.15 (-4.9)**
CEO Ownership			.85 (3.13)**
Board Outsiders Ratio			-.07 (-1.06)
CEO/Board Chair Duality			-.02 (-.47)
R&D*CEO Ownership			.15 (1.20)*
R&D*Board Outsiders Ratio			-.61 (-2.30)*
R&D*Duality			.12 (2.54)*
R^2	0.386	0.430	0.452
F-statistic	117.85***	113.46***	56.72***
ΔR^2		0.045	0.026
Change in F		58.95***	5.78***

* $p < .05$; ** $p < .01$.
Standardized regression coefficients are reported.
T-test results are in parentheses.

4 CONCLUSION

Drawing on agency theory, this study explores the relationship between R&D intensity and performance of Chinese firms, as well as the moderating effects of various corporate governance systems. An empirical analysis was implemented on a multi-year sample of 343 Chinese firms.

The findings improve the understanding of the relationship between R&D investment and the performance of Chinese firms. In

particular, R&D investment is found to have a positive and significant impact on firm performance. Furthermore, the results indicate that both CEO stock ownership and the separation of the board chair form the CEO strengthen the positive relationship between R&D intensity and firm performance. However, contrary to expectation, the outsider ratio in the board composition was found to negatively moderate the R&D intensity-performance relationship in Chinese firms.

The findings of this study provide important implication for both researchers and practitioners, showing that R&D investment is beneficial for increasing the performance level of Chinese firms. They also imply that R&D investment may have a more positive influence on Chinese firms that effectively monitor and control the decisions of their top managers through governance systems. Thus, this study provides practical guidelines for Chinese firms undertaking R&D management. Effective governance systems should be introduced to intensify the positive impacts of R&D investment on performance. Firms that are not able to effectively monitor and control the decision of top managers regarding their R&D management may not experience positive net gains from R&D investment. In addition, this study contributes to the innovation strategy literature by focusing on an emerging market and incorporating variables related to the corporate management system to test for R&D management.

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