

An Empirical Investigation on the Impact of Corporate Governance Structure on R&D Intensity: The Case of Information Technology Industry in China

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Abstract: R&D is an important factor for companies to achieve sustainable development. Exploring the relationship between R&D investment and corporate governance structure is of great importance for companies to conduct innovation and improve corporate governance structure. This paper investigates the impact of corporate governance structure on R&D intensity of firms. The empirical results show that both the number of top management shareholdings and equity concentration has significant positive effects on corporate R&D intensity.

Keywords: corporate governance, R&D intensity, information technology industry

I. Introduction

Innovation is of strategic importance to the development of firms, and it is an important driving force for firms and even countries to achieve sustainable growth. On the one hand, R&D investments can enhance the competitiveness of firms with improved absorptive capacity and technological innovation capabilities. On the other hand, the main characteristics of R&D activities, such as high risk and return uncertainty, which determines that it may bring long-term returns while carrying great uncertainty and high risk, which largely restricts the investment in R&D projects.

Given the importance of R&D investments, there is a large amount literature on factors influencing R&D expenditures. Early literature mainly focused on factors external to firms, such as market concentration and industry life cycles. Recent literature has been paying attention to the impact of internal factors on R&D investment. For example, Patrik & Andreas (2003) explored the effects of firm size, competitive positions, technological opportunities, technological spillovers, capital intensity, human capital and form of ownership on firm R&D investment using micro data on firms during the period 1990-1999. The purpose of this paper is to systematically investigate how various corporate governance structure characteristics affect corporate R&D intensity and then propose managerial implications for firms to achieve sustainable growth.

II. Literature review and research hypothesis

2.1 Literature Review

In the last decades, scholars have gradually recognized the influence of micro-level factors such as firm size, financial

resources, and corporate governance on R&D investments. Soete (1979) used R&D expenditure to measure R&D investments, and found that the ratio of R&D expenditure to sales increases with the size of the firms. Barke & Muller (2002) argued that the CEO's background has a greater impact on the firm's R&D investment than other factors and that CEOs maximize their own interests by changing R&D investments as their tenure progresses. Jensen & Murphy (1990) argued that a large CEO shareholding aligns the benefits with the wealth of the firm's shareholders, and that CEOs with equity in their firms will invest more in R&D in order to increase the firm's profitability and competitiveness. Hambrick & Fukutami (1991) found that older executives have greater difficulty in accepting new knowledge and skills, so elder CEOs are less likely to invest in R&D. Compared to factors such as age, shareholding status and percentage, there is very limited literature on the impact of executives' education, professional background and work experience on R&D investments. Changan & Sambharya (1987) examined the tobacco industry and found that if firms adopted a product innovation strategy, it would be related to more executives with production skills and R&D backgrounds and fewer executives with financial backgrounds. Shleifer & Vishny (1986) also showed that institutional investors can effectively constrain managers with the aim of maximizing firms' shareholder interests and reduce the opportunistic behavior of managers. Despite the increasing importance of institutional investors in listed companies, there is much uncertainty regarding its impact on corporate governance. Some scholars argued that institutional investors care only about the short-term returns on their investments rather than the long-term growth of firms (Wahal, 1996; Webb et al., 2003).

2.2 Research hypothesis

Corporate governance structure determines, to a certain extent, the R&D investment decisions of a company. Five dimensions which reflect corporate governance are as follows: board structure, the ratio of management shareholding, the status of state-owned shareholding, equity concentration, and intensity of board meetings.

Generally speaking, independent directors are independent of the company's shareholders and do not serve as employees of the company. They are not involved in company-specific operations, and can make independent judgments on the company's affairs, i.e., independent directors are responsible for the listed company and all shareholders. At present, the governance structure of China's listed companies is not perfect, and the close relationship between the corporate directors and the CEO of the company leads to the decrease of the supervisory power of the corporate directors. Since the independent directors are independent of the management, and are generally experts in economics, law, etc., to a large extent they can express their opinions more objectively and fairly, and may contribute to R&D investment decisions. Therefore, H1 is proposed as follows:

H1: The greater the proportion of independent directors to board members, the higher the R&D intensity.

R&D investments are very difficult for outside investors to monitor. As a relatively low-cost incentive, equity holdings providing management executives certain shares and making them subject to the same degree of risk as shareholders. When executives hold more shares, they will pay more attention to the long-term growth of the company, and investment in R&D is important for the long-term development of the company. Therefore, H2 is proposed as follows:

H2: The higher the percentage of shares held by management, the higher the R&D intensity of the company

The state, as a shareholder of the enterprise, often performs a series of supervisory and management actions indirectly through the government, whose goal, unlike that of ordinary shareholders, is not to maximize the profit of the enterprise, but rather to take into account the current state of society as a whole, such as expanding employment, and therefore lacks the incentive to effectively supervise managers. State-owned company is a company in which the

proportion of state equity is high (generally with 50% as the dividing line) in the total shares of the company and the state is the actual controller of the company. In this case, the ultimate controller (manager) of the company is generally reluctant to carry out risky R&D investments. Therefore, H3 is proposed as follows:

H3: State-owned firms will invest less in R&D than non-state-owned firms.

In recent years, the influence of equity concentration of listed companies on R&D investment has gradually gained attention. Equity concentration is generally measured by the squared sum of the shareholdings of the top ten shareholders or the logarithm of the squared sum of the shareholdings of the top ten shareholders. Some scholars believe that when equity is relatively concentrated, they are more willing to spend time to supervise managers. Others held that when equity is more concentrated, shareholders' interests will be more closely related to corporate innovation, and shareholders will actively supervise corporate innovation, so it has a promotional effect on R&D investment. Therefore, H4 is proposed as follows:

H4: The higher the concentration of equity, the higher the R&D intensity of the firm.

Board meeting intensity is often used as a measure of board involvements in corporate governance, which is generally expressed in terms of the number of meetings. Boards of directors exercise rights in the simplest way by holding board meetings, and some studies have shown that changing the intensity of board meetings can improve corporate governance outcomes more easily and effectively than changing the board structure or ownership structure, and at a lower cost than the former two. In other words, the more frequently the board meetings are held, the more timely the board members can address the current problems of the company, including the problems in R&D investment activities, and ensure that the projects can be carried out smoothly.

Hypothesis H5: The higher the intensity of board meetings, the higher the R&D intensity of the company.

III. Research design

3.1 Sample and data sources

In this paper, the cross-sectional data of all listed companies in the information technology industry traded on the Shanghai Stock Exchange and Shenzhen Stock Exchange in 2012 are selected as the sample. To ensure the validity of the data, ST companies and companies without relevant information are excluded, and a total of 185 listed companies in the information technology industry are taken as the sample. The governance characteristics and other financial data of listed companies used in this paper are obtained from the China Stock Market & Accounting Research Database, and the final data of various variables are calculated by compiling the data in the annual reports published by listed companies.

3.2 Variables

3.2.1 Dependent variable: R&D intensity

Because listed companies in China generally do not disclose R&D investment data separately, the data of R&D investment is usually not directly available. There are various methods to measure the intensity of R&D investment, such as R&D expenditure per capita, R&D expenditure or the ratio of R&D expenditure to sales revenue, etc. The ratio of R&D expenditure to sales revenue is one of the most used indicators. Statistics show that most listed companies attribute R&D expenses to "other cash flows paid in relation to operating activities. Therefore, in this paper, we take the data of "other cash flow related to operating activities" in the cash flow statement of listed companies as the R&D expenditure roughly; meanwhile, we take the item of "operating income" in the income statement as the sales revenue, so as to calculate the R&D intensity.

3.2.2 Independent variables

(1)The ratio of independent directors (OUT_RATIO), which is used as a proxy of the board structure. It is expressed as the ratio of the number of independent directors to the size of the board of directors.

(2)The management shareholding ratio (MSR), which reflects the level of equity incentives for executives, is expressed as the ratio of the total shareholding of management to the total equity capital of the company.

(3) The proportion of state-owned shares (POSO), which is used to indicate whether a listed company has state-owned shares and the number of state-owned shares, expressed as a ratio of the total number of state-owned shares to the total equity capital of the company.

(4) Concentration of equity (CSTR10), which is also used as a measure of equity structure, generally refers to the concentration of shareholdings of the top ten shareholders, and is often expressed as the sum of the squares of the shareholdings of the top ten shareholders or the logarithm of the sum of the squares of the number of shares held by the top ten shareholders. In this paper we use the former approach to represent it.

(5) Board meeting intensity (MEET_BOARD), which, as the name suggests, measures the frequency of the board's meetings, can be obtained directly from the database and does not need to be calculated.

3.2.3 Control variables

In this paper, firm size is set as a control variable, specifically represented by the leverage ratio (ROL).

IV. Empirical results

4.1 Descriptive statistical analysis

Table 1 presents the descriptive statistical results of each variable.

Table 1 Descriptive statistics

Variables	N	Minimal value	Maximum value	Mean	Standard deviation
R&D	185	0.0000	4.1996	0.1722	0.3173
OUT_RATIO	185	0.3077	0.6000	0.3736	0.0504
MSR	185	0.0000	0.6814	0.1393	0.1903
POSO	185	0.0000	0.7997	0.0469	0.1420
CSTR10	185	0.0093	0.4916	0.1508	0.0973
MEET_BOARD	185	3	20	9.37	2.896
ROL	185	0.0110	8.2564	0.3244	0.6141

4.2 Regression analysis

4.2.1 Overall goodness of fit of the model

Table 2 shows the goodness-of-fit test for the sample data, which detects the extent to which the sample data fall in the area of the regression line. Since this regression equation has multiple independent variables, the goodness-of-fit should be measured based on the adjusted coefficient of determination.

Table 2 Model Summary

Model	R	R ²	Adj-R ²	Standard Error
1	0.340	0.115	0.075	7.5203E8

a. Predictor variables: (constant), leverage ratio, number of board meetings, equity concentration, number of state-owned shares, number of executive shareholdings, and number of independent directors.

b. Dependent variable: R&D intensity

According to Table 3, the significance test of the regression equation can be performed, in which the total sum of squares of the independent variables is 18.520, the sum of squares of the regression and the sum of squares of the residuals are 17.657 and 0.863, respectively., The observed value of the F-test statistic is 1.075. Since the corresponding probability P-value is 0.0006, it means that the regression coefficients are not simultaneously equal to zero. The linear relationship between the dependent variable and all independent variables is significant, and the established linear model is valid.

Table 3 ANOVA table

Models	Sum of Square	df	Mean Square	F-value	Sig
Residuals	0.863	8	0.108	1.075	0.005 ^a
Regression	17.657	176	0.100		
Total	18.520	184			

a. Predictor variables: (constant), leverage ratio, number of board meetings, equity concentration, number of state-owned shares, number of executive shareholdings, and number of independent directors.

b. Dependent variable: R&D intensity

4.2.2 Regression results

As can be seen from Table 4, except for the number of management shareholdings and equity concentration, which passed the significance test, all other variables failed the test, i.e., H2 and H4 were confirmed and all other hypotheses were not supported.

Table 4 Regression results

Model	coefficient	Standard Error	t-value	Sig.	VIF
(Constant)	0.407	0.164	2.484	0.014	
OUT_RATIO	-0.013	0.073	-0.181	0.857	3.350
MSR	7.048E-10	0.000	2.038	0.043	1.093
POSO	-4.745E-11	0.000	-0.216	0.830	1.057
CSTR10	-0.494	0.248	-1.994	0.048	1.065
MEET_BOARD	-0.007	0.009	-0.765	0.445	1.232
ROL	-0.008	0.039	-0.202	0.840	1.236

V. Conclusions

The purpose of this paper is to investigate the relationship between corporate governance structure and R&D investments. The main findings are as follows:

(1) There is a positive effect of the percentage of management shareholdings on the R&D intensity, which indicates that the equity incentive for management can indeed motivate them to participate more attentively in the governance of the company, link the rise and fall of the company with their own remuneration bonuses, and focus on the long-term growth of the company rather than just the short-term returns.

(2) There is a positive effect of equity concentration on corporate R&D intensity, demonstrating that when the equity

of a company is more concentrated, the majority shareholders are more willing to pay attention to monitor the managers' decisions and the company's operation because a large portion of their own interests are involved. The number (or proportion) of state-owned shares inevitably comes to mind when equity concentration is mentioned. In this study, no significant relationship was found between the number of state-owned shares and R&D intensity, largely due to the fact that the proportion of selected IT industry companies with state-owned shares was too small, resulting in insignificant findings.

The limitations of this paper are, firstly, for the measurement of the dependent variable, since most companies list R&D expenditure as "other cash flows paid in connection with operating activities", but there is a lack of sufficient data to support which part of it is R&D expenditure. Secondly, cross-sectional data are used in this study fails to consider the long-term impact of corporate governance structure on R&D intensity.

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