The impact of R&D investment on the value of construction companies based on engineering management

Ruijie Xin¹ and Hejie Sun²

¹School of Economics and Management, Beijing Jiaotong University, Beijing, 100044, China
²School of Economics and Management, Beijing Jiaotong University, Beijing, 100044, China
*Corresponding author’s e-mail: 18120669@bjtu.edu.cn

Abstract. This paper takes the construction enterprises listed on China's Shanghai and Shenzhen stocks in 2016-2018 as a research sample, introduces management power as a regulatory variable, and studies the regulatory effect of management power on the relationship between R&D investment and corporate value. The study found that R&D investment has a significant impact on company performance, and management power has a regulatory effect on this outcome. This study provides a new perspective for Chinese construction companies to examine the impact of R&D intensity on corporate value. It also provides advice on the value enhancement of companies with multiple engineering management projects.

1. Introduction
In recent years, the state has attached great importance to independent innovation of enterprises. To survive and develop, enterprises must accelerate independent technological innovation, continuously improve their own comprehensive competitiveness, and enhance corporate value. However, enterprise value is affected by many aspects, among which the R&D innovation of enterprises and the effective management of managers are important influencing factors.

On the one hand, most studies show that the investment of Research & Development (R&D) may lead to positive firm’s value and performance. Tassey used high-tech enterprises as a sample to demonstrate a positive correlation between company R&D expenditure and company performance [1]. Cheng Hongwei found that R&D intensity is positively related to company performance, but the positive impact is weakening year by year [2]. On the other hand, in companies with agency problems, the will of top managers plays a leading role in the decision-making of innovation activities. How they use the power to balance the proportion of innovation investment is an important factor affecting the value of enterprises. Most studies only study the impact of a single dimension of management power on corporate value, which is one-sided. Quan Xiaofeng’s research found that the greater the CEO’s power, the better the company’s operating performance, but the business risk increases [3]. Hambrick used management's tenure to measure management power and found that the CEO’s tenure and corporate value were in a U-shaped relationship [4].

This paper takes the construction enterprises listed in China's A-shares from 2016 to 2018 as a research sample, uses hierarchical regression method to explore the regulatory role of construction enterprise management power on the relationship between R&D investment and corporate value. The sample is then divided into two groups— state-owned subsample and non-state-owned subsample to
study whether the moderating role of management power will be different in different equity nature.

2. Hypothesis argumentation and research hypothesis
R&D investment itself does not bring about an increase in corporate value, and its contribution to corporate value depends on whether it is effectively utilized. In practice, the management controls the allocation of residual control rights and claims, influences the technological innovation activities of the enterprise, and affects the company's short-term performance and long-term value [5]. Because R&D investment projects have the characteristics of high sunk cost, long cycle and high risk, the management tends to pay more attention to the short-term benefits of the enterprise due to the consideration of their own reputation, salary and other personal interests, which will reduce the R&D investment projects. Finkelstein divides management power into four dimensions: prestige power, structural power, ownership power, and expert power, depending on the source of power [6]. Then it triggers a series of studies on the influence of management power on company operations. Therefore, the positive effect of R&D on corporate value is partly influenced by management power: with the increase of management power, higher investment in technology innovation will increase agency costs, which may not necessarily lead to an increase in corporate value. Therefore, this paper deduces the following hypothesis:

\( H_1 \): Management power has a negative regulatory effect on the relationship between R&D investment and corporate value.

The behaviour of state-owned listed companies is not only restricted by laws, policies, market competition, but also by the supervision of higher-level government departments [7]. Relatively speaking, the management of non-state-owned enterprises enjoys greater power and is subject to less supervision. Therefore, from the perspective of the constraint mechanism, the management of non-state-owned listed companies is more likely to control R&D investment projects, which in turn affects corporate value. Based on the above analysis, this paper proposes the second hypothesis:

\( H_{2a} \): In state-owned enterprises, management power has a regulatory effect on the relationship between R&D investment and corporate value.

\( H_{2b} \): In non-state-owned enterprises, management power has a regulatory effect on the relationship between R&D investment and corporate value.

3. Data sources and sample selection
This paper takes the construction enterprises listed on China's Shanghai and Shenzhen stocks in 2016-2018 as a research sample. This paper eliminates the special treatment (ST) firms and the incomplete and abnormal samples, and obtained 307 samples from 77 listed companies.

4. The design of variables and construction of model
4.1 Variable
This article chooses Tobin's Q (tbq) as dependent variables to measure corporate value.

\[ \text{tbq} = \frac{\text{stock market value + net debt market value}}{\text{total assets}}. \]

This article chooses R&D intensity (rd) as independent variables.

\[ \text{R&D intensity} = \frac{\text{R&D investment}}{\text{operating income}}. \]

This paper draws on Finkelstein's (1992) power model and other scholars' ideas, and selects the following indicators to measure management power. CEO duality(power1). This paper defines power 1 as “1” when the chairman or directors serve as firm’s CEO, otherwise, it is recorded as “0”. Board independence(power2). This paper defines power 2 as “1” when the ratio of the number of independent directors to the total number of board members is less than the sample mean, otherwise, it is recorded as “0”. Executive shareholding(power3). This paper defines power 3 as “1” when the shareholding ratio of the executive is greater than the sample mean, otherwise, it is recorded as “0”. Foreign shares(power4). This paper defines power 4 as “1” when there is no foreign stock, otherwise, it is recorded as “0”. Board size(power5). This paper defines power 5 as “1” when the size of the board of directors is larger than
the sample mean, otherwise, it is recorded as “0”.

Management power(power) is conducted as moderating variable. It is a comprehensive concept. 

\[ \text{Power} = \text{power}_1 + \text{power}_2 + \text{power}_3 + \text{power}_4 + \text{power}_5. \]

Firm’s size (SIZE), asset-liability ratio (LEV), Year-On-Year growth rate of operating income (growth), assets structure (as) are conducted as control variables.

4.2 Model

\[ \begin{align*}
\text{tbq} &= a_0 + a_1 \text{rd} + a_2 \sum \text{control} + \epsilon \\
\text{tbq} &= b_0 + b_1 \text{rd} + b_2 \text{power} + b_3 \sum \text{control} + \epsilon \\
\text{tbq} &= c_0 + c_1 \text{rd} + c_2 \text{power} + c_3 \text{rd} \times \text{power} + c_4 \sum \text{control} + \epsilon
\end{align*} \] (1)

5. Empirical analyses

5.1 Descriptive analysis

Table 1 reports descriptive analysis. As Table 1 shows, the maximum value of R&D intensity is 55, but the minimum value is only 0.01, which indicates that China’s construction enterprises have large gaps in the R&D investment. In 2016-2018, only 9.4% of the 77 sample firms disclosed the amount of R&D expenditure.

|     | N  | Min | Mean | Median | Max  | Std  |
|-----|----|-----|------|-------|------|------|
| tbq | 0.860 | 3.300 | 2.700 | 15    | 2.100 |
| rd  | 0.0100 | 9.400 | 7.200 | 55    | 7.200 |
| power | 0 | 1.900 | 2 | 5 | 1.200 |
| lev | 0.0280 | 0.350 | 0.320 | 1.700 | 0.180 |
| size | 20 | 22 | 22 | 26 | 1.100 |
| growth | -1.700 | 0.0450 | 0.0540 | 0.530 | 0.120 |
| as  | 0.00730 | 0.220 | 0.180 | 0.830 | 0.140 |

5.2 Pearson correlation analysis

Table 2 reports Pearson correlation analysis. As Table 2 shows, the R&D intensity is significantly positively correlated with the enterprise value. It is preliminarily verified that the more R&D investment, the greater the enterprise value. However, there is no significant positive correlation between management power and corporate value. The relationship needs further testing. The correlation coefficients between the explanatory variables are all less than 0.4, and there is no multicollinearity problem in the regression analysis.

|     | tbq | rd  | power | lev | size | growth | as     |
|-----|-----|-----|-------|-----|------|--------|--------|
| tbq | 1   |     |       |     |      |        |        |
| rd  | 0.2202* | 1  |       |     |      |        |        |
| power | 0.0668 | -0.0147* | 1  |     |      |        |        |
| lev  | -0.3581* | -0.2806* | -0.0645 | 1  |      |        |        |
| size | -0.5167* | -0.1962* | -0.0276 | 0.4839* | 1  |        |        |
| growth | 0.1368* | -0.0455 | 0.0347 | -0.1844* | 0.1094* | 1  |        |
| as  | 0.3037* | 0.2108* | 0.0520 | -0.2997* | -0.2089* | 0.1256* | 1  |

Note: * indicates P < 0.001 (double tail test).

5.3 Regression Analysis

In this paper, F-value test and Hausman test are used to obtain that the model 1, model 2 and model 3 should use the fixed-effects model for regression analysis.

This paper uses hierarchical regression method to verify the influence of management power on the relationship between R&D investment and corporate value. The first step is to do the regression of R&D
and enterprise value. The second step is to introduce the executive power indicator as the independent variable. The third step is to introduce the product term of the executive power and R&D intensity (rd*power) as the independent variable. The regression results are shown in Table 3. The column (1), column (2), and column (3) of Table 3 respectively examine these three processes.

It can be seen from column (3) that rd*power is significantly negative, indicating that management power has a negative regulation effect on R&D and corporate performance. And in column (2), the coefficient of power is significantly negative, which indicates that management power is a semi-regulated variable. This shows that with the increase of management power, it will weaken the effectiveness of technology innovation, which will reduce R&D activities. Hypothesis 1 is confirmed.

According to column (4) and (5), rd*power is not significant, and the power in column (4) is significantly negative. It shows that the power of management has a main effect on the value of state-owned enterprises, and it has no regulatory effect on the R&D investment of state-owned enterprises. It cannot verify the hypothesis H2a. According to column (6) and (7), rd*power is significantly negative, indicating that management power has a negative regulatory effect on R&D and corporate value in non-state-owned companies. H2b is confirmed. The possible reason is that the technological innovation capability of non-state-owned listed companies is more mature than that of state-owned listed companies, and the transformation of R&D investment into R&D output is easier to achieve. Therefore, the role of management power in the process of business management will be different. On the other hand, the sample of state-owned enterprises included in the total sample selected in this paper is less, so the test results of non-state-owned enterprises are closer to the results of the full sample test.

### Table 3. Regression analysis.

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|----------|-----|-----|-----|-----|-----|-----|-----|
| rd       | 0.0804*** | 0.0809** | 0.0332*** | 0.0402*** | 0.0430*** | 0.00990*** | 0.0377*** |
|          | (-3.69) | (-3.72) | (-1.09) | (-0.60) | (0.55) | (0.98) | (-1.15) |
| lev      | -1.138 | -1.091 | -1.102 | 1.386 | 1.492 | -0.118 | -1.292 |
|          | (-1.43) | (-1.37) | (-1.39) | (0.69) | (0.76) | (-0.25) | (-1.50) |
| size     | -4.133*** | -4.101*** | -4.071*** | -2.585*** | -2.525*** | -1.992*** | -4.280*** |
|          | (-17.01) | (-16.85) | (-16.75) | (-4.65) | (-6.60) | (-13.25) | (-16.06) |
| growth   | 2.375*** | 2.336*** | 2.275*** | -0.308 | -0.482 | 2.491*** | 2.366*** |
|          | (4.23) | (4.17) | (4.07) | (-0.15) | (-0.23) | (5.00) | (3.96) |
| as       | 3.992*** | 3.970*** | 3.921*** | -0.745 | -0.836 | 3.526*** | 4.098*** |
|          | (6.39) | (6.36) | (6.30) | (-0.36) | (-0.41) | (7.08) | (6.21) |
| power    | -0.159** | -0.388*** | -0.318* | -0.176 | -0.0964* | -0.392*** |
|          | (1.73) | (2.83) | (1.48) | (0.53) | (1.71) | (2.64) | |
| rd*power | -0.0261** | -0.0545 | -0.0233* |
|          | (-2.25) | (-1.97) | (-1.85) | |
| _cons    | 94.07*** | 93.05*** | 91.99*** | 61.75*** | 59.55*** | 26.06*** | 96.10*** |
|          | (17.86) | (17.59) | (17.37) | (4.97) | (4.84) | (14.82) | (16.64) |
| R²       | 0.401 | 0.404 | 0.408 | 0.194 | 0.223 | 0.439 |
| adj. R²  | 0.097 | 0.099 | 0.104 | -0.278 | -0.244 | 0.148 |

Note: *** indicates P<0.01; ** indicates P<0.05; * indicates P<0.1.

### 5.4 Robustness test

In order to test the reliability of the above conclusions, the paper makes the following robustness test. Using ROA instead of Tobin’s Q value as an indicator to measure the value of the enterprise, and keeping other variables unchanged, the sign and significance of the regression results have not changed substantially, indicating that the conclusion of this paper is more stable.

### 6. Conclusions and implications

This paper takes the construction enterprises listed in China's A-shares from 2016 to 2018 as a research sample, uses the fixed-effects model and hierarchical regression method to explore the regulatory role of construction enterprise management power on the relationship between R&D investment and...
corporate value. According to the regression results, the following conclusions are drawn. The R&D investment of construction companies has a significant positive correlation with corporate value, indicating that increasing R&D investment is conducive to technological innovation and corporate value. Management power has a significant negative adjustment effect on the relationship between R&D investment and construction enterprise value. In non-state-owned construction enterprises, the negative adjustment effect of management power on the relationship between R&D investment and corporate value is more obvious. Therefore, excessive management power is not only not conducive to improving corporate value, but also enables management to use its power to reduce R&D investment projects and damage shareholder interests and corporate value. In the process of corporate governance reform, we should adhere to the separation of the two powers and improve the structure of the capital market. These can effectively constrain the CEO's power and significantly increase corporate value.

The limitation of this paper is that the number of state-owned enterprises included in the selected enterprise sample is small, which may cause bias in sample selection, thus affecting the universality of conclusions. Therefore, the regulatory role of the management power of state-owned construction listed companies needs further verification.

References
[1] Tassey, G. (1983). Competitive strategies and performance of family owned supermarkets in machakos county, kenya. Journal of Economics & Business, 35(1), 0-40.
[2] Hongwei, C. (2006). Empirical research on the correlation between company's R&D investment and performance. Scientific Management Research (3), 110-113.
[3] Xiaofeng, Q. (2010). CEO power, information disclosure quality and corporate performance variability: empirical evidence from the listed companies in sze. Nankai Business Review, 13(4), 142-153.
[4] Fukutomi, H. G. D. S. (1991). The seasons of a CEO's tenure. The Academy of Management Review, 16(4), 719-742.
[5] Hart, O. (1990). Property rights and the nature of the firm. Journal of Political Economy, 98(6), 1119-1158.
[6] Finkelstein, S. (1992). Power in top management teams: dimensions, measurement, and validation. The Academy of Management Journal, 35(3), 505-538.
[7] Rui, L. (2008). Management power, on-the-go consumption and property efficiency: Evidence from Chinese Listed Companies. Nankai Management Review, 11(5), 85-92.