Data analysis of relationship between equity concentration and innovation investment

Qian Xu¹, Hongzhen Lin²

¹Wuhan University of Science and Technology, Wuhan 430034, China  
²Wuhan University of Science and Technology, Wuhan 430034, China

Corresponding author and e-mail: Hongzhen Lin, linhongzhen@wust.edu.cn

Abstract. Based on the relevant data of A-share listed high-tech enterprises in Shanghai and Shenzhen in 2014-2018, the relationship between ownership structure and innovation input is empirically studied according to the principal-agent theory and Information asymmetry theory, and combined with the intermediary effect model, further analysis of internal control in the relationship between the intermediary role. It is found that the degree of equity concentration has a negative correlation with innovation input, but has a positive correlation with internal control. The degree of equity concentration can weaken the negative influence on innovation input through the positive influence on internal control, it can be seen that internal control plays an intermediary role in the relationship between ownership concentration and innovation input. The research results can provide enlightenment for high-tech enterprises to optimize the ownership structure, improve the effectiveness of internal control, enhance innovation input and enhance the competitive advantage of science and technology.

1. Introduction

With the introduction of the "innovation-driven" strategy, enterprises continue to increase their investment in innovation and promote their own innovative development, especially high-tech enterprises. Innovation has become a core element to improve core competitiveness and promote sustainable development. Previous research on innovation investment has mainly been conducted in two aspects: one is to take innovation investment as a dependent variable and study the direct or indirect influence of corporate governance issues on innovation investment; the other is to take innovation investment as an independent variable and study the direct or indirect influence of innovation investment on innovation performance. Among the factors influencing innovation inputs, the most studied are the effects of equity structure and internal control on them. First of all, the results of research on the influence of equity concentration on innovation investment can be roughly divided into three categories: first, the theory of equity concentration promotion, large shareholders will pay more attention to long-term development [1], and companies with concentrated equity are more encouraged to innovate technology and increase investment in research and development [2]. The second is the suppression theory of equity concentration, based on investors' risk aversion psychology; equity concentration will affect the control of private benefits and negative affect innovation investment [3]. Third, the nonlinear theory of equity concentration, there are "inverted U-shaped" relationship [4], "N-shaped" relationship [5], "U-shaped" relationship [6] and other research findings proposed. Secondly, on the study of the impact of internal control on innovation investment, some results show that internal...
control will promote the positive impact of R&D investment on innovation performance [7], but some scholars have indicated that internal control is not strong on innovation investment [8]. It has also been argued that the effect of internal control on investment in innovation has the effect of promoting insignificant, tendency to inhibit, and no significant effect in firms with active innovation, moderate innovation levels, and more negative innovation, respectively [9].

However, few previous studies have examined the relationship between equity structure and innovation inputs from an internal control perspective. In view of this, this paper collects relevant data from 2014 to 2018 for Shanghai and Shenzhen A-shares, and based on the principal-agent theory and information asymmetry theory, in exploring the relationship between equity structure and innovation investment, it attempts to explore how the equity structure of high-tech firms affects innovation investment under the mediating effect of internal control as a mediating variable, which can provide a new approach from the theoretical research perspective in enhancing the study of innovation investment in high-tech firms and broaden the perspective of the study of innovation investment.

2. Theoretical analysis and research hypothesis

2.1. Ownership concentration and innovation input
Corporate governance decisions are related to the shareholding structure, and the shareholding structure naturally has an impact on the R&D investment decisions of the firm. As a knowledge- and technology-intensive entity, high-technology firms have an indispensable technological reserve for technological innovation.

Some scholars believe that equity concentration is positively effective for innovation investment, and most of these conclusions are based on the fact that equity concentration will make shareholders and their interests more closely related to the interests of the enterprise, and the major shareholders pay more attention to the long-term development interests of the enterprise [10]. But on the other hand, equity concentration will also make large shareholders take greater risks for the failure of the enterprise's investment, and shareholders will have a risk-averse psychology, and then make decisions to reduce investment in innovation, even to the detriment of small and medium shareholders [11]. Zheng Yi et al [12], based on the empirical analysis of the GEM, that the case of concentrated equity, large shareholders will be more likely to control the phenomenon of private interests and the trench effect, weakening the intensity of the enterprise's investment in innovation. High-tech enterprises need a large amount of capital investment for innovation and research and development, and the shareholding structure of high-tech enterprises is more concentrated, which is also prone to the trench effect to inhibit and weaken the innovation investment. Based on the above analysis, a hypothesis 1 is proposed.

H1: Ownership concentration is negatively correlated with investment in innovation

2.2. Ownership concentration, internal control and innovation input
Internal control is a series of self-regulation and control methods set up to ensure the basic objectives of asset integrity, financial information accuracy, and the legitimacy of enterprise operations. According to the principal-agent theory, agency problems between shareholders and managers are more likely to manifest themselves in the dispersion of equity, which leads to the dispersion of shareholders' interests.

At present, most scholars believe that internal control will have a positive impact on the enterprise's investment in innovation, effective internal control on the one hand can solve the problems brought about by information asymmetry, shareholders can obtain more real and effective information, but also the supervision and management of management, reducing the possibility of self-interested behavior of managers [13]; on the other hand, it can be more effective in assessing the risk, reducing the risk of enterprise investment in research and development. For high-tech enterprises, their technological innovation demand, investment and high risk, effective internal control not only helps enterprises to finance, but also can reasonably allocate resources, making enterprises have more funds to invest in
innovation and research and development [14], so internal control can promote the enterprise's innovation investment.

According to the above analysis, in the relationship between equity concentration, internal control and innovation input, the equity structure can not only affect innovation input, but also affect the internal control of the firm, and the internal control further affects the innovation input of the firm, indicating that the equity structure has the possibility to affect the innovation input of the firm by affecting the internal control. Based on the above analysis, Hypothesis 2 and Hypothesis 3 are proposed as follows.

H2: Equity concentration is positively correlated with internal control
H3: Equity concentration can weaken its negative effect on a firm's investment in innovation by strengthening its internal controls

3. Data source and model construction

3.1. Sample selection and data sources
In this paper, the data related to Shanghai and Shenzhen A-share listed high-tech enterprises from 2014 to 2018 were used as the research sample, and the data were screened to ensure the completeness and reliability of the data: companies with incomplete data and undisclosed internal control information were excluded, and after processing, 7155 research samples were finally left. The internal control data in this study were obtained from the DIB database, and other relevant data were obtained from the CSMAR database.

3.2. Definition of variables

3.2.1. Dependent variables. Innovation investment is usually defined as the intensity of a firm's investment in research and development, with a larger index indicating that the firm is investing more in innovation. In this paper, to make the data more concise, innovation investment is defined as R&D expenditure taking the natural logarithm and its sign is set to R&D.

3.2.2. Independent variables. Equity concentration refers to the distribution of a firm's equity, and this indicator checks whether the equity is concentrated or dispersed. In this paper, the proportion of shares held by the largest shareholder is used as a measure of equity concentration, and its symbol is set to Er.

3.2.3. Intermediate variables. Internal control refers to a series of risk prevention and control systems established by an enterprise, and good internal control contributes to the business management and development of the enterprise. In order to make the data analysis more concise, this paper divides the internal control index of the DIB database by 100 as the measurement index, and sets its symbol as IC.

3.2.4. Control variables. In addition to the above-mentioned variables, this paper also uses return on net worth, liquidity turnover, firm size, firm growth, and capital structure as control variables and sets their symbols as ROE, CAT, Size, Grow, and Lev, respectively, and uses Year as a dummy variable, and the description of each research variable is shown in Table 1.

| Variable | Variable name | Variable | Variable definition |
|----------|---------------|----------|---------------------|
| Dependent variable | Investment in R & D | R & D | R & D expenditure is taken as a natural logarithm |
| Independent variable | Ownership | Er | First largest shareholder’s stake |
| Intermediate variable | Internal | IC | DIB’s internal control index divided by 100 |
3.3. Model building

The mediating effect model in this paper refers to the model of Zhonglin Wen et al.[15]. The explained variables have a direct effect (c₁) and an indirect effect (α*b) on the explanatory variables, c is the total effect of equity concentration (X) on innovation input (Y), i.e., the sum of direct and indirect effects, and e₁, e₂, and e₃ represent the effects of other factors. The premise of the intermediary effect test is that c, α, and b are all significant, and if one of the three is not significant it means that there is no intermediary effect. If c₁ is significant it means that it is a partial mediating effect, and vice versa is a full mediating effect. Based on this, the following model is constructed in this paper.

\[ R&D = \beta_0 + \beta_1 Er + \beta_2 Roe + \beta_3 CAT + \beta_4 Size + \beta_5 Grow + \beta_6 Lev + \sum Year + \varepsilon \]

\[ IC = \alpha_0 + \alpha_1 Er + \alpha_2 Roe + \alpha_3 CAT + \alpha_4 Size + \alpha_5 Grow + \alpha_6 Lev + \sum Year + \varepsilon \]

\[ R&D = \gamma_0 + \gamma_1 Er + \gamma_2 IC + \gamma_3 Roe + \gamma_4 CAT + \gamma_5 Size + \gamma_6 Grow + \gamma_7 Lev + \sum Year + \varepsilon \]

4. Empirical test and result analysis

4.1. Descriptive statistics

According to the results of the descriptive analysis in Table 2, the difference in the level of innovation investment among high-tech enterprises is large and high on average, and the level of equity concentration among different enterprises also has a large gap between the maximum and minimum values of the control variables, indicating that there are large differences in the operating capacity, development capacity and debt service capacity among high-tech enterprises in the sample data.

| Variable | Number of | Mean value | Median | Standard | Minimum | Maximum |
|----------|-----------|------------|--------|----------|---------|---------|
| R&D      | 7155      | 7.922      | 7.862  | 0.530    | 6.280   | 10.200  |
| Er       | 7155      | 0.331      | 0.311  | 0.136    | 0.100   | 0.800   |
| IC       | 7155      | 6.520      | 6.612  | 0.723    | 1.321   | 9.084   |
4.2. Correlation analysis

Table 3 reports the correlation coefficients between the variables, and the results indicate that there is some correlation between the variables, which allows for further regression analysis.

| Variable | R & D | Er  | IC   | Roe  | Cat  | Size | Lev  | Grow |
|----------|------|-----|------|------|------|------|------|------|
| Roe      | 7155 | 0.069 | 0.069 | 0.103 | -1.277 | 0.743 |
| Cat      | 7155 | 0.835 | 0.711 | 0.660 | 0.000 | 8.972 |
| Size     | 7155 | 9.603 | 9.543 | 0.503 | 8.338 | 12.27 |
| Lev      | 7155 | 0.395 | 0.384 | 0.175 | 0.095 | 0.886 |
| Grow     | 7155 | 0.134 | 0.124 | 0.207 | -0.460 | 0.691 |

Note: ** And * are significant at 1% and 5% respectively.

4.3. Regression analysis

The regression results from model 1 in Table 4 show that equity concentration can have a negative impact on firms' innovation investment, and firms with concentrated holdings may reduce their innovation investment based on risk aversion. The regression results from model 2 conclude that equity concentration helps the effectiveness of internal control, and internal control is more effective in firms with concentrated equity than in firms with dispersed equity. Model 3 tests the mediating role of internal control in the relationship between equity concentration and innovation investment. From the test results of model 3, it is concluded that equity concentration and innovation input show a significant negative relationship, and internal control and innovation input show a significant positive relationship, according to the intermediary effect model, internal control plays an intermediary effect in the relationship between equity concentration and innovation input, and it is a partial intermediary effect. Increasing investment in innovation.

| Variable | Model 1 | Model 2 | Model 3 |
|----------|---------|---------|---------|
| Er       | -0.051 * | 0.274 ** | -0.054 * * |
|          | (-2.167) | (-4.611) | (-2.309) |
| IC       | 0.012 * |         | (-2.659) |
| Roe      | 0.235 * * | 1.838 ** | 0.212 * * |
|          | (-7.033) | (-21.614) | (-6.129) |
### 4.4. Comparative analysis of model regression results

According to Figure 2, the regression analysis of the three models is essentially linear, and the negative effect index of equity concentration on innovation inputs differs significantly from the positive effect index of equity concentration on internal control, but weakens the negative effect of equity concentration on innovation inputs to a lesser extent with the mediating effect of internal control.

![Comparison chart of three regression models](#)

**Figure 2.** Comparison chart of three regression models.

### 5. Conclusions

This paper takes high-tech enterprises listed on A-shares in Shanghai and Shenzhen from 2014 to 2018 to study the relationship between equity structure and innovation investment from the perspective of internal control, and analyze the mediating role of internal control in the relationship between the two.

In the empirical study, it is found that enterprises with relatively concentrated equity, large shareholders will be reluctant to strengthen their investment in high-risk investments based on the psychology of risk aversion, thus will reduce their investment in innovation; the concentration of equity reflects the control size of shareholders to a certain extent, and relative to enterprises with dispersed equity, the concentration of equity will make the link closer between shareholders' own
interests and the interests of the enterprise, and the protection of shareholders’ own interests will strengthen the supervision and management of the firm and enhance the quality of internal control. Equity concentration can weaken its negative impact on innovation investment through the mediating effect of internal control and this mediating effect is a partial mediating effect, the firm can enhance the level of innovation investment by strengthening the effectiveness of internal control in the presence of higher equity.

Acknowledgement
This research was supported by the National Social Science Foundation of China, Name of the project: "Entrepreneurial law education research based on risk control in science and Engineering University ". (Grant No.BIA170192.)

References
[1] Daniel Shefer, Amnon Frenkel. R&D, firm size and innovation: an empirical analysis. Technovation, vol.25, no.1, pp.25-32, 2005.
[2] Hill C W L, Snell S A. External control, corporate strategy, and firm performance in research-intensive industries. Strategic Management Journal, vol.9, no.6, pp. 577-590, 1988.
[3] Jianjun Yang, Suo Sheng. An empirical study of the effects of corporate ownership structure on technological innovation Input. Studies in Science of Science, vol.25, no.4, pp.787-792, 2007. (In Chinese)
[4] Genfu Feng, Jun Wen. An Empirical Study on Relationship between Corporate Governance and Technical Innovation of Chinese Listed Companies. China Industrial Economy, no.7, pp.91-101, 2008. (In Chinese)
[5] Fang Wen. Ownership Concentration, Outside Blockholders, and R&D Expenditure: Evidence from China’s Listed Companies. South China Journal of Economics, no.4, pp.41-52, 2008. (In Chinese)
[6] Su Zhang, Yuan-yuan Ling. The Effect of Ownership Structure on R & D Investment: Evidence from Listed Companies on the ChiNext. Journal of South China University of Technology (Social Science Edition), no.1, pp.27-35, 2014. (In Chinese)
[7] Fusheng Zhang, Lisheng Zhang, Xiaoxue Wang. R&D Input and Firm Performance - Based on the Moderating Role of Internal Control. Communication Of Finance and Accounting, no.12, pp.73-75, 2019. (In Chinese)
[8] Yuxin Liu, Liangrong Song, Lili Ruan. The Relevance of Internal Control and Sustainable Innovation Value: Empirical Evidence Based on Shanghai and Shenzhen Main Board Listed Manufacturing Companies. Productivity Research, no.6, pp. 125-130, 2017. (In Chinese)
[9] Juan Zhang, Zhizhong Huang. Internal Control, Innovation and Firm Performance: Empirical Evidence from Chinese Manufacturing Companies. Economic Management Journal, no.9, pp. 120-134, 2016. (In Chinese)
[10] Haiyun Ren. Relationship between Ownership Structure and R&D Inputs: Evidence from Listed Manufacturing Companies in China. China Soft Science, no.5, pp.126-135, 2010. (In Chinese)
[11] Li Li, Peifeng Huang, Jing Cui. The Influence of Enquity Incentive and Its Concentration on R&D Expenditure——Based on the Difference between Executive Incentive and Core Technician Incentive in Information Technology Industry. Technoeconomics & Management Research, no.2, pp. 18-22, 2020. (In Chinese)
[12] Yi Zheng, Linline Wang, Minghua Wang, et al. Correlation Test between Ownership Structure and R&D Investment Based on Empirical Evidence from Growth Enterprises Market. Science and Technology Management Research, vol.36, no.24, pp.69-76, 2016. (In Chinese)
[13] Lanlan Han. Innovation Input, Internal Control and Cost Stickiness. Research on Economics and Management, vol.39, no.10, pp.131-144, 2018. (In Chinese)
[14] Ziqin Yu. Internal control, equity structure and the conversion rate of corporate R&D investment. Communication Of Finance and Accounting, no.3, pp.107-111, 2019. (In Chinese)
[15] Zhonglin Wen, Lei Zhang, Jietai Hou, et al. Testing and Application of The Mediating Effects. Acta Psychologica Sinica, vol.36, no.5, pp.614-620, 2004. (In Chinese)