Analysis of Equity Structure and Technological Innovation in Electric Power Enterprises

——Empirical Study on A-share and H-share Listed Companies

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Abstract. The research is based on 499 listed A-share and H-share power companies from 2009 to 2023, and empirically examines the impact of equity structure and technological innovation analysis. The research results indicate that increasing the concentration of corporate equity is not conducive to promoting technological innovation in power enterprises, but increasing the concentration of equity in state-owned power enterprises is conducive to promoting technological innovation, while the balance of equity in non-state-owned enterprises has a greater effect on promoting technological innovation. Based on the research results, this article proposes targeted equity structure adjustment suggestions for different types of power enterprises, such as state-owned and non-state-owned, around the technological innovation of serving power enterprises.

Keywords: equity structure, state-owned enterprises, technological innovation

1 Introduction

With the goals of "carbon peak" and "carbon neutrality" proposed in 2020, carbon reduction transformation has been fully integrated into the medium and long-term development plans of power enterprises. In order to actively accelerate the green transformation and upgrading of the energy and power industry, stimulate technological innovation and development vitality, it is necessary for power enterprises to further adjust their capital structure, optimize their equity layout, and carry out equity structure adjustments.

There are different mechanisms of how equity structure affects technological innovation in enterprises: on the one hand, equity concentration is beneficial for shareholders to supervise and constrain the behavior of managers, so enterprise managers will actively engage in innovation activities; On the other hand, when equity is concentrated, major shareholders may bear excessive innovation risk costs, which may reduce their support for innovation activities.

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In summary, on the one hand, there are opposing views on the role of equity structure in technological innovation in power enterprises, and a unified conclusion has not yet been reached; On the other hand, there is a lack of literature on the relationship between equity structure and technological innovation based on a sample of Chinese power companies, and further categorizing state-owned enterprises and non-state-owned enterprises. Based on the above reasons, this article selects 499 A-share and H-share listed companies of Chinese power enterprises from 2009 to 2023, and empirically examines the impact of equity structure on technological innovation in power enterprises and provides suggestions for power enterprises to implement equity structure optimization, improve corporate governance level, and promote technological innovation and progress.

2 Theoretical Analysis and Research Hypotheses

Some scholars believe that the increase in equity concentration will promote technological innovation in enterprises. Foreign scholars Zhou et al. (2023)[2] found through research that equity concentration has a positive promoting effect on the R&D intensity of enterprises, and the R&D intensity of enterprises will increase with the increase of their equity concentration; Lee (2012)[1] used South Korean manufacturing companies as a sample for empirical research and believed that ownership concentration would promote companies to increase their R&D investment intensity. Domestic scholar Wang Lili (2021)[5] found through research on small and medium-sized listed companies from 2010 to 2018 that equity concentration promotes R&D investment in enterprises; Li Wengui et al. (2015)[6] measured innovation investment by R&D expenditure and R&D expenditure intensity, and found that the enthusiasm of privatized enterprises to participate in innovation activities increases with the increase of non-state-owned equity shareholding ratio; The research results of Sun Zao et al. (2015)[7] indicate that in capital and technology intensive industries, with the increase of equity concentration, there is a significant increase in innovation investment of enterprises.

In summary, this article proposes hypothesis H1a: Concentration of equity will enhance the level of technological innovation in enterprises; Equity balance will reduce the level of technological innovation in enterprises.

Some scholars have also found that equity concentration may inhibit technological innovation in enterprises. Gao et al. (2024)[3] found that when a company has multiple major shareholders sharing control, it creates a situation where the equity of multiple major shareholders is balanced against each other. Equity balance can effectively prevent individual major shareholders from encroaching on their interests, thus preventing the company's funds from being seized and having sufficient funds to carry out innovative investment activities, increasing the company's value. Mace (2023)[4] conducted research on a large number of companies in Western Europe and found that when equity concentration has a negative impact on a company's R&D and innovation activities, equity checks and balances play a role in balancing rights and reducing the adverse effects of excessive equity concentration. Domestic scholars Zhu Bing et al.(2018)[8] found through research that the concentration of corporate equity is high, and there will

be an "excessive supervision" effect among multiple major shareholders, which will lead to a decrease in the company's ability to bear risks, a decrease in tolerance for innovation failure, and is not conducive to the development of corporate innovation activities.Zhang Yujuan et al.(2018)[10] concluded that the inhibitory effect of equity concentration on enterprise innovation was more significant in private enterprises, and the promotion effect of equity balance on enterprise innovation was more significant in state-owned enterprises.Zhu Lei and Chen Xi (2019)[9] found that the higher the equity diversity of mixed ownership state-owned enterprises, the higher their innovation investment level.

In summary, this article proposes hypothesis H1b: Concentration of equity will reduce the level of technological innovation in enterprises; Equity balance will enhance the level of technological innovation in enterprises.

3 Empirical Research Design

3.1 Model Settings and Variable Definitions

In order to study the impact of equity concentration and balance on corporate technological innovation, this paper sets up the following two regression models, with the dependent variable being corporate technological innovation, where equation (1) explains equity concentration and equation (2) explains equity balance. Considering the time lag effect, in order to evaluate the impact of equity structure on the long-term effects of technological innovation, this paper uses dynamic panel data to study the influence of enterprise technological innovation on the concentration and balance of equity in the previous period.

$$\mathrm{Innovation}_{i,t} = \beta_0 + \beta_1 \mathrm{CR1}_{i,t-1} + \beta_2 \mathrm{Controls}_{i,t-1} + \varepsilon_{i,t-1} \quad (1)$$

$$\mathrm{Innovation}_{i,t} = \beta_0 + \beta_1 \mathrm{Z}_{i,t-1} + \beta_2 \mathrm{Controls}_{i,t-1} + \varepsilon_{i,t-1} \quad (2)$$

In terms of the dependent variable, this article analyzes the ratio of total R&D expenditure to operating income (Innovation) as a proxy variable for corporate technological innovation.

In terms of explanatory variables, the main ones are equity concentration and equity balance. This article measures equity concentration through the shareholding ratio of the largest shareholder (CR1) and the top five shareholders (CR5), and the higher CR1 and CR5, the higher the equity concentration. This article measures the degree of equity balance by the sum of the shareholding ratios of the second to fifth largest shareholders and the shareholding ratio of the first largest shareholder (Z), where a larger Z represents a higher degree of equity balance.

In terms of control variables, six indicators are selected as control variables: (1) enterprise size (SIZE): the logarithm of the total assets. (2) The asset liability ratio (LEV)(3) The size of the board of directors (DIR): the natural logarithm of the number of board members. (4) The proportion of independent directors (IND): the ratio of the number of independent directors to the number of board members. (5) Age of Enterprise

Listing (AGE): the difference between the current year and the year of enterprise listing. (6) The industry in which the enterprise operates.

3.2 Data Sources and Sample Selection

This study takes Chinese A-share and H-share listed companies from 2009 to 2023 as the initial research sample, with a total of 499 listed companies in the power industry including three sub industries: power generation, power grid, and power equipment. To avoid the impact of data outliers, this paper truncated all continuous variables at the 1% and 99% positions of their distribution.

4 Empirical Result Analysis

4.1 Analysis of Basic Regression Results

Table 1 shows the regression results of equity concentration and equity balance on the operating performance of power enterprises. However, the results showed that the CR1 and CR5 coefficients in terms of equity concentration are not consistent, while the equity balance coefficient is not significant. It is suspected that the differences in the results are caused by endogeneity issues.

Table 1. The Impact of Equity Concentration and Equity Balance on Enterprise Technological Innovation

Variable	*(1) Innovation*	*(2) Innovation*	*(3) Innovation*
CR1	0.159** (0.003)		
CR5		-0.085** (0.003)	
Z			0.691 (0.006)
SIZE	-0.004* (0.000)	-0.003* (0.000)	-0.006 (0.000)
LEV	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
DIR	-0.005* (0.001)	-0.003 (0.001)	-0.006* (0.001)
IND	0.002 (0.004)	-0.005** (0.004)	0.008 (0.004)
Observations	7406	7289	7289

4.2 Instrumental Variable Regression

Considering endogeneity issues, this article selects the Shareholder Responsibility Index (SRI) of the professional evaluation system for social responsibility reports of listed companies as the instrumental variable. It involves earnings per share, dividend financing ratio, dividend yield, etc., which are highly correlated with the explanatory variable equity concentration, and are exogenous to the proportion of R&D expenditure as the dependent variable. $CR1'_{i,t-1}$ and $Z'_{i,t-1}$ are the exogenous parts generated by instrumental variables, allowing Innovation to regress them.

$$Innovation_{i,t} = \beta_0 + \beta_1 CR1'_{i,t-1} + \beta_2 Controls_{i,t-1} + \varepsilon_{i,t-1} + \beta_1 (CR1_{i,t-1} - CR1'_{i,t-1}) \quad (3)$$

$$Innovation_{i,t} = \beta_0 + \beta_1 Z'_{i,t-1} + \beta_2 Controls_{i,t-1} + \varepsilon_{i,t-1} + \beta_1 (Z_{i,t-1} - Z'_{i,t-1}) \quad (4)$$

Table 2 shows the regression results of equity concentration and equity balance on the operational performance of power enterprises after adding instrumental variables. From the results in columns (1) and (2), it can be seen that the coefficients of equity concentration are significantly negative, indicating that the higher the equity concentration, the less conducive it is to technological innovation in the enterprise. From the results in column (3), it can be seen that the coefficient of equity balance is significantly positive, indicating that a higher degree of equity balance is more conducive to improving the level of technological innovation in enterprises. The experimental results are consistent with expectations.

Table 2. Regression using shareholder responsibility index as an instrumental variable

Variable	*(1) Innovation*	*(2) Innovation*	*(3) Innovation*
CR1	-0.038*** (0.002)		
CR5		-0.040*** (0.002)	
Z			0.541*** (0.054)
Observations	7406	7289	7289
First-stage F	144.76***	502.76***	310.72***
Wald test	12.26***	17.34***	19.28***

4.3 Further Analysis

To further investigate whether the impact of equity concentration and equity balance on technological innovation in power enterprises varies under different types of enterprises, this paper conducts research through grouped regression and the addition of

cross terms (nature×CR1, nature×Z). As shown in Table 3, the coefficient of nature×CR1 in column (3) is significantly positive, indicating that compared to state-owned enterprises, the higher the concentration of equity in non-state-owned enterprises, the less conducive it is to technological innovation. The coefficient of nature×Z in column (6) is significantly negative, indicating that compared to state-owned enterprises, a higher degree of equity balance in non-state-owned enterprises is more conducive to technological innovation.

Table 3. The impact of equity concentration and equity balance on technological innovation in state-owned and non-state-owned enterprises

Variable	(1)Non state-owned enterprises	(2)State-owned enterprises	(3)Full samples	(4)Non state-owned enterprises	(5)State-owned enterprises	(6)Full samples
CR1	-0.044*** (0.003)	-0.018*** (0.003)	-0.043*** (0.003)			
Z				0.580*** (0.064)	0.226*** (0.084)	0.602*** (0.065)
Nature×CR1			0.021*** (0.004)			
Nature×Z						-0.440*** (0.110)
Observations	5477	1929	7406	5377	1912	7289
First-stage F	408.26***	193.91***	381.87***	133.90***	196.54***	367.57***
Wald test	80.61***	19.84***	34.32***	159.86***	14.90***	24.09***

5 Conclusion and Implications

5.1 Empirical Analysis Conclusion

The study found that the higher the equity concentration of power enterprises, the less likely the major shareholders are to bear the risks of technological innovation, thus making it less conducive to enterprise technological innovation.Moderate diversification of equity in power enterprises while maintaining a certain level of control as the largest shareholder is more conducive to improving the technological innovation level of power enterprises. Compared to non-state-owned enterprises, the higher the concentration of equity in state-owned enterprises, the more favorable it is for technological innovation. This is because state-owned enterprises with more concentrated equity usually hold a leading position in the industry and have the driving force to lead industry transformation and upgrading, and promote innovative development; Compared to state-owned enterprises, the higher the concentration of equity in non-state-owned enterprises, the less conducive it is to technological innovation, as non-state-owned enterprises need to diversify the risks brought by technological innovation through highly dispersed equity.

5.2 Empirical Analysis Provides Insights

Based on the empirical analysis of the equity structure of A-share and H-share listed companies in China and the characteristics of equity concentration and balance, the following insights are provided for the equity structure of different types of power enterprises:

Firstly, for the technological innovation of state-owned power enterprises, it is recommended to maintain a relatively centralized holding of the company's shares, leverage the advantages of state-owned power enterprises in market resources, technological endowments, etc., and promote technological innovation in carbon reduction transformation, energy conservation and consumption reduction of power enterprises such as coal-fired and gas-fired power.

Secondly, for units with a high level of marketization, it is recommended to adopt an equity structure of "one leading share+moderate diversification+incentive shares" to strengthen corporate governance. For new energy storage, photovoltaic, and wind power enterprises, their marketization level is high and competition is fierce. By reducing the shareholding ratio of major shareholders and achieving actual control without consolidation, relying on stock incentives to effectively drive the technological innovation enthusiasm of key employees.

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