Research on the Relationship between Female Executive Participation and Technology Generality

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Abstract: Employing female executives can optimize the gender structure of the top management team and bring more diversified decision-making perspectives to the enterprise. These new ideas will also help the enterprises develop high-quality innovation. Therefore, the purpose of this paper is to try to find an effective way to improve the R&D innovation ability of enterprises from the characteristics of the top management team. From the perspective of female executives, this study uses big data technology—the Web crawler to obtain more accurate background information of executives, and then conducts an empirical analysis through Stata on the relationship between female executives and technology generality in 244 listed companies from 2009 to 2019, while introducing executive political connection to study its moderating effect. Through the research, we draw the following conclusions: (1) The relationship between female executive participation and technology generality is inverted U-shaped; (2) Executive political connection has a negative moderating effect on female executive participation and technology generality.

Keywords: Female Executives, Technology Generality, Political Connection

1 Introduction

The prominence of top management team in enterprise operation and management is definitely obvious. The background and personal characteristics of managers will directly affect the company's operating performance and innovation objectives [1]. In many academic studies, scholars have begun to pay attention to the impact of the structure of the top management team on different types of decision-making, especially the proportion of men and women in the top management team [2] . In recent years, with the increasing proportion of female executives, the significant impact of female executives on enterprise innovation decisions has gradually received attention [3]. Academics have begun to research into whether female executives have a differentiated impact on different types of enterprise innovation.

As a representative of high-quality technological innovation, generic technology has the characteristics of fundamentality, externality, relevance, etc. It is a technology that integrates multiple fields and can be widely used in one or more industries. It is the basis for technological progress and industrial development, helps to break through the common bottleneck of industrial technology development [4], and promotes the leapfrog and sustainable development of the economy and society [5]. Currently, the number of patent applications in China has entered a stage of rapid growth, but there is still a contradiction of "large quantity with lower quality". The number of patents is the basis. While emphasizing the quantity of patents, it is also

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necessary to consider their applicability and universality. However, few studies have included technology generality in R&D performance to explore the relationship between top management team and technology generality.

On the basis of existing research, this paper takes the senior team structure as the starting point, selects the panel data of 244 listed companies from 2009 to 2019, combines big data technology with stata analysis, and obtains the first-hand senior executive information the Web crawler to help us more accurately analyze the process of the impact of executive characteristics on enterprise performance of technology generality. Considering that the two important methods of enterprise development are to enhance the enterprise's innovation ability and obtain political connection. In order to obtain necessary resources, enterprises must maintain good relations with the government [6]. However, it is inevitable that some enterprises will focus on one side without consideration of the other side [7]. Hence, the acquisition cost of the two ways has become a decisive factor. Therefore, we introduce executive political connection as a moderator variable, and explore the mechanism of political connection in senior executives' decision-making process which helps to enrich innovation research.

2 Theoretical Basis and Research Assumptions

2.1 The influence of female executive participation on technology generality

Female executive participation in the top management team of enterprises can effectively improve the gender structure of members, promote the formation of a great innovation atmosphere of enterprises, and thus drive the process of technological innovation. Based on different ways of thinking, experiences and preferences, female executives can give play to the advantages of different genders in thinking and handling problems, and provide innovative perspectives and new ways to solve problems for enterprise management decisions. At the same time, gender is also an important part of the heterogeneity of the top management team. The higher the heterogeneity of the top management team, the more inclined to become a leader in the industry rather than a follower, and to launch new products earlier and faster than competitors [8].

In addition, female executive participation in the board of directors or top management team can help enterprises better understand the market and customers [9]. In today's competitive market, product updates are fast, and the diversity of customers is continually increasing. A diversified top management team can better match potential customers. Women executives can use their own characteristics to grasp the changes of customer demand and the market accurately, so as to develop targeted differentiation strategies, and achieve timely conversion of product innovation.

In general, the sensitivity and accuracy of female executives to market demand is an important basis for enterprises to develop generic technology for the fundamentality, universality and advancement. When female executives account for a certain proportion in the decision-making leadership, the decision-making style is easier to adapt to the market and their technology generality is higher. However, when the proportion of female executives is too high, it may cause the company's top managers to return to a single gender structure, and the technology generality will also decline.

Hypothesis 1: The relationship between female executive participation and technology generality is inverted U-shaped.

2.2 The moderating effect of executive political connection

The essence of political connection is a relationship between government and enterprises, which is an informal and implicit relationship built by enterprises in various forms. Enterprise innovation will be restricted by external environment and institutional factors, such as relevant government policies, legal environment, financial system, etc. Under the market competition environment, the government still has the power to allocate scarce resources and formulate industrial policies. Enterprises with political connection can enjoy the preferential policies, which makes them face fewer restrictions and easier to obtain relevant resource allocation.

However, the dual nature of external social capital [10] makes enterprises confront the risk of "embedding" while obtaining external resource opportunities. Particularly, highly embedded political networks may require high social costs [11]. These social costs include both material expenditure and the degree of autonomy of decision-making. When the two exchange resources, it is inevitable that senior executives will exchange a certain proportion of decision-making autonomy for government resources, which may restrict the innovation thoughts [12], thus adversely affecting the development of the generic technology.

Hypothesis 2: Executive political connection has a negative moderating effect on female executive participation and technology generality.

3 Method

3.1 Data collection

The financial data for this paper is from CSMAR database, and the patent data is from Derwent Innovations Index and Soopat. We collect the data of 587 listed enterprises from 2009 to 2019 and delete the enterprises with missing values. A total of 10 variables in 244 samples form the balanced panel data.

3.2 Variable definition and measurement

3.2.1 Dependent variable: technology generality (Tg)

This paper uses the patent data in the Derwent database to measure technology generality. With regard to the measurement method of technology generality, the calculation formula of Herfindahl Index proposed by Ardito is used to measure the diversity of technical fields of those specialties that cite a target patent, which evaluates the innovation performance of technology generality of enterprises. The principle of this index is that the more diverse the technical fields in which patents are granted, the higher the technical universality of the target patents. On the contrary, if the citation patent focuses on a few technical fields, the target patent has lower technique universality.

$$\text{Technology generality (Tg)} = \frac{F_P}{F_P - 1}\left[1 - \sum\left(\frac{F_{ip}}{F_p}\right)^2\right] \qquad (1)$$

In Formula (1), F_P is the number of all forward citations of the target patent, F_{ip} is the number of citations of the target patent based on three-digit international patent classification number (IPC class). The Huffindall index of the enterprise in that year can be obtained by summing up the Huffindall index of these specific patents in that year.

3.2.2 Independent variable: Female executive participation (Fem)

This paper uses the proportion of female executives proposed by Ren Ting [13] (2010) and Zeng Ping [14] (2012) to represent the participation of female executives, which is the number of female executives divided by the total number of executives. We uses Python to get the annual report of the enterprise through the Web crawler to determine the number of female executives in the enterprise.

3.2.3 Moderating variable: Executive political connection (Pc)

This paper uses the proportion of executives with political connections to represent the degree of political connection of executives in the enterprise, which is the number of executives with political connections divided by the total number of senior executives. We obtain executives' resumes through the Web crawler, and screen whether keywords such as "government", "military", "NPC representative" or "CPPCC member" appear in the resumes to determine whether the executives have political connection.

3.2.4 Control variables

In order to reduce the impact of other variables on the research model, the following variables are controlled in this paper: (1) Corporate performance (TobinQ). (2) Ownership concentration (Oc). (3) Current ratio (Cr). (4) Earnings per share (Eps) [15]. (5) Asset-liability ratio (Agr). (6) Return on assets (ROA). (7) Capital intensity (Ci) [16].

4 Results and analysis

4.1 Descriptive statistics

The results of descriptive statistics are shown in Table 1. The average of technology generality is only 0.5032, which indicates the low degree of technology generality in most enterprises. While the standard deviation is 0.328, which means that the technology generality among enterprises is not ideal, and the overall degree of technology generality is low. The average of female executive participation is 0.129, showing that the proportion of female executives in enterprises has mostly reached more than 10%, with a small standard deviation, thus there is no significant difference among enterprises.

4.2 Correlation test

According to the results in Table 1, there is a positive correlation between female executive participation and technology generality, which is significant at the level of 1%, with a correlation coefficient of 0.153. However, after the moderating variable and control variables are added, we need regression analysis to further verify whether these assumptions are valid.

Table 1. Descriptive Statistical Results

	mean value	Standard deviation	Tg	Fem	Pc	TobinQ	Oc	Cr	Eps	Agr	ROA	Ci
Tg	.503233	.3278794	1									
Fem	.129599	.1093633	0.153***	1								
Pc	.1855909	.1541724	0.256***	0.090***	1							
TobinQ	1.877795	1.48981	0.141***	0.353***	0.160***	1						
Oc	27.85286	17.30852	0.381***	0.241***	0.546***	0.274***	1					
Cr	2.527577	3.553409	0.00100	0.210***	0.0190	0.252***	0.153***	1				
Eps	.3374302	.5477419	0.091***	0.118***	0.217***	0.216***	0.321***	0.148***	1			
Agr	.348425	.2310829	0.413***	0.159***	0.459***	0.099***	0.469***	-0.286***	0.052***	1		
ROA	.0368406	.0697593	0.0290	0.142***	0.095***	0.311***	0.173***	0.203***	0.688***	-0.169***	1	
Ci	1.968123	2.432292	0.173***	0.140***	0.104***	0.120***	0.137***	0.212***	-0.106***	0.163***	-0.080***	1

Note: * * *, * * and * respectively indicate that the two tailed t-test values are statistically significant at 1%, 5% and 10% levels.

4.3 Regression analysis results

In this paper, the interaction terms are decentralized to prevent the multicollinearity problem among variables. In Table 2, Model 1 is the relationship between control variables and technology generality, and Model 2 adds the linear and quadratic terms of female executive participation. It can be seen from the data that the correlation between the quadratic term of female executive participation and technology generality is negative, and it is significantly correlated at the level of 0.05. While the correlation between the linear term and technology generality is positive, with a significant correlation at the level of 0.01, indicating an inverted U-shaped relationship between the two. With the increase of the proportion of female executives, the technology generality changes in a shape of parabola, rising to the maximum value first and then declining. When the proportion of female executives changes to a certain value, the technology generality declines after reaching the maximum. So Hypothesis 1 is supported.

Model 3 is a regression model that adds the executive political connection and the interaction term of the executive political connection and independent variable that includes the linear and

quadratic terms. It can be found that the correlation coefficient between interaction term of executive political connection and technology generality is negative which passees the 1% significance level test. The correlation coefficient between the square interaction term and technology generality is negative, and it has passed the 10% significance level test. It shows that under the moderating effect of political connection, the inverted U-shaped relationship between female executive participation and technology generality will be weakened. When the degree of political connection becomes higher, the impact of female executive participation on technology generality is less. So Hypothesis 2 is supported.

Table 2. Regression Results

	Variables	(1) F1_Tg	(2) F1_Tg	(3) F1_Tg
Independent variable	Fem		0.407***	0.389***
	Fem2		-0.735**	-0.766**
Moderating variable	Pc			-0.079
Moderating variable interaction term	Fem_Pc			-2.749***
	Fem2_Pc			-4.289*
Control variables	TobinQ	0.012***	0.012***	0.011**
	Oc	0.004***	0.004***	0.004***
	Cr	0.001	0.001	0.000
	Eps	-0.027	-0.026*	-0.024
	Agr	0.279***	0.294***	0.275***
	ROA	0.412***	0.358***	0.333***
	Ci	0.007***	0.007***	0.007**
Constant	Constant	0.265***	0.219***	0.258***
	Observations	2684	2,684	2,684
	R-squared	0.238	0.236	0.241
	N	244	244	244
	r2_a	0.142	0.157	0.161
	F	87.38	83.44	64.15

Note: *0. Significant correlation at 0.1 level (two-tailed);**0. Significant correlation at 0.05 level (two-tailed);***0. Significant correlation at 0.01 level (two-tailed).

4.4 Robustness test

In order to avoid the contingency in the empirical research and ensure that the research conclusions are valid and reliable, the robustness of the main model and the moderating effect is tested. In this paper, we choose three kinds of robustness test: adding or reducing control variables, reducing sample size, and winsorize processing. The results show that the significance level of the main effect and the moderating effect has not changed substantially, which proves the robustness of the conclusions.

5 Conclusions

5.1 Main conclusions

Through the research on the influence of female executives on technology generality, this paper draws the following conclusions:

First of all, there is a significant inverted U-shaped relationship between female executive participation and technology generality. Based on the universality and advancement of generic technology, the accurate understanding of market demand by female executives have built an important foundation for enterprise technology innovation. However, when the proportion of female executives is too high, it may lead to the single gender structure of the top management team, which affects the development of creativity.

Second, executive political connection negatively regulates the relationship between female executive participation and technology generality. Due to the close relationship with the government, executives divert their attention and transfer part of management autonomy, resulting in insufficient investment in internal R&D resources, thus reducing the technology generality.

5.2 Management enlightenment

The following aspects are the main management implications of this article. First of all, enterprises should appropriately increase the proportion of female executives. While optimizing the structure of the top management team, enterprises can strengthen the internal harmony and improve management efficiency of senior management. However, enterprises that focus on innovation strategies need to control the proportion of female executives to avoid the adverse consequences of excessive proportion. At the same time, it is particularly important for enterprises to cultivate risk taking capacity of female executives, encourage them to take reasonable risks, and strengthen the training and education in innovation.

Second, in order to cope with political environments, enterprises should build corresponding political strategies and have a good interaction with the government. While taking into account the positive role of social capital, enterprises must recognize the dual nature of social capital, avoid "excessive embeddedness" and the adverse impact of political connection.

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