

Executive Vertical Concurrently to Enterprise Green Innovation

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Abstract: Guiding enterprises to carry out green innovation and accelerating the forging of new competitive advantages in green industry has become an important direction of national innovation after the top 20. Based on the panel data of A-share non-financial listed companies from 2015 to 2020, this paper empirically examines the impact of vertical concurrent executive positions on corporate green innovation. The results show that the vertical concurrent position of senior executives significantly improves the degree of green innovation of enterprises. The vertical concurrent position of senior executives can effectively play the supervision function of major shareholders, improve the efficiency of resource allocation, and promote the green innovation behavior of enterprises. This result held up after a series of robustness tests. Therefore, more explicit regulations should be introduced for the vertical part-time system of senior executives of listed companies, so as to guide enterprises to establish a reasonable and efficient vertical part-time system of senior executives and improve the degree of green innovation of enterprises.

Keywords: Executive vertical concurrent, Green innovation, Information Asymmetry, Profit motive.

1. Introduction

The Party's 20 major report points out that promoting green economic and social development is a key link to achieve high-quality economic development in China, of which green innovation and development of enterprises is an important part. As the main carrier of Chinese innovative activities, enterprises' green innovation level and innovation quality undoubtedly determine the degree of sustainable economic development in our future, which is different from innovative activities in the general sense. The emphasis is on the protection of the environment while achieving technological breakthroughs, and under the guidance of the idea of "building a resource-friendly society", enterprises' green development transformation. In the new era, the socialist modernization drive with Chinese characteristics has entered a new journey, and the Chinese-style modernization drive has been fully launched. While recognizing the outstanding contribution of enterprise innovation activities to economic growth, higher requirements have been set for green innovation in enterprises. Therefore, how to promote enterprise green innovation has become a hot topic that academia and policy makers continue to pay attention to.

Generally speaking, the green innovation behavior of enterprises is influenced by both external and macro factors, such as innovation policies, financing environment, market competition, etc., and internal factors, among which, the widespread vertical concurrent position of senior executives is an important factor. The vertical concurrent position of senior executives refers to the phenomenon that the chairman or general manager of a listed company serves in a major shareholder. China Securities Regulatory Commission has also introduced a series of regulatory measures for the vertical concurrent position of senior executives, such as the introduction of independent director system in 1997, the requirement of "three separation" between listed companies and the parent company in 1999, and the change to "five separation" in 2001. Although scholars have reached a consensus on the significant impact of vertical executive

positions on corporate governance structure and internal risk control, the impact results are still controversial. On the one hand, listed companies with vertical executive positions have stronger supervisory motivation of their controlling shareholders, which helps to alleviate the degree of information asymmetry. On the other hand, executive holding companies with vertical adjunct positions have more obvious motives to usurp the interests of listed companies by taking advantage of their special status. Both aspects will have a significant impact on the green innovation behavior of enterprises. Therefore, under the guidance of the new development concept of "ecological priority", it is of great theoretical and practical significance to study the influence mechanism of vertical executive part-time on the green innovation of enterprises.

2. Literature Review and Theoretical Mechanism

2.1. Related literature review

The research on vertical adjunct of senior executives can be traced back to Porta (1999)'s study on the management of American family enterprises, which pointed out that vertical adjunct of senior executives can actually improve enterprise value by reducing agency problems. Later, scholars conducted a series of studies on this issue and reviewed existing literatures. In this paper, literatures on the impact of vertical concurrent tenure of senior executives on corporate green innovation are mainly classified into the following three categories:

First, the influence of the phenomenon of executive connection on corporate governance. This kind of literature focuses on the influence of information asymmetry on corporate governance from the perspective of information asymmetry, including both horizontal and vertical connection. Xu Peng and Zhang Heng (2022) used the threshold regression method and the data of listed companies within the framework of enterprise groups to empirically investigate the influence of the longitudinal connection of senior executives

of parent-subsidary companies on the stability of subsidiary governance. The results showed that only when the degree of senior executives' connection exceeded a certain threshold value, the longitudinal connection of senior executives could have a stable positive promoting effect. Shuguang and Ma Zhong (2022), based on the perspective of different types of concurrent executives, investigated the impact of vertical concurrent executives of parent-subsidary companies on the capital allocation efficiency of listed companies, and the results showed that when concurrent executives represented different corporate interests, there were significant differences in governance effects.

The second is the influence of executive vertical concurrent position on enterprise investment efficiency. Zheng Gao Ping and Xue Jian (2014) pointed out in their research that there were listed companies in which senior executives concurrently held vertical positions, and the value of the companies decreased significantly. Although concurrently serving as senior executives can strengthen shareholders' control over the company, such control does not substantially improve the value of the company. More importantly, it provides convenience for shareholders to seize the interests of minority shareholders. Yan Zhenli and Liang Shangkun (2021) made use of the data of listed companies from 2009 to 2016 to study the impact of vertical concurrent executive positions on corporate investment efficiency. The results show that the vertical concurrent position of senior executives has an obvious inhibitory effect on the investment efficiency of enterprises, and this inhibitory effect is more obvious in non-state-owned enterprises and enterprises with a high degree of separation of two powers.

Third, the influence of executive vertical concurrent position on enterprise violations. Qiao Fei and Wen Wen (2021) used A-share listed companies in Shanghai and Shenzhen from 2003 to 2018 as research samples to empirically investigate the influence of vertical concurrent appointment of senior executives on corporate violations, and also proved the inhibiting effect of vertical concurrent appointment of senior executives on the tendency and frequency of corporate violations. Different from other literatures, they concluded that This inhibitory effect was present when distinguishing between different types of chairman and general manager. Suma Zeng and Han Jinhong (2020), taking Chinese A-share listed companies from 2007 to 2017 as samples, studied the impact of vertical executive summing on stock price crash risk. After A series of robustness tests, similar conclusions were reached.

On the whole, there are still no consistent conclusions on the impact of vertical concurrent executive positions on corporate green innovation in literature, which also provides an opportunity for empirical investigation in this paper.

2.2. Theoretical mechanism

In theory, the vertical concurrent position of senior executives has two impacts on green innovation of enterprises. On the one hand, there is positive facilitation. Generally speaking, the major shareholders of listed enterprises with vertical executive positions often have clear corporate development strategies. Driven by the wave of digital economy, they can take the lead in realizing the significance of corporate green innovation for high-quality economic development, and then optimize corporate investment through digital transformation to better play the advantages of enterprises in building new green innovation ground. At the

same time, the vertical concurrent position of senior executives can also play a supervisory role in the management of listed enterprises, strengthen the quality of accounting information disclosure of enterprises, reduce the opportunistic behavior of management, avoid ineffective investment, and promote the green innovation of enterprises, which can alleviate the agency problems caused by information asymmetry. On the other hand, there is a negative inhibitory effect. Large shareholders with vertical concurrent positions may not only optimize corporate investment and improve the efficiency of corporate resource allocation, but also occupy the resources of listed enterprises due to their own rent-seeking motives, instead of promoting effective corporate governance. Major shareholders have more decision-making power in corporate investment behavior, so they may be more inclined to induce enterprises to invest in projects with high short-term returns, while green innovation, which is not obvious in the short term, is obviously not the focus of attention. Therefore, driven by rent-seeking behavior, the resources required by enterprises to carry out green innovation activities are crowded out, thus reducing the degree of green innovation of enterprises and showing an inhibitory effect.

Based on the above studies, this paper proposes the following hypotheses, which are proved by empirical evidence:

H1: From the perspective of information asymmetry, the vertical concurrent position of senior executives improves the degree of green innovation of enterprises.

H2: Under the rent-seeking motive, the vertical dual position of senior executives inhibits the green innovation behavior of enterprises.

3. Data Source and Variable Description

3.1. Source of sample data

In this paper, A-share non-financial listed companies are selected as research samples. The sample period is 2015-2020, and the characteristics data of senior executives and green innovation behavior data of listed companies are all from CSMAR database. During sample screening, the following criteria were adopted: first, the observation values of ST abnormal companies were eliminated; Second, sample observations with serious financial data missing are eliminated. Third, eliminate financial and real estate enterprises. In order to avoid the influence of extreme values, the tail reduction treatment was carried out on all continuous variables at the level of 1%, and the final effective sample observation value was 15,341.

3.2. Variable description

1) The explanatory variable of this paper is the longitudinal executive concurrent position. The dummy variable is used for measurement. If the chairman or general manager of the listed company holds the post in the enterprise with the main controlling shareholder, that is, the longitudinal concurrent position of senior executives exists, then the value is 1; otherwise, it is 0.

2) The explained variable of this paper is enterprise green innovation. The measurement of enterprise green innovation in previous literature is mainly divided into two categories: one is from the perspective of green innovation input of listed companies, using the total R&D input, R&D input intensity,

the number of R&D personnel, the proportion of the number of R&D personnel, capitalized R&D input and the proportion of capitalized R&D input to R&D input. The other is from the perspective of green innovation output of listed companies, using the number of green patent applications and green patent acquisition indicators to measure. Referring to the research of Yan Zhenli (2019), this paper uses the total number of green patents independently obtained in that year

to measure the level of green invention patents of enterprises.

3) According to the research of Xu Peng (2022), the control variables selected in this paper include: net profit rate of total assets, growth rate of operating revenue, company size, asset-liability ratio, cash flow ratio, age of vertical part-time executives, etc. See Table 1 for the specific definition and calculation method of variables.

Table 1. Main variable definitions and descriptive analysis

Variable	name	Variable definition and calculation method	minimum	maximum	mean	standard deviation
Exe_vertical	Executive vertical concurrent	If there is vertical adjunct of senior executives, the value is 1; otherwise, it is 0	0	1	0.031	0.173
Green_innovation	Corporate green innovation	The total number of green patents obtained independently that year	0.693	5.799	1.933	1.165
roa	Rate of return on total assets	Net profit/average total assets×100%	-0.143	0.179	0.034	0.046
ibr	Operating revenue growth rate	(Total operating revenue - Total operating revenue of last year)/ Total operating revenue of last year ×100%	-0.377	1.645	0.183	0.313
size	Company size	The total assets of the enterprise are treated as logarithms	20.994	27.349	23.313	1.358
lev	Asset-liability ratio	Total liabilities/total assets at the end of the period x 100%	0.00006	0.369	0.095	0.086
cr	Cash flow ratio	Net cash flow from operating activities/ending current liabilities	-0.110	0.205	0.048	0.057
age	Vertical concurrent executive age	The actual age of a vertical executive	24	76	48.357	6.511

3.3. Model specification

Referring to existing studies, the benchmark regression model constructed in this paper is as follows:

$$Green_innovation_{it} = \beta_0 + \beta_1 Exe_vertical_{it} + \gamma X_{it} + \varepsilon_{it}$$

Wherein, Ginnovation represents corporate green innovation, and vert represents vertical executive concurrent position. If the chairman or general manager of a listed company holds positions in a company with major controlling shareholders, that is, vertical executive concurrent position exists, then the value is 1; otherwise, it is 0. X is a series of control variables, including total assets net profit rate, operating revenue growth rate, company size, asset-liability ratio, cash flow ratio, vertical part-time executive age, etc., ε_{it} represents the random disturbance term. β_1 describes the impact of vertical adjunct of senior executives on corporate green innovation. If there is a positive impact, the coefficient is significantly positive, that is, vertical adjunct of senior executives significantly improves the degree of corporate green innovation. After the empirical part will be specific verification.

4. Positive Research

4.1. Data preprocessing and descriptive analysis

Table 1 provides a descriptive analysis of variables required for the demonstration. From the results of the full sample, the average of vertical adjunct of senior executives is 0.031, indicating that 3.1% of listed companies in the samples selected in this paper have vertical adjunct behavior of senior executives, and the average of green invention patent level of enterprises is 1.933. Sample characteristics of other control variables are not explained one by one. From the sample

distribution of longitudinal part-time executives, it has not become a common phenomenon in Chinese listed enterprises, and its influence on green innovation behavior of enterprises needs further empirical analysis.

4.2. Regression result

This paper uses the benchmark regression model constructed to investigate the impact of vertical concurrent executive positions on corporate green innovation, and the results are reported in Table 2. Among them, control variables are added to column (1), and the regression coefficient is 0.181, which is significant at the 1% level, indicating that vertical concurrent appointment of senior executives will significantly improve the green innovation level of enterprises. Column (2), based on column (1), reports robust standard error with a coefficient of 0.181, still significant at the 1% level. The H1 is verified.

In column (3), the level of green invention patents is used to replace the total level of green patents as the proxy variable of the degree of green innovation of enterprises. The coefficient is 0.204, slightly increased and still significant at the level of 1%, which once again proves that the vertical concurrent position of senior executives can promote the green innovation of enterprises. Column (4), based on column (3), reports robust standard error with a coefficient of 0.204, still significant at the 1% level. Again, we verify the H1. As mentioned above, in listed companies with vertical concurrent executive positions, major shareholders can use vertical concurrent executive positions to strengthen the degree of intervention in listed companies, and are more motivated to seek private interests rather than pay attention to the company's green innovation behavior. In conclusion, the results of benchmark regression verify H1, that is, the vertical concurrent position of senior executives inhibits the green innovation behavior of enterprises.

Table 2. Regression results of the influence of vertical concurrent positions of senior executives on corporate green innovation

Variable Name	Explained Variable			
	(1) Green patent Overall level	(2) Green patent Overall level	(3) Green invention patent level	(4) Green invention patent level
Exe_vertical	0.181** (0.049)	0.181*** (0.050)	0.204*** (0.051)	0.204*** (0.052)
roa	1.538*** (0.217)	1.538*** (0.199)	1.907*** (0.225)	1.907*** (0.213)
ibr	0.006 (0.029)	0.006 (0.028)	0.008 (0.030)	0.008 (0.029)
size	0.411*** (0.007)	0.411*** (0.009)	0.426*** (0.007)	0.426*** (0.009)
lev	-1.342*** (0.110)	-1.342*** (0.120)	-1.551*** (0.114)	-1.551*** (0.124)
cr	-0.617*** (0.166)	-0.617*** (0.158)	-0.457*** (0.001)	-0.457*** (0.164)
age	-7.142*** (0.160)	-0.008*** (0.001)	-0.008*** (0.001)	-0.008*** (0.001)
constant term	-7.142*** (0.160)	-7.142*** (0.196)	-7.998*** (0.166)	-7.998*** (0.203)
control variable	control	control	control	control
N	15341	15341	15341	15341
Adj-R2	0.200	0.198	0.200	0.200
F-value	541.54	356.46	548.03	359.85
Prob>F	0.000	0.000	0.000	0.000

4.3. Robustness test

The benchmark regression results of this paper show that the vertical concurrent position of senior executives can significantly improve the degree of green innovation of enterprises. This part intends to further analyze this positive impact. Column (1) in Table 3 uses the level of green utility patents as the proxy variable for the degree of green innovation of enterprises, and the results show that the coefficient is 0.118, which is less significant, but still significant at the level of 5%. Column (2) is based on column (1) and reports robust standard error with a coefficient of 0.118, significant at the 5% level. The result of baseline regression is verified again.

Columns (3) and (4) in Table 3 are the results of sub-sample

regression. The enterprises with more than or equal to 3 vertical adjunct positions of senior executives are defined as high-frequency adjunct positions and reported in column (3), while the rest are low-frequency adjunct positions and reported in column (4) for grouping regression. The results show that the coefficient of high frequency adjunct is 0.130, which is significant at 5% level, while the coefficient of low frequency adjunct is 0.156, which is significant at 5% level, indicating that the vertical adjunct of senior executives with low frequency is more about using the advantage of major shareholders to reduce the degree of information asymmetry of listed companies and improve the efficiency of enterprise resource allocation. However, the high frequency of vertical adjuncts of senior executives highlights their profit-seeking motives and inhibits enterprises' green innovation behavior.

Table 3. Robustness test results of the influence of vertical concurrent positions of senior executives on corporate green innovation

Variable Name	Explained Variable			
	(1) Green utility patent level	(2) Green utility patent level	(3) High frequency concurrent	(4) High frequency concurrent
Exe_vertical	0.118** (0.046)	0.118** (0.048)	0.130** (0.072)	0.156** (0.067)
roa	0.445** (0.205)	0.445** (0.181)	0.013 (0.494)	0.516*** (0.194)
ibr	-0.002 (0.027)	-0.002 (0.027)	-0.025 (0.079)	0.0005 (0.029)
size	0.294*** (0.007)	0.294*** (0.008)	0.311*** (0.023)	0.292*** (0.008)
lev	-0.720*** (0.104)	-0.720*** (0.109)	-0.677** (0.289)	-0.724*** (0.118)
cr	-0.580*** (0.157)	-0.580*** (0.152)	-0.433 (0.438)	-0.618*** (0.164)
age	-0.006*** (0.001)	-0.006*** (0.001)	-0.007** (0.004)	-0.005*** (0.001)
constant term	-5.335*** (0.151)	-5.335*** (0.181)	-5.701*** (0.512)	-5.281*** (0.194)
control variable	control	control	control	control
N	15341	15341	1939	13402
Adj-R2	0.125	0.125	0.131	0.124
F-value	311.54	217.64	29.42	189.94

5. Conclusions and Policy Recommendations

The Central Economic Work Conference in 2022 emphasized green and low-carbon development, increased green financial support for enterprises, and forged competitive advantages in green industry, which undoubtedly put forward higher requirements for green innovation of enterprises. Based on the panel data of A-share non-financial listed companies from 2015 to 2020, this paper empirically examines the impact of vertical concurrent appointment of senior executives on corporate green innovation, and the results show that vertical concurrent appointment of senior executives has a significant positive impact on corporate green innovation. After dividing the number of companies with vertical adjunct of senior executives, it is found that the high frequency of vertical adjunct of senior executives has a lower impact on the green innovation behavior of enterprises than the low frequency of vertical adjunct of senior executives, showing more profit-seeking motivation.

Therefore, this paper puts forward the following policy suggestions:

First, from the perspective of enterprises, establish and improve the internal control system to reduce the influence of individual decision-making characteristics on corporate decision-making. The research of this paper shows that the major shareholders with a high frequency of vertical adpositions of senior executives tend to have strong rent-seeking motives and can directly influence the investment behavior and development strategy of enterprises through the dispatched vertical adpositions of senior executives. Enterprises are more inclined to invest with high short-term returns, thus squeezing out the resources originally used for corporate green innovation. Therefore, enterprises should strengthen the internal control system, formulate investment strategies based on the enterprise's future positioning, reduce violations of vertical concurrent executives, and improve the allocation efficiency of enterprise resources.

Second, from the perspective of regulatory authorities, policies should be introduced to guide enterprises to establish a standard vertical part-time system for senior executives, and the rights, obligations and penalties for violations of vertical part-time executives should be clearly defined. In theory, the

vertical concurrent position of senior executives can reduce the degree of information asymmetry, make use of the investment experience and investment market of major shareholders to facilitate the investment behavior of listed enterprises, better play the supervisory function of the vertical concurrent position of senior executives, and improve the quality of accounting information disclosure of enterprises. Therefore, in the context of the explosive growth of digital economy and the promotion of digital transformation by national policies, it is of great practical significance for enterprises to play the communication role of vertical part-time executives more actively for green innovation.

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