

Corporate Financialization and Green Innovation

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Abstract: With the national focus on green and sustainable development, green innovation has gradually become the focus of attention for many enterprises. However, green innovation has a high degree of risk and uncertainty, and often requires a large amount of capital investment during green innovation. In the current period, due to the intensification of the phenomenon of enterprise financialization, there is a strange lack of funds in the real investment field, which will inevitably have an impact on green innovation. This paper takes listed companies in the manufacturing industry in Shanghai and Shenzhen A-shares from 2008 to 2022 as the research object to empirically test the impact of corporate financialization on green innovation. On this basis, this paper further focuses on the role played by external supervision between the two. The findings show that corporate financialization can significantly inhibit corporate green innovation, but external supervision can significantly mitigate the negative impact between the two.

Keywords: Corporate Financialization; Green Innovation; External Supervision; Analyst Focus; Institutional Investor Ownership.

1. Introduction

Since the reform and opening up, China's economy has developed rapidly, and its economic output has continued to grow at a high rate. However, for a long time, China's economic development model of high energy-consuming inputs and high factor outputs has caused serious damage to the ecological environment. At the same time, as the state attaches more and more importance to economic development, the number of incidents of sacrificing the environment to promote regional economic development has gradually increased in various places, and the contradiction between economic development and environmental protection has become more and more prominent. The report of the 20th Party Congress points out that nature is the basic condition on which human beings rely for survival and development, and that all development should put nature in the first place. In this context, the promotion of technological innovation to solve the problem of environmental pollution and promote high-quality economic development has become a priority for current economic development.

Green innovation is the most important part of technological innovation. Green innovation is different from non-environmental innovation in that it pays more attention to the impact of innovation activities on the ecological environment, i.e., in addition to pursuing the economic benefits and economic value of innovation activities, it pays more attention to the impact of innovation activities on the ecological environment. For enterprises, green innovation is not only to reduce resource consumption and pollution emission; it is also to further improve production efficiency, reduce costs, and improve the competitiveness of enterprises in the market.

With China's important commitment to the world of "carbon peak" and "carbon neutrality", carbon reduction and emission reduction have become the common goal of the whole society and enterprises. For enterprises, green innovation is the best way to realize energy saving and emission reduction. Similar to other innovative activities, green innovation is characterized by high investment and

slow return. Therefore, sufficient financial support is a prerequisite for enterprises to carry out green innovation. Under the current background of overall market overcapacity and insufficient demand, in order to obtain higher profits, more and more real enterprises detach themselves from their main business and invest their funds in the field of financial assets, leading to the phenomenon of financialization of enterprises. This investment structure bias also leads to the already tight R&D funds of many enterprises to become more scarce, which in turn has a direct impact on enterprise green innovation. In this context, it is of great significance to explore the specific impact of corporate financialization on green innovation. In addition, external supervision is a way of corporate governance, external supervision can have a certain degree of influence on corporate decision-making, and when the level of corporate external supervision is low, its financialization is generally more significant. Therefore, this paper chooses the level of external supervision as a moderating variable to further test the impact of external supervision on the relationship between corporate financialization and green innovation.

2. Theoretical Analysis and Hypothesis Development

With the deepening of China's economic system reform and the rapid development of the capital market, the participation of enterprises in the financial market has gradually increased, and the phenomenon of enterprise financialization has become more and more common. Research on the phenomenon of enterprise financialization has found that enterprise financialization is often driven by the arbitrage motive. When the rate of return on financial assets is higher than the rate of return on physical investments, enterprises tend to allocate more resources to the financial sector to obtain excess returns. Existing research shows that there are two main channels through which the financialization of enterprises affects green innovation: first, the "crowding-out effect". According to the resource base theory, the total amount of resources within an enterprise is limited, and there

is a "substitution effect" between various resources. In the case of limited enterprise resources, if the enterprise invests more money in financial assets, then it will inevitably reduce the investment in the real economy, which will inhibit the enterprise's green innovation. Second, the "reservoir effect". Enterprise green innovation consumes a long time, high risk, uncertainty, the total demand for capital and timeliness requirements are very high, requiring enterprises to maintain a long period of sustained capital investment. If sufficient funds cannot be invested in a timely manner, enterprises are likely to bear huge sunk costs incurred in the course of the project. Financialized investment, on the other hand, is more liquid and can meet the instantaneous capital needs of enterprises in a short period of time, ensuring the continuity of enterprises' green innovation investment and promoting their green innovation. Based on this, the following research hypothesis is proposed:

H1a. Corporate financialization will reduce the level of green innovation

H1b. Corporate financialization will increase the level of green innovation

The characteristics of enterprise green innovation, such as long investment cycle, large investment amount and high adjustment cost, make enterprise green innovation have high risk and serious information asymmetry. And the financing constraint caused by information asymmetry will further inhibit enterprise green innovation. In addition, management short-sightedness also reduces corporate green innovation. In order to cater to investors and avoid being fired, corporate managers often tend to invest in financial assets to obtain excess short-term profits, thus boosting the financial position and stock price of the firm, which will reduce corporate green innovation. Therefore, reducing market information asymmetry and mitigating corporate management short-sightedness can improve corporate green innovation.

With the development of China's capital market, external supervision plays an increasingly important role in corporate decision-making and development. For enterprises, external supervision includes such methods as securities analyst tracking and institutional investor shareholding. Different types of external monitoring methods have different paths of action. Specifically, analysts, as independent third-party

information intermediaries, have their unique channel advantages, and are able to obtain specific information about the green innovation projects of enterprises that cannot be accessed by other investors, and then collate and analyze this information to form a research report, which is transmitted to external investors, thus alleviating the information asymmetry between enterprises and investors. For institutional investors, when their shareholding ratio reaches a certain level, institutional investors can participate in corporate governance as shareholders, thus playing a supervisory role in corporate operations and reducing the short-sighted effect of management. Overall, external supervision can reduce market information asymmetry and mitigate the myopic effect of corporate management, thus playing a positive role in reducing the financialization of enterprises and improving the level of corporate green innovation. In summary, this paper proposes the following hypotheses.

H2. External supervision can weaken the disincentive effect of corporate financialization on green innovation.

3. Research Design

3.1. Data Source and Sample

This paper selects Shanghai and Shenzhen A-share manufacturing firms from 2008 to 2022 to empirically test the impact of corporate financialization on green innovation. This paper eliminates endogeneity by fixing individual effects and time effects. The green patent application data used in this paper are from the China Research Data Service Platform database (CNRDS); other data, such as financialization data, corporate financial data and analysts' attention data, are from the Cathay Pacific database (CSMAR). In order to ensure the reliability of the empirical results, the following treatments are applied to the research data in this paper: (1) ST and * ST type of enterprises are excluded; (2) sample data with outliers and missing values of core variables are excluded; (3) in order to control the impact of extreme values on the research results, all continuous variables are shrink-tailed at the 1% level.

3.2. Variable Definition

Table 1. The definitions of variable of the model

Variables	Acronyms	Measurement form
Green innovation	GI	Logarithm of Green Patent Filings plus 1 for Listed Companies
Enterprise financialization	FIN	The proportion of financial assets to total assets
Analyst's attention	Analyst	Logarithm of the number of analysts plus one
Institutional investor shareholding	INST	The proportion of shares held by institutional investors to the total number of shares
The size of the enterprise	Size	The natural logarithm of total assets
Asset liability ratio	Lev	Total liabilities to total assets
Total asset profit margin	ROA	Net profit divided by the average balance of total assets
Cash flow ratio	Cashflow	Operating cash flow divided by liabilities
Enterprise growth capability	Growth	Growth rate of main business income
Company age	ListAge	Year of establishment of the company
ownership concentration	Top1	Shareholding ratio of the largest shareholder
Proportion of independent directors	Indep	The proportion of independent directors in the total number of directors
Duality	Dual	Virtual variable, assigned a value of 1 when the chairman and general manager of the enterprise are the same person, otherwise 0

In the empirical study, this paper defines the green innovation level (GI) as the logarithmic value of the number of green patent applications of an enterprise in that year plus

1, because the number of patent applications of an enterprise can most directly reflect its green innovation output in that year. The larger the value of GI is, the more significant the

green innovation results of an enterprise are, and the higher the innovation level is. For the degree of financialization (FIN) of enterprises, this paper adopts the proportion of enterprises' financial assets to total assets to measure. Among them, the definition of financial assets refers to the research of Du Yong (2017) and Gu Haifeng (2021), and includes trading financial assets, derivative financial assets, net loans and advances granted, net available-for-sale financial assets, net held-to-maturity investments, and net investment real estate into the category of financial assets. The level of external supervision is measured by two indicators: analysts' attention (Analyst) and the proportion of shares held by structured investors (INST). In this case, analyst attention takes the logarithmic value of the number of analysts tracking plus one. The selection of control variables is shown in Table 1.

3.3. Models

In order to study the impact of corporate financialization on green innovation, this paper adopts a multiple linear regression model to benchmark the processed panel data. The constructed regression model is as follows:

$$GI_{it} = \alpha_0 + \alpha_1 FIN_{i,t} + \alpha_2 Controls_{i,t} + \mu_i + \gamma_i + \varepsilon_{i,t} \quad (1)$$

Where i represents the enterprise, t represents year; GI_{it} represents the green innovation level of firm i in year t ; $FIN_{i,t}$ represents the financialization level of firm i in year t ; $Controls_{i,t}$ represents the set of control variables; μ_i represents individual fixed effects; γ_i represents the time fixed effect, which are used to control the factors that change with individuals and the time, respectively, and $\varepsilon_{i,t}$ represents the random perturbation term.

In order to study the role of external supervision on the relationship between the two, the level of external supervision and its cross-multiplier term with the financialization of firms are added to model (1) while keeping other variables constant to form model (2), and the specific regression model is shown below:

$$GI_{it} = \alpha_0 + \alpha_1 FIN_{i,t} + \alpha_2 Exterior_{i,t} + \alpha_3 FIN_{i,t} \times Exterior_{i,t} + \beta_4 Controls_{i,t} + \mu_i + \gamma_i + \varepsilon_{i,t} \quad (2)$$

Where $Exterior_{i,t}$ represents the level of firm i in year t .

In the analysis, α_1 and α_3 are the coefficients to focus on, in which α_1 is used to portray the impact of the degree of financialization of enterprises on green innovation, and α_3 describes how the external supervision affects the relationship between the financialization of enterprises and green innovation, based on the theoretical analysis in the previous section, it is expected that the sign of α_1 is negative, and the sign of α_3 is positive, i.e., the external supervision has a positive moderating effect.

4. Empirical Analysis

4.1. Descriptive Statics and Correlation Analysis

4.1.1. Descriptive Statics

From the descriptive statistics in Table 2, it can be seen that the sample includes a total of 10,725 data. Among them, the mean value of financialization (FIN) is 0.026, indicating that the overall financialization level of the manufacturing industry is not high. However, the difference between the median and the mean of FIN is large, indicating that there are some enterprises with a high degree of financialization, which plays a pulling role in the overall financialization of the manufacturing industry. The standard deviation of FIN is 0.053, and the overall degree of fluctuation is small, indicating that there is a polarization in the degree of financialization of the enterprises in the sample. The mean value of Green Innovation (GI) is 0.808, which is very different from the maximum value of 4.718, indicating that the overall degree of green innovation in the manufacturing industry is low. And the median of GI is 0, with a large difference from the mean value, indicating that some manufacturing enterprises have more green patent applications, which in turn pulls up the green innovation level of the whole industry.

Table 2. Descriptive statistics of variables

variable	Number	mean	p50	sd	min	max
GI	10725	0.808	0	1.071	0	4.718
FIN	10725	0.026	0.003	0.053	0	0.318
Size	10725	21.79	21.65	1.056	20.01	25.62
Lev	10725	0.348	0.333	0.176	0.049	0.767
ROA	10725	0.055	0.050	0.057	-0.165	0.232
Growth	10725	0.182	0.137	0.296	-0.412	1.519
Cashflow	10725	0.052	0.050	0.0610	-0.116	0.234
ListAge	10725	1.767	1.792	0.819	0	3.296
Top1	10725	0.326	0.306	0.135	0.089	0.700
Indep	10725	0.376	0.333	0.053	0.333	0.571
Dual	10725	0.348	0	0.476	0	1
SOE	10725	0.178	0	0.382	0	1

4.1.2. Correlation Analysis

The specific results of the correlation analysis of this paper are shown in Table 3. As can be seen in Table 3, the coefficient of financialization (FIN) on green innovation (GI) is -0.023 and significant at the 5% significance level, indicating a significant correlation between financialization and green

innovation. The correlation coefficients between the other variables are less than 0.5. The VIF test of the variables reveals that the VIF values of all the variables are less than 2, which is much less than 10, indicating that there is no multicollinearity between the variables.

Table 3. Correlation analysis of variables

	GI	FIN	Size	Lev	ROA	Growth	Cashflow	ListAge	Top1	Indep	Dual
GI	1										
FIN	-0.023**	1									
Size	0.505***	0.038***	1								
Lev	0.325***	-0.095***	0.516***	1							
ROA	-0.040***	0.032***	-0.062***	-0.386***	1						
Growth	0.055***	-0.044***	0.048***	0.061***	0.294***	1					
Cashflow	0.024**	0.080***	0.094***	-0.122***	0.434***	-0.014	1				
ListAge	0.281***	0.187***	0.582***	0.371***	-0.248***	-0.085***	0.114***	1			
Top1	-0.084***	-0.050***	0.004	-0.038***	0.143***	0.005	0.068***	-0.186***	1		
Indep	0.013	0.038***	0.001	0.001	-0.029***	-0.004	-0.002	0.004	0.067***	1	
Dual	-0.035***	0.004	-0.126***	-0.085***	0.038***	0.035***	-0.012	-0.184***	0.044***	0.141***	1

4.2. Empirical Result

Table 4. The impact of corporate financialization on green innovation

	(1)	(2)	(3)
	GI	GI 1	GI 2
FIN	-0.813*** (-5.21)	-0.488*** (-3.72)	-0.713*** (-5.22)
Size	0.518*** (25.85)	0.407*** (24.13)	0.370*** (21.09)
Lev	0.011 (0.14)	0.037 (0.56)	0.041 (0.59)
ROA	0.271 (1.53)	0.141 (0.94)	0.214 (1.37)
Growth	-0.044* (-1.84)	-0.049** (-2.43)	-0.049** (-2.32)
Cashflow	0.389*** (2.89)	0.440*** (3.89)	0.253** (2.14)
ListAge	-0.103*** (-4.29)	-0.132*** (-6.52)	-0.081*** (-3.86)
Top1	0.295** (2.36)	0.253** (2.41)	0.361*** (3.29)
Indep	0.097 (0.51)	0.134 (0.83)	0.103 (0.61)
Dual	-0.023 (-1.11)	-0.006 (-0.33)	-0.039** (-2.15)
_cons	-11.127*** (-14.37)	-8.312*** (-12.77)	-8.288*** (-12.22)
N	10725	10725	10725
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R ²	0.273	0.210	0.215
Adj.R ²	0.181	0.110	0.116

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; The value in parentheses is the value of t

In order to test hypothesis H1, i.e., the impact of financialization on corporate green innovation, this paper uses the least squares method to conduct multiple linear regression on model (1), and the specific regression results are shown in Table 4. After controlling for individual fixed effects and time fixed effects, it can be seen that the regression coefficient of financialization (FIN) on green innovation (GI) is -0.813, and it is significantly negative at the 1% level, which indicates that financialization can significantly inhibit corporate green innovation, and its inhibitory effect on corporate green

innovation gradually increases with the deepening of financialization. Further, regressing the two sub-dimensions of green innovation, green invention innovation (GI_1) and green utility model innovation (GI_2), respectively, it is found that the values of financialization coefficients of the two are -0.488 and -0.713, respectively, which are both significant at 1% level of significance, suggesting that the effect of financialization on enterprises' green invention and green utility model innovation also both have inhibitory effects, verifying hypothesis H1a.

In order to test hypothesis H2, the effect of external supervision on the relationship between corporate financialization and green innovation, external supervision and the interaction term between external supervision and financialization are added to model (1), i.e., model (2) is regressed. Among them, analyst attention (Analyst) and institutional investor shareholding ratio (INST) are chosen as the measures for external supervision, and the specific regression results are shown in Table 5. Among them, column (1) is the regression result with the addition of Analyst attention and its interaction term with financialization, and column (4) is the regression result with the addition of institutional investor shareholding and its interaction term with financialization.

From Table 5, the value of the coefficient of FIN in column (1) is -1.261, which is significantly negative, and the coefficient of the cross-multiplier term FIN×Analyst is 0.391, which is significantly positive, suggesting that analysts' attention is able to mitigate the inhibitory effect of financialization on firms' green innovation. It proves that analysts, as information intermediaries in the capital market, are able to promote high-quality dissemination of information and reduce information asymmetry in the market by, for example, publishing research reports. The value of the coefficient of FIN in column (2) of Table 5 is -1.637, which is significantly negative at the 1% level, and the coefficient of the cross-multiplier term FIN × INST is 2.617, which is significantly positive at the 1% level, indicating that institutional investor shareholding can significantly mitigate the inhibitory effect of corporate financialization on green innovation. It indicates that for professional investment institutions, institutional investors can reduce the short-sighted effect of management by playing a supervisory role. In summary, regardless of whether the measurement indicator is analysts' concern or institutional investors' shareholding, it can indicate that external supervision can alleviate the inhibitory effect of corporate financialization on green

innovation.

Table 5. Corporate financialization, external supervision, and green innovation

	(1)	(2)
	GI	GI
FIN	-1.261***	-1.637***
	(-7.18)	(-6.68)
Analyst	0.007	
	(0.58)	
FIN×Analyst	0.391***	
	(2.71)	
INST		-0.011
		(-0.17)
FIN×INST		2.617***
		(3.81)
_cons	-10.865***	0.513***
	(-11.89)	(12.74)
Control variable	Yes	Yes
Number of observations	10725	10725
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
R ²	0.274	0.275
Adj.R ²	0.271	0.272

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; The value in parentheses is the value of t

4.3. Robustness

4.3.1. Different Dependent Variable

Table 6. Different dependent variable

	(1)	(2)	(3)
	GI_new	Green_INV	Practical_Inv
FIN	-0.536***	-0.181*	-0.568***
	(-3.62)	(-1.92)	(-3.93)
_cons	-9.187***	-5.042***	-7.717***
	(-10.65)	(-7.27)	(-9.75)
Number of observations	10725	10725	10725
Control variable	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R ²	0.258	0.120	0.217
Adj.R ²	0.255	0.116	0.215

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; The value in parentheses is the value of t

In order to ensure the accuracy of the empirical results, this paper replaces the explanatory variables. In the previous section, green innovation (GI) represents the number of green innovation applications, and now this indicator is replaced with the number of green patents granted to enterprises in the year (GI_new), the number of green invention patents granted (Green_INV) and the number of green utility model patents granted (Practical_INV), where the number of green patent

grants is the sum of the number of green invention patents and the number of green The authorized number of green patents is the sum of the authorized number of green invention patents and green utility model patents. The number of green patents granted, the number of green invention patents granted and the number of green utility model patents granted are brought into the model (1) in turn for regression, and the regression results obtained are shown in Table 6.

The regression results in Table 6 show that after controlling for time and industry fixed effects, the coefficients of both GI_new and Practical_INV are significantly negative at the 1% level, and the coefficient of Green_INV is significantly negative at the 10% level. This suggests that the inhibitory effect of corporate financialization on green innovation still exists after replacing the measure of the dependent variable, proving the robustness of the findings.

4.3.2. Endogeneity

There may be mutual causality between corporate financialization and green innovation. Therefore, this paper needs to find suitable instrumental variables to eliminate the possible endogeneity between corporate financialization and green innovation as much as possible. In this paper, we refer to the method of Du Yong (2017), and use the financialization level with one period lag (L.FIN) as an instrumental variable to test for endogeneity. As shown in Table 7, when the explanatory variable is L.FIN, it passes the Anderson LM test and the F test, indicating that the variable L.FIN meets the requirements of exogeneity and correlation of instrumental variables. Therefore, L.FIN is substituted as an instrumental variable in model (1) for validation, and the specific results are shown in Table 7.

Table 7. Regression results of instrumental variables

	First stage (1)	Second stage (2)
L.FIN	0.441***	
	(40.46)	
FIN		-1.078***
		(-2.61)
Number of observations	9246	9246
Control variable	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
R ²	0.195	0.243
Adj.R ²	0.034	0.130
Anderson LM	1366.877***	

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; The value in parentheses is the value of t

As can be seen in Table 7, column (1) is the result of the first stage regression, where FIN with one period lag is significantly positively correlated with FIN. Column (2) is the result of the second-stage regression from the perspective of green innovation, where FIN and green innovation show a significant negative correlation, which is consistent with the previous conclusion.

5. Conclusion and Recommendations

5.1. Conclusion

Based on the above research, this paper draws the following two conclusions: (1) Overall, the financialization of

manufacturing firms has a significant inhibitory effect on green innovation, and the level of firms' green innovation is declining as the degree of firms' financialization increases. This conclusion still holds in the subsequent robustness and endogeneity tests. (2) External monitoring can weaken the inhibitory effect of corporate financialization on green innovation. The results of the empirical tests using analysts' attention and institutional investors' shareholding as indicators of external monitoring show that both analysts' attention and institutional investors' shareholding can positively regulate the inhibitory effect of corporate financialization on green innovation.

5.2. Recommendations

Based on the above theoretical analysis and empirical research, this paper puts forward the following suggestions: (1) For the government, it is necessary to further strengthen the supervision of financial investment in manufacturing enterprises and improve the relevant regulatory system. For example, big data technology is utilized to build an intelligent monitoring platform to monitor the level of financial investment of enterprises. In addition, the government can formulate corresponding policies and regulations to limit the number of financial assets allocated by enterprises, such as setting a reasonable financial asset allocation range for enterprises and ensuring that enterprises can strictly comply with it. (2) For enterprises, it is necessary to correctly understand the behavior of financialization and set up a correct business philosophy. For enterprises, moderate financialization can bring benefits to enterprises, but the behavior of abandoning the main business and focusing only on financial investment will bring disaster to enterprises. In addition, the return rate of financial assets is volatile and the risk of different types of financial assets varies. When allocating financial assets, enterprises should choose the right type of financial assets according to their own situation and pursue the maximum investment returns under the control of investment risks.

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