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Impact of Corporate Innovation on Greenwashing Behavior

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Abstract: As global attention to environmental protection intensifies, an increasing number of companies are engaging in greenwashing practices, which misrepresent their sustainability efforts. This paper presents an empirical analysis examining the impact of corporate innovation on greenwashing behavior. The findings reveal that innovation serves a crucial role in suppressing such misleading practices, as demonstrated by a fixed effects model. Furthermore, moderation effect analysis indicates that the relationship between innovation and greenwashing becomes more pronounced under imitative competitive pressure, suggesting that firms may enhance their commitment to sustainability when influenced by competitors. However, heterogeneity analysis indicates that this suppressive effect is less pronounced among state-owned enterprises and high-pollution industries, thereby underscoring the necessity for tailored strategies in these sectors. In sum, the findings offer valuable insights for corporate managers, market regulators, and investors, enabling more informed decision-making and promoting a more transparent and sustainable business landscape.

Keywords: innovation, greenwashing behavior, imitative competitive pressure, regression analysis, moderating effect.

1. Introduction

In recent decades, increasing environmental pressures have generated significant incentives for companies to communicate with their stakeholders in environmentally sustainable behavior [1]. As the urgency and importance of global carbon emission reduction have escalated in recent years, numerous firms are considering ideas to develop innovative green technologies to contribute to the low-carbon economy [2]. This transition is not merely a reaction to regulatory obligations and consumer expectations; it also signifies a broader acknowledgment that sustainable operations can cultivate long-term profitability and advantage [2].

However, alongside these genuine efforts toward sustainability, a troubling phenomenon has emerged, commonly called "greenwashing". Greenwashing refers to the behavior of companies presenting a deceptive image of environmental responsibility, often involving the exaggeration or fabrication of sustainability claims to gain favor with consumers and stakeholders [1]. Such actions can potentially undermine the credibility of genuinely sustainable practices and create confusion in the marketplace, eroding consumer trust [3]. Almost half of the companies exhibit varying degrees of greenwashing behavior, and this trend is increasing year by year [4].

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The relationship between corporate innovation and greenwashing is a complex and multifaceted phenomenon. On the one hand, corporate innovation, characterized by the development of new products, processes, and business models, has the potential to result in genuine enhancements in environmental performance [5]. Conversely, the pressure to appear sustainable may also prompt some companies to engage in greenwashing as a means of projecting an environmentally friendly image without implementing significant changes.

The objective of this study is to examine the correlation between an enterprise's propensity for innovation and the likelihood of engaging in greenwashing behavior. By investigating this relationship, we aim to address a pivotal question: Does a higher level of corporate innovation correlate with a lower propensity for greenwashing? It is crucial for stakeholders, supervisors, and investors to comprehend this relationship in order to ascertain authentic, reliable companies and make rational decisions.

2. Literature review and hypotheses development

Tang et al. have pointed out that corporate innovation remains a cornerstone of enterprises' economic development [6]. It encompasses a range of activities aimed at developing new products, processes, or business models that enhance a firm's competitiveness and sustainability, which will weaken the enterprise's dependence on greenwashing behaviors. Additionally, among all the innovations, green technology innovation is potentially the answer to the lack of motivation for independent green innovation, which can effectively alleviate many difficulties faced by enterprises engaging in independent green innovation according to Ma and Lin [7], and it will also inhibit greenwashing because of an authentic rise of the enterprise's green level.

Moreover, Li and Ding's research has found that enterprises' profits exhibit an inverted U-shaped trend as their greenness increases in the first period and a continuing negative trend in the second period [8]. This indicates that greenwashing can only yield short-term advantages for a corporation. Conversely, innovation will yield long-term benefits. Consequently, a company that focuses on innovation is more likely to prioritize long-term benefits and, as a result, is less likely to engage in greenwashing. Also, Shi et al.'s research has suggested that executive green human capital could significantly alleviate firms, greenwashing, stimulating the inherently pro-environmental behavior within enterprises [9]. This finding suggests that corporate executives with an awareness of environmental issues play a significant role in influencing corporate greenwashing behavior. These individuals tend to demonstrate a greater inclination towards engaging in green innovation.

Above all, innovation has the potential to mitigate the impact of corporate greenwashing. This is because the implementation of environmentally conscious innovations can directly influence a company's environmental footprint. Additionally, the pursuit of innovation can contribute to the development of long-term benefits for the company, reducing its reliance on greenwashing tactics. Moreover, innovation, to some extent, can prove that the corporation prioritizes long-term benefits and that its executives are equipped with green awareness, which will decrease the chance of greenwashing. Therefore, we propose the following hypothesis:

H1.: A higher level of corporate innovation will inhibit its behavior of greenwashing.

Furthermore, the research conducted by Bai et al. [10]has demonstrated that imitative competitive pressure is a contributing factor in the promotion of greenwashing behavior. Imitative competitive pressure can be defined as the tendency of firms to imitate competitors or benchmark firms in the industry when faced with environmental uncertainty or ambiguity of organizational goals. This is done in order to mitigate turbulence and to maintain legitimacy and competitive advantage. However, greenwashing by other firms in the industry threatens these advantages, which in turn creates imitative competitive pressure to the firm [10]. This pressure may serve to modify the relationship between innovation and greenwashing. In the face of such pressure, the firm persists in its commitment to

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innovation over imitation. This decision provides the firm with enhanced resilience to greenwashing compared to other firms in other low-imitative-competitive-pressure industries, thereby reinforcing the inhibitory relationship. Therefore, we propose the following hypothesis:

H2.: Imitative competitive pressure has a reinforcing moderating effect on the ability of innovation to inhibit greenwashing.

3. Data and methodology

3.1. Data source

The firm-level data are primarily sourced from the China Stock Market and Accounting Research Database (CSMAR). To ensure the validity of our research, we have excluded firms listed on the Shanghai Stock Exchanges that are in the financial industry and those that have been tagged as requiring special treatment (ST and *ST). To ensure the timeliness of our analysis, we selected data from 2018 to 2022. The research comprises 4,514 firm-year observations.

3.2. Variables

3.2.1. Dependent variable: Greenwashing

To quantify greenwashing, we adopt the approach in Li et al. [11]'s research as follows:

$$GW = \frac{ESG_{Disclosure} - \overline{ESG_{Disclosure}}}{\sigma_{ESG_{disclosure}}} - \frac{ESG_{Practice} - \overline{ESG_{Practice}}}{\sigma_{ESG_{Practice}}} \quad (1)$$

The fundamental premise of this model is to quantify the discrepancy between the environmental protection policies espoused by firms and their actual practices. The first term represents the firm's stated position, while the second term represents the firm's actual practice. The respective measurements are obtained by normalizing a firm's score in the Bloomberg and Huazheng ESG scores.

3.2.2. Independent variable: Innovation

To assess a company's level of innovation, we have adopted the methodology proposed by Tang et al. [6]. The logarithm of the number of patents filed by the company in question in the given year, plus one, is employed as a measure of the company's innovation index. Additionally, the number of patents granted was selected and processed as a proxy variable for subsequent robustness tests.

3.2.3. Moderating variable: Imitative competitive pressure

A moderating variable modifies the strength or direction of the relationship between the independent and dependent variables, thereby altering the effect of the independent variable on the dependent variable under different conditions. In our research, we have adopted the approach proposed by Bai et al. [10], which employs imitative competitive pressure as a variable. This variable is calculated to determine the average level of greenwashing in that industry by measuring the mean value of the greenwashing index within an industry. It has a moderating effect on the relationship between dependent and independent variables because a firm is more likely to engage in greenwashing to maintain its competitiveness if its peers are also doing so [10].

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3.2.4. Control variables

Additionally, some other variables are considered in our research as control variables, which are age, size, lev, growth, ROA, dual, top5, and inra. All the variables and their definition are illustrated in Table 1.

Table 2 presents a summary of the statistical data pertaining to our sample, offering an overview of the principal variables utilized in the analysis. The incorporation of these control variables allows for a comprehensive analysis of the influence of analyst coverage on greenwashing, thereby ensuring the robustness and reliability of our findings.

Table 1: Variables and Definitions

Variable	Definition
GW	Greenwashing index of the corporation
Inno	Logarithm of number of patents filed plus one
Patent	Logarithm of number of patents gained plus one
Imi	Average greenwashing index of an industry
Age	Logarithm of age of the corporation plus one
Size	Total assets of the corporation
Lev	Asset liability ratio of the corporation
Growth	Business growth rate of the corporation
ROA	Return on asset of the corporation
Dual	Whether there is a manager who is also a director, if there is, take 1, if there is not, take 0.
Top5	Shareholding of top five shareholders
Inra	Proportion of independent directors

Table 2: Descriptive Statistics

Variable	N	Mean	SD	Min	p50	Max
GW	4514	-0.020	1.170	-3.790	-0.0600	5.030
Inno	4514	1.940	1.980	0	1.610	9.300
Patent	4514	1.730	1.830	0	1.390	8.820
Imi	4514	0	0.410	-2	-0.040	1.410
Age	4514	2.490	0.770	0	2.710	3.400
Size	4514	23.520	1.250	20.330	23.40	28.640
Lev	4514	0.460	0.190	0.010	0.480	1.700
Growth	4514	0.350	7.060	-0.870	0.110	429
ROA	4514	0.050	0.080	-0.970	0.040	0.640
Top5	4514	0.540	0.160	0.130	0.540	0.970
Dual	4514	0.230	0.420	0	0	1
Inra	4514	0.380	0.060	0.250	0.360	0.800

3.3. Model construction

3.3.1. Baseline model

To examine the impact of corporation innovation on greenwashing behavior, we adopt the model below:

$$GW_{i,t} = \alpha_0 + \alpha_1 Inno_{i,t} + \alpha_2 \Sigma Controls_{i,t} + \Sigma Industry + \Sigma Year + \varepsilon_{i,t} \quad (2)$$

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where $GW_{i,t}$ represents the corporate greenwashing behavior of firm i in year t. $Inno_{i,t}$ defines the corporate innovation index of firm i in year t. $Controls_{i,t}$ denotes other the control variables. $\sum Industry$ and $\sum Year$ are the industry and year fixed effect respectively. $\varepsilon_{i,t}$ is the random error term.

3.3.2. Mechanism test

Following the previews literature, and combined with model (2), we construct the following model to further explore the moderating effect of *Imi* on the relationship between innovation and greenwashing:

$$GW_{i,t} = \beta_0 + \beta_1 Inno_{i,t} + \beta_2 Imi + \beta_3 \Sigma Controls_{i,t} + \Sigma Industry + \Sigma Year + \varepsilon_{i,t} \quad (3)$$

$$GW_{i,t} = \gamma_0 + \gamma_1 Inno_{i,t} + \gamma_2 Imi + \gamma_3 Inno \cdot Imi + \gamma_4 \Sigma Controls_{i,t} + \Sigma Industry + \Sigma Year + \varepsilon_{i,t} \quad (4)$$

where *Imi* serves as a moderating variable and posts some effect on the relationship between *Inno* and *GW*. Model (4) can assess this effect and a significant moderating effect represents that *Imi* can change the strength or direction of the relationship between the independent and dependent variables.

4. Empirical analysis

4.1. Baseline results

Table 3 presents the results of the baseline model. The table shows that the coefficient for Inno is -0.0583, which is significant at the 1% level. This indicates that a higher level of corporate innovation tends to inhibit greenwashing behavior, thereby supporting the validity of hypothesis H1.

4.2. Moderating effect

To test the moderating effect of *Imi* on the relationship between *Inno* and *GW*, we add moderating variable and interaction terms to model (2) and construct model (3) and model (4). The results are shown in Table 4.

From column (2) in Table 4, it can be seen that the coefficient for the interaction is -0.106, which is significant at the 5% level. In comparison to the coefficient of the *Inno* term, this coefficient has the same sign. This suggests that *Imi* has a reinforcing moderating effect, proving the validity of hypothesis H2. In industries with a high average greenwashing index, innovation will more significantly inhibit greenwashing behavior.

Table 3: Baseline Results

	(1) GW
Inno	-0.058***
	(0.009)
Age	-0.023
	(0.023)
Size	0.156***
	(0.016)
Lev	0.768***
	(0.109)
Growth	0.001
	(0.002)

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Table 3: (continued).

ROA	-0.530**
	(0.212)
Top5	0.400***
	(0.112)
Dual	0.045
	(0.037)
Inra	-1.150***
	(0.257)
Year	Controlled
Industry	Controlled
_cons	-3.922***
	(0.379)
N	4514
R^2	0.304
adj. R^2	0.292

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.3. Robustness test

To enhance the robustness of our research findings, we conducted a thorough robustness test by substituting the independent variable (*Inno*) with *Patent*. Here, *Patent* is defined as the logarithm of the number of patents obtained, adjusted by adding one to account for instances where the patent count may be zero. The outcomes of this robustness test are comprehensively presented in Table 5, illustrating that our results remain consistent across different variable specifications. This further reinforces the reliability of our conclusions.

Table 4: Moderating Effect

	(1) GW	(2) GW
Inno	-0.058***	-0.038***
	(0.009)	(0.014)
Imi	0.244	0.265
	(0.414)	(0.414)
Age	-0.023	-0.026
	(0.023)	(0.023)
Size	0.156***	0.152***
	(0.016)	(0.016)
Lev	0.768***	0.767***
	(0.109)	(0.109)
Growth	0.001	0.001
	(0.002)	(0.002)
ROA	-0.531**	-0.521**
	(0.212)	(0.212)
Top5	0.401***	0.405***
	(0.112)	(0.112)
Dual	0.045	0.043

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Table 4: (continued).

	(0.037)	(0.037)
Inra	-1.148***	-1.146***
	(0.257)	(0.257)
Inno_Imi		-0.106**
		(0.052)
Year	Controlled	Controlled
Industry	Controlled	Controlled
_cons	-3.933***	-3.800***
	(0.380)	(0.385)
N	4514	4514
R^2	0.304	0.305
adj. R^2	0.292	0.292

From Table 5, we observe that the coefficient for *Patent* is -0.059, which is significant at the 1% level. This finding closely resembles the results obtained from the original independent variable, thereby providing strong evidence for the robustness of our model. The consistency of these results across different specifications reinforces the reliability of our conclusions and affirms the validity of our research framework.

Table 5: Robustness Test Results

	(1)
	GW
Patent	-0.059***
	(0.010)
Age	-0.021
	(0.023)
Size	0.157***
	(0.016)
Lev	0.757***
	(0.109)
Growth	0.000
	(0.002)
ROA	-0.585***
	(0.211)
Top5	0.390***
	(0.112)
Dual	0.042
	(0.037)
Inra	-1.143***
	(0.257)
Year	Controlled
Industry	Controlled
_cons	-3.938***
	(0.380)
N	4514
R^2	0.303
adj. R^2	0.291

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4.4. Endogeneity test

Since greenwashing by companies may have an impact on their innovation to some extent—for instance, companies with a high degree of greenwashing may pay less attention to innovation—there may be endogeneity issues in this model. To address this problem, we employed two methods for the test: (1) lagging the independent variable by one period and then re-running the regression; (2) using an instrumental variable approach, we selected the average innovation index of the industry excluding the company itself as the instrumental variable based on previous literature [12], and conducted a 2sls regression. The results of the test are shown in Table 6.

Table 6: Endogeneity Test Results

	(1) GW	(2) Inno	(3) GW
L_Inno	-0.043***		
	(0.011)		
Age	0.020	-0.171***	-0.017
	(0.031)	(0.031)	(0.023)
Size	0.168***	0.144***	0.151***
	(0.019)	(0.022)	(0.017)
Lev	0.796***	0.435***	0.766***
	(0.128)	(0.151)	(0.108)
Growth	0.036**	-0.001	0.001
	(0.015)	(0.003)	(0.002)
ROA	-0.629**	2.019***	-0.547**
	(0.255)	(0.292)	(0.212)
Top5	0.291**	-0.371**	0.403***
	(0.129)	(0.155)	(0.111)
Dual	0.036	-0.049	0.046
	(0.043)	(0.052)	(0.037)
Inra	-1.029***	0.095	-1.152***
	(0.299)	(0.355)	(0.255)
iv		-26.120***	
		(0.600)	
Inno			-0.040**
			(0.017)
Year	Controlled	Controlled	Controlled
Industry	Controlled	Controlled	Controlled
_cons	-4.277***	17.060***	-3.820***
	(0.439)	(0.725)	(0.383)
N	3355	4505	4505
R^2	0.300	0.534	0.303
adj. R^2	0.284	0.526	0.290

In Table 6, *L_Inno* represents the lagged one-period independent variable. *Iv* is the instrumental variable calculated based on the average level of innovation in the industry, excluding the firm itself. Column (1) presents the results of the first method, while columns (2) and (3) show the results of the

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second method. The coefficients for *L_Inno*, *Iv*, and *Inno* in columns (1), (2), and (3) are all significant, indicating that the model has successfully passed the endogeneity test.

4.5. Heterogeneity analysis

To further explore the robustness of our findings, we conducted a heterogeneity analysis to examine whether the effects of innovation on greenwashing behavior differ across various subgroups. Our study divides the firms into the following two groups: (1) based on whether they are state-owned enterprises (SOE); (2) based on whether they are heavily polluting enterprises (HPE). We conducted a heterogeneity analysis on these groups, and the results are presented in Table 7.

Table 7: Heterogeneity Analysis Results

	(1) SOE = 1 GW	(2) SOE = 0 GW	(3) HPE = 1 GW	(4) HPE = 0 GW
Inno	-0.030**	-0.079***	-0.043**	-0.065***
	(0.013)	(0.013)	(0.017)	(0.011)
Age	0.117***	-0.059*	0.079*	-0.071***
	(0.044)	(0.030)	(0.043)	(0.027)
Size	0.114***	0.214***	0.147***	0.151***
	(0.023)	(0.025)	(0.031)	(0.019)
Lev	0.503***	0.985***	0.879***	0.748***
	(0.160)	(0.155)	(0.194)	(0.132)
Growth	-0.001	0.006	0.003	0.000
	(0.002)	(0.005)	(0.006)	(0.002)
ROA	-0.600	-0.425*	-0.295	-0.641**
	(0.411)	(0.255)	(0.377)	(0.257)
Top5	0.943***	0.288*	0.990***	0.089
	(0.174)	(0.155)	(0.201)	(0.136)
Dual	0.079	-0.019	-0.028	0.077*
	(0.079)	(0.044)	(0.068)	(0.044)
Inra	-0.933***	-1.059***	-0.631	-1.325***
	(0.341)	(0.403)	(0.486)	(0.301)
Year	Controlled	Controlled	Controlled	Controlled
Industry	Controlled	Controlled	Controlled	Controlled
_cons	-3.795***	-4.786***	-4.908***	-3.435***
	(0.539)	(0.594)	(0.673)	(0.435)
N	2118	2396	1529	2985
R^2	0.376	0.296	0.294	0.292
adj. R^2	0.354	0.274	0.281	0.277

In Table 7, the coefficients for Inno in every column are significant, indicating that hypothesis H1 is valid regardless of whether the firm is state-owned or whether it belongs to a high-pollution industry. However, it is important to note that the coefficient in column (1) and column (3) is less significant than those in the other columns, suggesting that the inhibitory effect of innovation on greenwashing is not as pronounced in high-pollution enterprises or state-owned enterprises compared to other firms.

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5. Conclusion

The objective of our research is to ascertain the influence of corporate innovation on greenwashing behavior. To this end, we have conducted a comprehensive analysis employing a range of sophisticated techniques, including fixed effects models, moderation effects analysis, variable substitution, endogeneity testing, and heterogeneity analysis. Our findings indicate that corporate innovation exerts a suppressive effect on greenwashing behavior.

Furthermore, our findings indicate that imitative competitive pressure plays a beneficial role in moderating the relationship between innovation and greenwashing. In industries with elevated imitative competitive pressure, characterized by a higher average greenwashing level, innovation exerts a more pronounced inhibitory effect on greenwashing.

Additionally, heterogeneity analysis indicates that in state-owned enterprises or high-pollution enterprises, the inhibitory effect of innovation on greenwashing is less pronounced than in other firms.

The findings of our research are of significant value to corporate managers, market regulators, and investors alike. For those in managerial roles, the findings highlight the necessity of prioritizing innovation as a means of reducing greenwashing behaviors and implementing authentic environmental practices. For market regulators and investors, the level of a company's innovation may serve as an indicator of its degree of greenwashing, thereby assisting in the formulation of appropriate management policies or investment decisions.

While this study offers insights into the relationship between innovation and greenwashing, it is essential to acknowledge the limitations of the research. Firstly, our quantification of greenwashing and innovation is incomplete and simplified, and thus, other important factors ought to be taken into consideration. Secondly, the sample selected for analysis does not account for geographical factors that may influence greenwashing from an environmental or political standpoint. It would be beneficial for future research to expand the scope to encompass these entities, thus providing a more comprehensive and holistic view of the relationship between innovation and greenwashing.

References

[1] *M. Kiran, S. Chughtai, and M. A. Naeem, "Navigating greenwashing in the G8: Insights into family-owned firms, technology innovation, and economic policy uncertainty," Research in International Business and Finance, vol. 71, 2024.*

[2] *S. Liu, J. J. Yu, and T. Feng, "The impact of green innovations on firm's sustainable operations: Process innovation and recycling innovation," Omega, 2024.*

[3] *Y. Wang, C. Xing, and L. Zhang, "Is greenwashing beneficial for corporate access to financing? Evidence from China," Finance Research Letters, vol. 65, 2024.*

[4] *L. Chen, Y. Ma, G.-F. Feng, and C.-P. Chang, "Does environmental governance mitigate the detriment of greenwashing on innovation in China?," Pacific-Basin Finance Journal, vol. 86, 2024.*

[5] *Z. Wei, Q. Chu, and Z. Wenyao, "Top management team characteristics, technological innovation and firm's greenwashing: Evidence from China's heavy-polluting industries %J Technological Forecasting & Social Change," vol. 191, 2023.*

[6] *J. Tang, R. Gong, Y. Shi, H. Wang, and M. Wang, "Does financialization inhibit enterprise innovation? Analysis of innovation behavior of Chinese enterprises based on evolutionary game," Heliyon, vol. 10, no. 16, 2024.*

[7] *R. Ma and B. Lin, "Internet development, information availability, and Chinese enterprises' cooperative green technology innovation," J Environ Manage, vol. 367, p. 121972, Sep 2024.*

[8] *X. Li and Z. Ding, "Decision-making mechanisms of greenwashing behaviors of building materials manufacturers: A media disclosure and consumer skepticism perspective," Environmental Technology & Innovation, vol. 35, 2024.*

[9] *D. Shi, S. Lu, and Z. Fang, "The effect of executive green human capital on greenwashing," Research in International Business and Finance, vol. 71, 2024.*

[10] *J. Bai, C. Luo, and F. Gu, "Institutional Legitimacy Pressure and Corporate ESG Greenwashing," Systems Engineering-Theory & Practice, 2024.*

[11] *D. Li, Z. Zhang, and X. Gao, "Does artificial intelligence deter greenwashing?," Finance Research Letters, vol. 67, 2024.*

DOI: 10.54254/2754-1169/139/2024.19233

[12] Y. Shen, "ESG performance, technological innovation and financing constraints," Management and Administration, 2024.