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EXECUTIVES' ENVIRONMENTAL BACKGROUNDS AND GREEN INNOVATION BUBBLES: EVIDENCE FROM CHINESE LISTED FIRMS

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Abstract: The study examines the impact of executives' environmental backgrounds on corporate green innovation bubbles, analyzing a sample of Chinese listed firms from 2010 to 2022. The findings indicate that appointing executives with environmental expertise significantly mitigates green innovation bubbles, a phenomenon characterized by the decoupling between the quantity and quality of green innovation. Mechanism analyses reveal that such executives operate through two key channels: by enhancing the green cognition of the management team and by improving government–enterprise communication. Furthermore, cross-sectional tests show that the restraining effect is more pronounced under specific conditions—particularly in firms facing higher performance pressure, those with higher resource allocation efficiency, or those receiving fewer government green R&D subsidies. Overall, the results suggest that executives with environmental backgrounds help firms shift their focus from short-term innovation metrics toward substantive green innovation. These insights offer meaningful implications for corporate governance and for policy design aimed at fostering high-quality green transitions.
Keywords: Executive's environmental background; Green innovation bubbles; Executives' green cognition; Government enterprise linkage

1 INTRODUCTION

Driven by the global climate governance and sustainable development agenda, green innovation has become a core strategy for nations worldwide to achieve synergistic coexistence between economic growth and ecological conservation. Within this grand narrative, corporate green technology innovation activities are no longer merely expressions of social responsibility but strategic imperatives concerning survival and development, as well as securing policy dividends and market favor. However, fueled by both policy incentives and market expectations, The "green innovation bubbles" is quietly emerging worldwide, posing a severe challenge to the effectiveness of the green transition.

The "green innovation bubbles" is a term used to describe a systemic divergence between "quantity" and "quality," as well as "form" and "substance," in corporate green innovation efforts. Specifically, it manifests as companies strategically allocating resources toward innovation activities that yield quickly measurable and reportable outcomes. These outcomes may include the company's ability to rapidly respond to external pressures, secure government subsidies, boost ESG ratings, or shape market perceptions. However, these outcomes may be achieved by intentionally or unintentionally neglecting breakthrough R&D that requires long-term investment, carries high risks, yet holds the potential for fundamental environmental improvement [1]. This "bubbles" is not a reference to inflated financial asset prices, but rather to the substantial hollowing-out of innovation outcomes. This phenomenon engenders an illusion of prosperity. On a macro level, there is a surge in green patent numbers and an increase in R&D investment ratios. On a micro level, companies experience gradual improvements in their environmental performance, while core technological bottlenecks persist [2].

In addressing this challenge, the strategic role of top management (TMT) is paramount. Among them, executives with environmental backgrounds are viewed as a potential key governance factor. According to upper echelons theory, the cognitive foundations and values of the executive team profoundly shape organizational strategy. The unique academic or professional backgrounds of executives with environmental expertise enable them to internalize long-term sustainability values. This allows them to transcend superficial perceptions that view environmental protection solely as compliance costs or public relations tools, instead examining the genuine benefits of green innovation from the perspective of strategic core competitiveness [3]. Simultaneously, through their decision-making authority and informal influence, they can permeate and elevate the entire executive team's "green cognitive threshold." This approach fundamentally resists superficial, bubble-like projects from the outset [4].

The extant literature on executives with environmental backgrounds primarily focuses on green innovation activities and corporate environmental responsibility implementation, with limited exploration of the novel research topic of green innovation bubbles [5]. This study empirically examines the impact of executives with an environmental background on green innovation bubbles and their underlying mechanisms. It uses a sample of Chinese A-share listed companies from 2010 to 2022. The study also investigates the moderating effects of external pressures and internal

governance factors, with the aim of providing theoretical foundations and practical insights for the governance and policy design of corporate sustainable development.

The present study makes three key contributions to the field. Firstly, the theoretical conceptual contribution. The present study introduces the concept of the "green innovation bubble" into the research discourse on corporate sustainability and innovation management, thereby shifting the focus from the question of "whether innovation occurs" to the examination of "what kind of innovation occurs." This provides a novel and important theoretical perspective for understanding opportunistic behaviour within corporate environmental strategies.

Secondly, the analysis of the mechanisms involved. The objective of this study is to explore the mechanisms through which environmentally conscious executives exercise influence. The text elucidates how these executives curb innovation bubbles through a dual approach: enhancing the green cognition of the executive team and strengthening government-enterprise linkages based on professional capabilities. The present study contributes to the extant literature on the subject by offering a more sophisticated theoretical explanation of how micro-level executive decisions impact macro-level organisational strategic outcomes.

Thirdly, the contribution to the context. The present study will examine the moderating effects of internal and external contextual factors, with a view to answering the question of under what conditions environmental executives are most effective. This contextualisation enhances the practical relevance and managerial implications of the findings.

2 HYPOTHESIS DEVELOPMENT

Environmental executives typically possess educational backgrounds or extensive professional experience in environmental science, engineering, or sustainability-related fields. This distinctive “imprint” shapes their cognitive framework, setting them apart from other executives. They tend to evaluate innovation projects from the perspective of long-term ecological sustainability and corporate social responsibility, rather than focusing solely on short-term financial returns or policy arbitrage opportunities. This inherent cognitive bias makes them naturally wary of “bubble-like” projects that prioritize inflating innovation metrics over delivering tangible environmental benefits. Consequently, it reduces the likelihood of companies engaging in a “quantity game” within the green innovation race from the strategic outset [6]. We believe that environmental executives primarily curb corporate green innovation bubbles through the following two channels.

First, executives with environmental backgrounds can elevate the green awareness of the executive team, thereby curbing green innovation bubbles. The more direct and fundamental role of executives with environmental backgrounds is to comprehensively enhance the executive team's green awareness and strategic prioritization through knowledge transfer, agenda setting, and decision-making influence [7]. They introduce systematic environmental science knowledge, life-cycle environmental impact assessment methodologies, and forward-looking assessments of corporate environmental risks into strategic discussions. For instance, when evaluating a green technology investment project, executives with environmental expertise guide the team to focus on its genuine emission reduction potential, technological iteration pathways, and long-term environmental benefits—rather than solely on its capacity to rapidly generate a large number of patentable innovations [8].

Secondly, executives with environmental backgrounds have the capacity to influence the mitigation of green innovation bubbles by enhancing government-enterprise connectivity.Exploiting their expertise, these executives can accurately interpret the complexities and trends within national policies [9]. In the context of government interactions, the company employs a specialised language to articulate its green technology roadmap, emissions reduction plans, and innovation strategies. This approach is intended to facilitate a more profound comprehension and increased trust on the part of the relevant authorities. This communication, grounded in a professional manner, enables enterprises to comprehend the substantive direction of policy support with greater expediency and precision. Consequently, enterprises are encouraged to prioritise high-quality, implementable green innovation, as opposed to merely accumulating innovation metrics [10].

Based on these arguments, this paper proposes the following hypothesis:

H1: Executive's environmental background can suppress corporate green innovation bubbles.

3 RESEARCH DESIGN

3.1 Regression Model

To test hypothesis H1, we construct the following model:

$$CGI\_bub = \beta_0 + \beta_1 Env\_executive + \beta_i X_{it} + \mu_i + \sigma_t + \varepsilon_{it} \quad (1)$$

In Model (1), *CGI_bub* is the dependent variable. *Env_executive* is the explanatory variable, which is measured in two ways: (1) the presence of executives with an environmental background (*Env_background*) and (2) the proportion of executives with an environmental background (*Env_ratio*). *Xit* is a set of control variables derived from firm characteristics, executive characteristics, board characteristics, and external factors. μi is the firm fixed effect, σt is the year fixed effect, and εit is the random error term.

3.2 Dependent Variable

This study draws upon extant literature and employs the number of green patent applications to measure the scale of green innovation [11]. The number of green patent grants is selected as a proxy indicator for the quality of green innovation. The present study calculates the difference between the quantity and quality of green patents, standardises this difference, and uses it to measure the degree of green innovation bubble in enterprises. An elevated value of this indicator is indicative of a more pronounced green innovation bubble within the enterprise.

3.3 Independent Variable

Referring to Andersén et al., we use the presence of executives with an environmental background (*Env_background*) and the proportion of executives with such backgrounds (*Env_ratio*) as measures of the independent variable [12]. Executives are determined based on whether they are members of the top management team. First, we manually search for executives' personal resume information in the annual reports of listed companies. Then, we judge whether their personal resumes contain keywords such as 'environment', 'environmental protection', 'new energy', 'clean energy', 'ecology', 'low carbon', 'sustainable development', and 'green', to determine the executive's environmental background. Based on this process, we tally the number of executives with an environmental background and determine whether they possess such backgrounds.

3.4 Control Variables

Exist research indicates that green innovation investment is influenced by firm factors like employee count (*Staff*), asset-liability ratio (*Lev*), return on net assets (*Roe*), and company size (*Size*) [13]. Board characteristics, such as board size (*Board*) and the largest shareholder (*Top1*), and executive characteristics like CEO duality (*Dual*), executive team's average age (*M_age*), and female presence in the executive team (*Female*) also play a role [14]. Other factors include tax burden (*Tax*), BIG 4 accounting firms (*Big4*), and institutional investors' shareholding ratio (*Ins*). The study controls for year and firm fixed effects. More details are in Appendix 1.

3.5 Sample Selection and Data Sources

This study uses all private A-share companies listed on the Shanghai and Shenzhen Stock Exchanges from 2010 to 2022 as the initial sample (a total of 35,227 firm-year observations). To ensure the validity and comparability of the sample, we applied the following sample selection procedures: first, we excluded 140 observations with missing values for green innovation bubbles; second, we excluded 17 observations from the financial industry; third, to avoid the impact of financial distress, we excluded 15 observations of ST and PT firms. To reduce the influence of outliers, we winsorize all continuous variables at the 1% and the 99% level. As a result of these procedures, our final sample comprises of 35,055 firm-year observations. The data on environmental background executives was collected from the personal resumes of executives in the annual reports of listed companies and the relevant information of executives' personal profiles provided by the CSMAR database. Corporate green patent data is sourced from the CNRDS database. The other financial and firm-level data were downloaded from the CSMAR database.

4 EMPIRICAL RESULTS

4.1 Descriptive Statistics

Descriptive statistics are shown in Table 1. In Panel A, the average value of the dependent variable *CGI_bub* is -0.055. The difference between the maximum and minimum values is 1.736, indicating significant heterogeneity in the green innovation bubbles of listed companies. The average value of independent variable *Env_background* is 0.153, which means that companies with executives having an environmental background only account for 15.3% of the sample. Additionally, the average value of *Env_ratio* is 0.038, suggesting that the proportion of executives with an environmental background among all executives in listed companies is small. In Panel B, we divide the listed companies into two groups based on whether they employed executives with environmental backgrounds (*Env_background*) and examine whether their impact on green innovation bubbles. The results from the univariate analyses highlight that the difference in coefficient between subsamples is statistically significant.

Table 1 Descriptive Statistics

Panel A

Variable	N	Mean	SD	Min	Max
CGI_bub	35,055	-0.055	0.202	-0.495	1.241
Env_background	35,055	0.153	0.360	0	1
Env_ratio	35,055	0.038	0.109	0	0.667
M_age	35,055	47.28	3.865	37.57	56
Female	35,055	0.634	0.482	0	1
Staff	35,055	7.615	1.261	4.357	11
Top1	35,055	0.341	0.147	0.091	0.742
Size	35,055	22.18	1.284	19.68	26.12
Big4	35,055	0.056	0.229	0	1

Ins	35,055	0.436	0.244	0.003	0.907
Lev	35,055	0.431	0.209	0.055	0.912
Roe	35,055	0.043	0.181	-1.158	0.347
Tax	35,055	0.018	0.024	-0.043	0.125
Dual	35,055	0.283	0.450	0	1
Board	35,055	2.122	0.196	1.609	2.639
Panel B Univariate analysis					
Variable	*Env_background*=1		*Env_background*=0		Diff.
Mean of *CGI_bub*	-0.054		-0.051		1.215**
N	5,364		29,691		

Note:This table presents the descriptive statistics and results from the univariate analysis. Diff is represented by the difference between *Env_background*=1 and *Env_background*=0. See Appendix A for the variable definitions.

4.2 Main Regression Results

Table 2 shows the impact of executives' environmental background on green innovation bubbles. Column (1) reports that the regression coefficient on *Env_background* is -0.017 and it is significantly negative at the 1% level. This indicates that executives' environmental background has a restraining effect on corporate green innovation bubbles. Similarly, column (2) reports that the higher the proportion of executives' environmental background is associated with reduced green innovation bubbles behavior (Coefficient on *Env_ratio* is -0.065, P<0.01). Collectively, these results support the upper echelons theory, which suggests that executives make decisions and strategic choices based on their experience and values. Executives with environmental background may consider the company's environmental responsibility and sustainable development when formulating corporate strategies, which reduces the behavior of green innovation bubbles and promotes real green R&D investment. Thus, our hypothesis 1 is supported.

Table 2 Results of Main Regression Analysis

	(1)	(2)
Variables	*CGI_bub*	*CGI_bub*
Env_background	-0.017***	
	(-3.099)	
Env_ratio		-0.065***
		(-2.718)
M_age	0.001*	0.001*
	(1.662)	(1.657)
Female	0.001	0.001
	(0.281)	(0.178)
Staff	0.007**	0.007**
	(2.269)	(2.272)
Top1	-0.001	-0.002
	(-0.065)	(-0.132)
Size	-0.003	-0.002
	(-0.630)	(-0.586)
Big4	0.029*	0.029*
	(1.831)	(1.802)
Ins	-0.006	-0.005
	(-0.482)	(-0.397)
Lev	0.000	0.001
	(0.050)	(0.122)
Roe	0.013**	0.013**
	(2.391)	(2.349)
Tax	-0.066	-0.066
	(-1.509)	(-1.508)
Dual	-0.001	-0.001
	(-0.379)	(-0.349)
Board	0.019	0.019
	(1.461)	(1.457)
Constant	-0.114	-0.119
	(-1.449)	(-1.530)
Year FE	Yes	Yes
Firm FE	Yes	Yes
N	35,055	35,055
Adj. R^2	0.344	0.344

Note: This table reports the results of main regression analysis. Column (1) presents the regression results for *Env_background* and *CGI_bub*. Column (2) presents the regression results for *Env_ratio* and *CGI_bub*. The t-statistic is shown in parentheses. * p < 0.10, ** p < 0.05, and *** p < 0.01. See Appendix A for the variable definitions.

4.3 Addressing Endogeneity Issues

4.3.1 Instrumental variable method

Our study may suffer from endogeneity issues. For example, it is possible that listed companies with more real green R&D activities prefer to hire executives with environmental backgrounds, leading to reverse causality problems. Following Li et al., this study uses the mean ratio of executives' environmental background in the same city and the same year (*Mean_ratio*) as the instrumental variable (IV) to address the issue of reverse causality [15].

Columns (1) and (2) of panel A in Table 3 report the first-stage regression results. It is shown that the coefficient on IV is significantly positive at the 1% level, suggesting that *Env_background* and *Env_ratio* are significantly and positively correlated with *Mean_ratio*, which aligns with theoretical expectations. Simultaneously, the F-value is greater than 10, indicating that the IV is not a weak instrumental variable. Columns (3) and (4) show the second-stage regression results. After controlling for IV, we continue to find a positive impact of *Env_background* and *Env_ratio* in reducing green innovation bubbless.

Table 3 Endogeneity Tests

Panel A: Instrumental variable results				
	First-stage		Second-stage	
	(1)	(2)	(3)	(4)
Variables	*Env_background*	*Env_ratio*	*CGI_bub*	*CGI_bub*
Mean_ratio	2.455***	0.941***		
	(0.057)	(0.018)		
Env_background			-0.016**	
			(-3.126)	
Env_ratio				-0.067**
				(-2.738)
Constant	-1.099***	-0.373***	0.065	0.070
	(0.162)	(0.052)	(0.045)	(0.044)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	35,055	35,055	35,055	35,055
Adj. R^2	0.151	0.220	0.396	0.397
Panel B: Results of PSM-DID and entropy balancing				
	PSM-DID		Entropy Balancing	
	(1)Before PSM	(2)After PSM	(3)	(4)
Variables	*CGI_bub*	*CGI_bub*	*CGI_bub*	*CGI_bub*
*Env_background*Post*	-0.016***	-0.017***		
	(-2.666)	(-2.680)		
Env_background			-0.016***	
			(-3.017)	
Env_ratio				-0.056***
				(-2.883)
Constant	-0.114	-0.115	-0.058	-0.067
	(-1.448)	(-1.455)	(-0.647)	(-0.758)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	35,055	34,969	35,055	35,055
Adj. R^2	0.344	0.344	0.277	0.277

Note: This table presents results from endogeneity tests. The t-statistic is shown in parentheses. * p < 0.10, ** p < 0.05, and *** p < 0.01. See Appendix A for the variable definitions.

4.3.2 PSM-DID method and entropy balance

The environmental protection tax reform implemented nationwide in 2018 has significantly improved the legal effectiveness and enforcement rigidity of environmental governance, making the internalization of environmental costs a hard constraint for enterprise operations. This study adopts the PSM-DID method to analyze the impact of this quasi-natural experiment on our main results. The listed companies that appoint executives with environmental background form the treatment group, and other companies are considered as the control group. We use all the control variables used in Model (2) as covariates and perform 1-to-1 nearest neighbor matching. We obtain a final sample of 34,969 firm-year observations for PSM-DID analysis using Model 2.

$$CGI\_bub = \varphi_0 + \varphi_1 Env\_backgr\,ound * Post + \varphi_i X_{it} + \varphi_2 \sum \text{Year} + \varphi_3 \sum Firm + \varepsilon_{it} \quad (2)$$

In Model 2, *Env_background* is the experimental group affected by the policy shock; *Post* is a time dummy variable, which takes the value of 1 in 2018 and thereafter, otherwise 0; *Env_background*Post* captures the policy implementation effect. Column (2) of panel B in Table 3 shows that the explanatory variable *Env_background*Post* is negative and statistically significant at the 1% level. This result indicates that, under the exogenous shock of the environmental protection tax reform, executive's environmental background still effectively restrains firms' green innovation bubbles. In addition, we adopt the entropy balancing method. Columns (3) and (4) of panel B in Table 3

show that after entropy balancing matching, *Env_background* and *Env_ratio* continue to be significantly negatively correlated with *CGI_bub* at the 1% level, indicating that the main test results are robust.

4.3.3 Parallel trend test and placebo

Figure 1 shows the parallel trend test results. Prior to policy implementation, the treatment and control groups showed no significant difference, satisfying the DID test's parallel trend assumption. Post-implementation, a significant and persistent difference emerged, confirming the policy's impact.

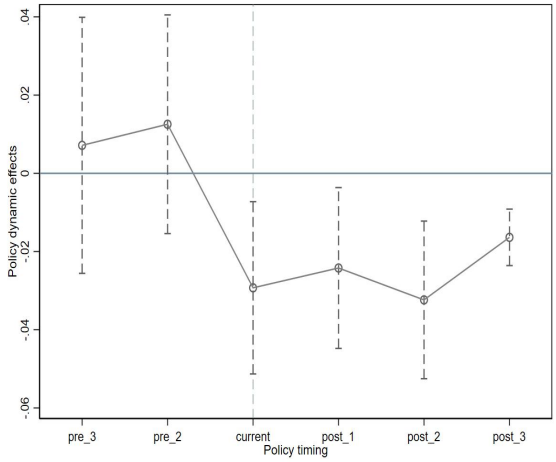

Figure 1 Parallel Trend Test

To provide further assurance on the treatment effect of the environmental protection tax reform, we perform placebo tests. We create a sham treatment group for placebo testing purposes. Following Chen et al., we generate a list of treatment groups by randomly selecting sample of listed firms for our treatment observations [16]. This process results in generating false multiplicative coefficient estimates. We repeat this procedure 500 times to observe the distribution of these 500 estimates. As depicted in Figure 2, the distribution is predominantly centered around the zero point and exhibits an approximate normal distribution. This indicates that unobservable factors do not significantly impact our results.

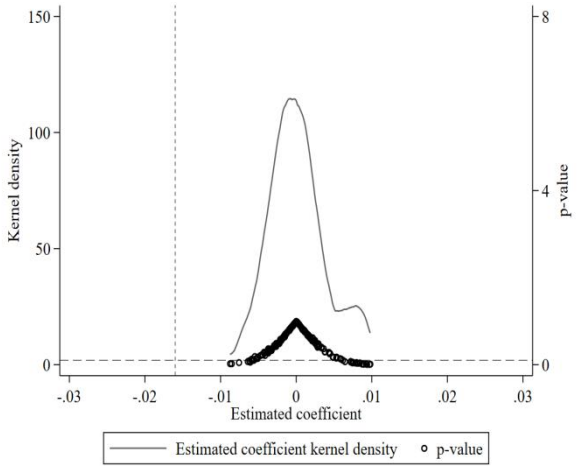

Figure 2 Placebo Test

4.4 Robustness Tests

4.4.1 Replacing explanatory variables

Acknowledging varying influence within the executive team, this paper separately measures whether there is a CEO with an environmental background (*EP_CEO*) and the proportion of board members with an environmental background (*EP_Chair*). In Table 4, the regression results of columns (1) and (2) of panel A show that both CEOs and other board members with an environmental background can effectively mitigate green innovation bubbless.

Table 4 Robustness Tests

Panel A：Replace explanatory variables and dependent variable respectively				
	(1)	(2)	(3)	(4)
Variables	*CGI_bub*	*CGI_bub*	*CGI_bub1*	*CGI_bub1*
EP_CEO	-0.016**			
	(-2.096)			

EP_Chair		-0.016**		
		(-2.066)		
Env_background			-0.019**	
			(-2.042)	
Env_ratio				-0.108***
				(-3.271)
Controls	Yes	Yes	Yes	Yes
Constant	-0.117	-0.119	-0.091	-0.100
	(-1.495)	(-1.547)	(-0.944)	(-1.040)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	33,677	33,636	35,046	35,046
Adj. R^2	0.350	0.348	-0.071	-0.071
Panel B：Exclude innovation-oriented cities and new energy demonstration cities				
	(1)	(2)	(3)	(4)
	Innovation=0	*Innovation*=0	*Energy*=0	*Energy*=0
Variables	*CGI_bub*	*CGI_bub*	*CGI_bub*	*CGI_bub*
Env_background	-0.017***		-0.011*	
	(-3.080)		(-1.688)	
Env_ratio		-0.064***		-0.066*
		(-2.682)		(-1.668)
Controls	Yes	Yes	Yes	Yes
Constant	-0.111	-0.117	-0.103	-0.108
	(-1.401)	(-1.485)	(-1.119)	(-1.218)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	34,911	34,911	21,469	21,469
Adj. R^2	0.344	0.344	0.300	0.300

Note: Panel A presents the regression results of the replacement explanatory variables and the dependent variable. Panel B presents the regression results for excluding the samples of innovation-oriented cities and new energy demonstration cities. *Innovation* represents the innovation-oriented pilot cities. *Energy* represents the new energy demonstration cities. The t-statistic is shown in parentheses. * p < 0.10, ** p < 0.05, and *** p < 0.01. See Appendix A for the variable definitions.

4.4.2 Replacing dependent variable

Because the utility model patent can better represent the practical practice of enterprise innovation activities. Therefore, we replace the original dependent variable with the number of applications and authorizations of green utility model patents, and construct the variable *CGI_bub1* with its difference. We re-run the regression analyses using this alternative measure of green innovation bubbles. The results in columns (3) and (4) of panel A in Table 4 reveal that the regression coefficients of *Env_background* and *Env_ratio* on *CGI_bub1* are significantly negative at the 5% level.

4.4.3 Excluding other interpretations

To account for the potential impact of local innovation and low-carbon development policies introduced by China during 2010-2022, and evolving tax incentive policies, we considered innovation-oriented cities and new energy demonstration cities in our analysis. After excluding the samples affected by these pilot policies, the regression results in panel B of Table 4 show that the impact of *Env_background* and *Env_ratio* on *CGI_bub* is still significantly negative, which proves the stability of the main test.

4.5 Channel Tests

4.5.1 Executives' green cognition

Referring to Jiang et al., we use the content analysis method to count the occurrence times of keywords related to environmental protection in the annual reports of listed companies. The occurrence frequency of these keywords can be used as an indicator of the green cognitive intensity of executives [17].

In Table 5, columns (1) and (2) show that the regression coefficients of *Env_background* and *Env_ratio* on *G_cognition* are both significantly positive (p<0.05). This indicates that executives with environmental background can better improve the green cognition of the top management team, thus affecting the company's green innovation activities. The results in columns (3) and (4) show that after adding *G_cognition* to Model 1, executives with environmental background can still restrain the green innovation bubbles, and the regression result between *G_cognition* and *CGI_bub* is significantly negative, which is in line with the theoretical expectation.

Table 5 Channel Tests of Executives' Green Cognition

	(1)	(2)	(3)	(4)
	G_cognition	*G_cognition*	*CGI_bub*	*CGI_bub*
Env_background	0.220**		-0.014**	
	(2.083)		(-2.421)	
Env_ratio		1.798***		-0.054**
		(3.907)		(-2.122)
G_cognition			-0.001**	-0.001**

			(-2.080)	(-2.047)
M_age	-0.008	-0.007	0.001	0.001
	(-0.822)	(-0.775)	(1.268)	(1.265)
Female	0.122*	0.130*	-0.001	-0.001
	(1.685)	(1.800)	(-0.209)	(-0.265)
Staff	0.101	0.105	0.008**	0.008**
	(1.461)	(1.534)	(2.544)	(2.538)
Top1	0.215	0.240	0.019	0.018
	(0.467)	(0.525)	(1.030)	(0.998)
Size	-0.010	-0.015	-0.002	-0.002
	(-0.122)	(-0.192)	(-0.424)	(-0.410)
Big4	-0.147	-0.136	0.035**	0.035**
	(-0.600)	(-0.556)	(2.076)	(2.064)
Ins	-0.330	-0.361	-0.012	-0.011
	(-1.145)	(-1.262)	(-0.901)	(-0.847)
Lev	-0.255	-0.275	0.001	0.001
	(-0.960)	(-1.042)	(0.098)	(0.145)
Roe	0.025	0.025	0.012**	0.012**
	(0.177)	(0.182)	(1.993)	(1.963)
Tax	-1.261	-1.290	-0.064	-0.063
	(-1.119)	(-1.151)	(-1.321)	(-1.300)
Dual	-0.098	-0.103	-0.003	-0.003
	(-1.306)	(-1.377)	(-0.861)	(-0.829)
Board	-0.021	-0.014	0.028**	0.028**
	(-0.098)	(-0.064)	(2.028)	(2.014)
cons	2.510*	2.537*	-0.157*	-0.157*
	(1.647)	(1.675)	(-1.878)	(-1.891)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	31,064	31,064	31,064	31,064
adj. R^2	0.478	0.479	0.329	0.329

Note: This table reports the results of channel tests of executives' green cognition. The t-statistic is shown in parentheses. * p < 0.10, ** p < 0.05, and *** p < 0.01. See Appendix A for the variable definitions.

4.5.2 Government enterprise linkage

Referring to Armstrong et al., we calculate the number of sentences in the annual reports of listed companies that refer to government agencies and any form of institutional action words in the keyword table to measure the exposure to government agencies [18].

In Table 6, columns (1) and (2) show that the regression coefficients of *Env_background* and *Env_ratio* on *A_Exposure* are both significantly positive (p<0.01). This indicates that executives with environmental background can use their professional knowledge and perception of policy changes to actively enhance the legitimacy of business strategy and strengthen the link between government and enterprises. The results in columns (3) and (4) show that after adding *A_Exposure* to Model 1, executives with environmental background can still restrain the green innovation bubbles, and the regression result between *A_Exposure* and *CGI_bub* is significantly negative, which is in line with the theoretical expectation.

Table 6 Channel Tests of Government Enterprise Linkage

	(1)	(2)	(3)	(4)
	A_Exposure	*A_Exposure*	*CGI_bub*	*CGI_bub*
Env_background	0.031***		-0.009*	
	(2.859)		(-1.952)	
Env_ratio		0.122***		-0.033*
		(2.731)		(-1.812)
A_Exposure			-0.006**	-0.006**
			(-2.060)	(-2.055)
M_age	0.000	0.000	0.001*	0.001*
	(0.045)	(0.047)	(1.721)	(1.721)
Female	0.004	0.004	0.002	0.002
	(0.402)	(0.459)	(0.488)	(0.446)
Staff	0.001	0.001	0.005**	0.005**
	(0.123)	(0.130)	(2.333)	(2.329)
Top1	-0.045	-0.043	-0.001	-0.002
	(-0.707)	(-0.689)	(-0.084)	(-0.104)
Size	-0.009	-0.009	-0.002	-0.002
	(-0.775)	(-0.795)	(-0.560)	(-0.545)
Big4	0.049*	0.049*	0.019	0.019
	(1.741)	(1.756)	(1.599)	(1.589)
Ins	0.145***	0.144***	-0.005	-0.005

	(3.796)	(3.771)	(-0.512)	(-0.487)
Lev	-0.027	-0.028	-0.002	-0.002
	(-0.799)	(-0.823)	(-0.282)	(-0.255)
Roe	-0.031*	-0.031*	0.011**	0.011**
	(-1.874)	(-1.862)	(2.153)	(2.138)
Tax	0.286*	0.285*	-0.052	-0.052
	(1.809)	(1.802)	(-1.349)	(-1.340)
Dual	-0.009	-0.009	-0.000	-0.000
	(-0.968)	(-0.984)	(-0.123)	(-0.111)
Board	-0.008	-0.007	0.013	0.013
	(-0.266)	(-0.253)	(1.284)	(1.274)
_cons	0.825***	0.829***	-0.110*	-0.111*
	(3.643)	(3.660)	(-1.813)	(-1.832)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	34,366	34,366	34,366	34,366
adj. R^2	0.404	0.404	0.292	0.292

Note: This table reports the results of channel tests of government enterprise linkage. The t-statistic is shown in parentheses. * p < 0.10, ** p < 0.05, and *** p < 0.01. See Appendix A for the variable definitions.

4.6 Cross-Sectional Analyses

4.6.1 Corporate performance pressure

Following Amore and Garofalo, the company's performance pressure is obtained by dividing the difference between the analysts' predicted net profit and the actual net profit of the enterprise and the company's total assets at the end of the period [19].

The results of panel A in Table 7 show that executives with environmental backgrounds have a more significant inhibitory effect on the green innovation bubbles when the pressure on corporate performance is high. Executives with environmental background can restrain the short-term tendency of the management, and are not persistent in pursuing short-term performance, which is consistent with the theoretical expectation.

Table 7 Moderating Effects of Performance Pressure, Resource Allocation Efficiency and Green R&D Subsidy

Panel A：Moderating effect of performance pressure				
	(1)	(2)	(3)	(4)
	Pressure>0	*Pressure>0*	*Pressure<=0*	*Pressure<=0*
Variables	*CGI_bub*	*CGI_bub*	*CGI_bub*	*CGI_bub*
Env_background	-0.021**		-0.015	
	(-2.574)		(-0.795)	
Env_ratio		-0.084***		-0.052
		(-2.854)		(-1.055)
Controls	Yes	Yes	Yes	Yes
Constant	-0.060	-0.066	-0.476	-0.473
	(-0.454)	(-0.505)	(-1.453)	(-1.444)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	21,054	21,054	4,383	4,383
Adj. R^2	0.323	0.323	0.426	0.426
Chow Test	2.13***	2.06***	2.13***	2.06***
Panel B：Moderating effect of resource allocation efficiency				
	(1)	(2)	(3)	(4)
	Ineff>M_Ineff	*Ineff>M_Ineff*	*Ineff<=M_Ineff*	*Ineff<=M_Ineff*
Variables	*CGI_bub*	*CGI_bub*	*CGI_bub*	*CGI_bub*
Env_background	-0.020**		-0.021***	
	(-2.315)		(-2.645)	
Env_ratio		-0.041*		-0.078***
		(-1.742)		(-2.893)
Controls	Yes	Yes	Yes	Yes
Constant	0.019	0.016	-0.287**	-0.288**
	(0.179)	(0.154)	(-2.418)	(-2.430)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	13,807	13,807	18,539	18,539
Adj. R^2	0.349	0.349	0.359	0.359
Chow Test	4.00***	4.07***	4.00***	4.07***
Panel C：Moderating effect of green R&D subsidy				
	(1)	(2)	(3)	(4)
	GRDS>M_GRDS	*GRDS>M_GRDS*	*GRDS<=M_GRDS*	*GRDS<=M_GRDS*
Variables	*CGI_bub*	*CGI_bub*	*CGI_bub*	*CGI_bub*

Env background	0.027		-0.019***	
	(0.943)		(-3.339)	
Env ratio		-0.002		-0.066***
		(-0.027)		(-2.653)
Controls	Yes	Yes	Yes	Yes
Constant	0.420	0.328	-0.116	-0.121
	(0.275)	(0.216)	(-1.510)	(-1.600)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	1,036	1,036	33,702	33,702
Adj. R^2	0.207	0.206	0.351	0.351
Chow Test	3.02***	3.02***	3.02***	3.02***

Note: This table implies the results of moderating effects. *Pressure* represents performance pressure; *Ineff* represents resource allocation efficiency ; and *GRDS* represents green R&D subsidy. The t-statistic is shown in parentheses. * p < 0.10, ** p < 0.05, and *** p < 0.01. See Appendix A for the variable definitions.

4.6.2 Resource allocation efficiency

Referring to the practice of Dehnokhalaji et al., the variable ineff is constructed from the residual of the regression model. The higher the value, the lower the efficiency of resource allocation [20]. The regression results are shown in panel B of table 7. The inhibition effect of executives with environmental background on the green innovation bubbles is better in the scenario of high resource allocation efficiency of the company. This shows that the company's resource allocation efficiency is low, which will lead to the slow response of management's decision-making, resulting in the time difference between implementation and strategy, leading to bubbles.

4.6.3 Government green R&D subsidy

Following the methodology of Shao and Chen, this study extracts government subsidy data from the CSMAR database containing terms related to research and development (R&D) and filters out subsidies specifically targeted towards environmental endeavors [21]. To identify environmental subsidies, keywords such as "desulfurization," "denitrification," "dust removal," "emission reduction," and "pollution" are employed, and subsidy data related to fields such as recycling, energy-saving and emission reduction technology, desulfurization and denitrification, and elimination of backward production capacity are manually sorted. The natural logarithm of the aggregated number of environmental subsidies plus 1 is utilized as the government green R&D subsidy variable (*GRDS*).

Panel C of table 7 shows that the inhibitory effect of environmental background executives on green innovation bubbles is better in the environment with low green R&D subsidies. When subsidies are low, firms engage more in policy rent-seeking, enhancing the influence of environmental executives on green innovation bubbles. When subsidies are high, firms are more likely to adopt clean practices, invest in green R&D, and transform production processes.

4.7 Economic Consequences

Refer to Tian et al. to construct the green investment efficiency variable (*Ginv*), and refer to Rahman et al. to construct the value creation variable (*Value*) [22-23]. The regression results are shown in Table 8. The regression results show that the regression results of the dependent variable (*CGI_bub)* on *Ginv* and *Value* are significantly negative, which indicates that the green innovation bubbles will damage the work efficiency and value creation ability of enterprises in the long run. However, the regression results of *CGI_bub*Env_background* and *CGI_bub*Env_ratio* interactive terms for *Ginv* and *Value* are significantly positive, which shows that executives with environmental backgrounds can effectively alleviate the occurrence of green innovation bubbles and ultimately have a positive impact on enterprises. The environmental background executives' containment of the green innovation bubbles can not only improve the green investment efficiency of enterprises, but also be beneficial to the long-term value of enterprises.

Table 8 The Economic Consequences of Green Investment Efficiency and Value Creation Efficiency

Panel A：The economic consequences of green investment efficiency			
	(1)	(2)	(3)
Variables	*Ginv*	*Ginv*	*Ginv*
CGI_bub	-0.193**	-0.275***	-0.258***
	(-2.280)	(-3.134)	(-2.993)
Env background		0.184*	
		(1.880)	
*CGI bub*Env background*		0.798**	
		(2.470)	
Env_ratio			1.014***
			(2.606)
*CGI_bub*Env_ratio*			2.657**
			(2.447)
Controls	Yes	Yes	Yes
Constant	-9.894***	-9.968***	-9.888***
	(-4.264)	(-4.307)	(-4.289)
Year FE	Yes	Yes	Yes

Firm FE	Yes	Yes	Yes
N	16,073	16,073	16,073
Adj. R2	0.596	0.597	0.597
Panel B：The economic consequences of value creation efficiency			
	(1)	(2)	(3)
Variables	*Value*	*Value*	*Value*
CGI_bub	-0.002**	-0.003***	-0.003***
	(-1.995)	(-2.637)	(-2.754)
Env_background		-0.002	
		(-1.291)	
*CGI_bub*Env_background*		0.006**	
		(2.258)	
Env_ratio			-0.006
			(-1.502)
*CGI_bub*Env_ratio*			0.024***
			(3.484)
Controls	Yes	Yes	Yes
Constant	0.775***	0.774***	0.774***
	(24.873)	(24.845)	(24.798)
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
N	34538	34538	34538
Adj. R2	0.816	0.816	0.816

Note: This table shows the results of economic consequence of executives' environmental background. *Ginv* represents the green investment efficiency. *Value* represents the value creation efficiency. The t-statistic is shown in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$. See Appendix A for the variable definitions.

5 CONCLUSION

The study empirically examines the influence of executives' environmental backgrounds on corporate green innovation bubbles, using a sample of Chinese A-share listed firms from 2010 to 2022. The results indicate that the presence and proportion of executives with environmental expertise significantly inhibit the formation of green innovation bubbles—a phenomenon characterized by the decoupling between the quantity and quality of green innovation. These findings remain robust after addressing potential endogeneity through methods such as the instrumental variable approach, PSM-DID, and entropy balancing, and withstand a series of robustness tests including alternative variable definitions and sample adjustments.

The theoretical contributions of this research are threefold. First, it introduces the concept of the "green innovation bubbles" into the literature on corporate sustainability and innovation management, shifting scholarly attention from "whether green innovation occurs" to "what type of innovation is undertaken," thereby offering a novel lens through which to examine opportunistic behavior in environmental strategy. Second, it elucidates the underlying mechanisms through which environmentally experienced executives exert influence—namely, by enhancing the green cognition of the top management team and strengthening government–enterprise linkages through professional policy interpretation and communication. These pathways provide a more nuanced understanding of how micro-level managerial attributes translate into macro-level strategic outcomes. Third, the study enriches the upper echelons perspective by contextualizing the effectiveness of environmental executives, demonstrating that their impact is moderated by internal and external contingencies such as performance pressure, resource allocation efficiency, and the intensity of government R&D subsidies.

On the practical front, the findings offer valuable insights for corporate governance, policy design, and investment evaluation. Firms pursuing substantive green transformation should consider incorporating executives with environmental expertise into their leadership teams, as such executives help align innovation activities with long-term ecological and strategic objectives rather than short-term metrics. Policymakers are advised to refine incentive schemes to encourage quality-driven green innovation while strengthening professional dialogue between regulators and enterprises. Investors and other stakeholders may also benefit from recognizing that firms with environmentally experienced executives are less prone to greenwashing and more likely to generate sustainable value.

Notwithstanding these contributions, the study has certain limitations. Although the measurement of green innovation bubbles is consistent with prior research, it may not capture all dimensions of innovation quality. Future studies could employ alternative indicators, such as patent citations or environmental performance metrics, to enhance validity. Furthermore, while the Chinese context provides a rich setting for examining policy-driven green transitions, cross-country comparative research would help generalize the findings. Subsequent investigations could also explore how digital governance tools or board diversity interact with executives' environmental backgrounds in shaping green innovation trajectories.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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APPENDIX 1 VARIABLE DEFINITIONS

Variable	Definition and measurement
	Panel A:Independent variable
Env_background	Dummy variable that takes the value of 1 if there is at least one executive who has the environmental background, and 0 otherwise
Env_ratio	The number of executives with environmental background in the company's executive team divided by the total number of executives in the company's executive team
	Panel B:Dependent variable
CGI_bub	According to the difference between the number of green patent applications and authorizations of listed companies in the CNRDS database, it is standardized
	Panel C:Control variables
M_age	The average age of executive team members
Female	Dummy variable that equals one if there is at least one female executive in the team
Staff	The number of employees in the company
Top1	Shareholding ratio of the largest shareholder
Size	The logarithm of total assets

Big4	Dummy variable that equals one if the auditor comes from the Big Four accounting firms
Ins	Shareholding ratio of institutional investors
Lev	Total debts divided by total assets
Roe	Return on equity
Tax	Income tax divided by operating income
Dual	Dummy variable equal to one if the executive manager serves also as the chairperson of the board of directors and zero otherwise
Board	The natural logarithm of the number of directors