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Executive's Environmental Protection Background and Corporate Green Innovation: Evidence from China

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Abstract: Green innovation is crucial to the sustainable development of corporates. The executive's environmental protection background has an impact on their comprehensive skills, value orientation, management style, and behavioral patterns, thus playing an important role in corporate green innovation strategy. Therefore, this study aims to explore the relationship between executives' environmental protection background and corporate green innovation and its boundary mechanisms. Using data of A-share listed companies in China from 2007 to 2021, this relationship was empirically investigated using Stata analysis software and the establishment of a fixed-effects analysis model. Based on the upper echelons theory, this study finds that executive environmental protection background positively affects corporates' green innovation. The above positive relationship persists when measures of green innovation and alternative regression models address robustness. Furthermore, this study explores the moderating role of the external environment and internal organizational factors (i.e., media attention and board independence). This study concludes that media attention and board independence positively moderate the positive relationship between executives' environmental protection background and green innovation. The study contributes to the upper echelons theory and provides new insights into green innovation in emerging economies.

Keywords: green innovation; environmental protection background; media attention; board independence

Citation: Bai, X.; Lyu, C. Executive's Environmental Protection Background and Corporate Green Innovation: Evidence from China. *Sustainability* **2023**, *15*, 4154. https://doi.org/10.3390/su15054154

Academic Editors: Akrum Helfaya and Ahmed Aboud

Received: 13 January 2023
Revised: 22 February 2023
Accepted: 22 February 2023
Published: 24 February 2023

1. Introduction

At the 75th session of the United Nations General Assembly in September 2020, the Chinese government committed itself to peak carbon emissions by 2030 and to achieve carbon neutrality by 2060 [1]. Enterprises are the main actors in green governance, playing a key role in achieving peak carbon and carbon-neutral targets. China is in a new normal phase, committed to the green transformation of its energy system to reduce heavy pollution [2]. With the implementation of a series of environmental regulation policies and the increased importance society attaches to sustainable development, green innovation is gaining attention from the government, enterprises, and the market. As a means to achieve sustainable development, green innovation is considered conducive to a win-win situation of economic growth and environmental protection [3]. Regulating and guiding enterprises toward cleaner production has become an important way to promote green development. Enterprises face high costs in transitioning and upgrading to cleaner directions, so they find it challenging to meet the needs of green development. Therefore, exploring the optimal development of green innovation has become essential in deepening sustainable goals.

With the implementation of a series of environmental regulation policies and the improvement of society's attention to sustainable development, green innovation has been gradually more valued by the government, enterprises, and the market [4]. Green innovation refers to new or improved products, processes, technology, or practice innovations that mitigate environmental damage [5], and focus on and achieve innovative models of environmental sustainability [6]. At the same time, based on the upper echelons theory, it is believed that executive characteristic factors tend to influence the strategic decisions

of corporates, which means that the influence of executive characteristics on corporate strategy has become an important focus of academic attention. Prior research has conducted a series of discussions on the antecedents of green innovation, including technological capabilities [7], environmental regulations [8], green knowledge sharing [9], consumer pressure [10], and market demand [11]. However, existing studies are less likely to explore the impact of green innovation from the perspective of executive characteristics. Recent upper echelons theory points out that executives with long experience in a field may develop selective cognition and consider decisions based on cognitive preferences from long prior experience [12]. Executives inject much of their personality, experiences, and values into their behavior. This degree of individualization can determine the formation of strategy or the actions of others, and the organization becomes a reflection of the executives [13]. These characteristics shape the cognitive structure of the enterprise and thus affect the green innovation of enterprises [14]. Executives' reactions to environmental changes as strategic decision-makers in their firms are influenced by their perceptions of environmental issues. If executives view environmental issues as opportunities for corporate growth, they choose forward-looking environmental strategies, which enhance corporate environmental performance [15]. Therefore, this study focuses on an essential but understudied executive characteristic: environmental protection background. This characteristic represents the individual's experience and background in environmental protection. It is unclear whether and how the environmental protection background of executives influences green innovation, and this study aims to fill this gap. Therefore, the motivation of this study is mainly to explore the relationship between an executive's environmental protection background and corporate green innovation and its boundary conditions.

Further to this, an executive's environmental protection background is internalized in the enterprise's strategic decisions, leading the corporate to protect the environment and demonstrate to the outside world that the enterprise is committed to environmental causes. Existing research assumes that the interests of the firm and the managers are perfectly aligned and therefore managers will follow the development of the firm and take the necessary actions for the firm to achieve its goals. However, agency theory emphasizes that there is an inherent conflict of interest in the agency–principal relationship and therefore the need for proper governance [16]. Thus, corporate oversight mechanisms also play a crucial role in aligning the interests of managers and shareholders. Given that media coverage and board independence are two key oversight mechanisms, we explore how they shape the impact of executives' environmental backgrounds on green innovation strategies. On the one hand, media coverage is recognized as an essential monitoring mechanism, as it can act as a watchdog and motivate corporates to work in the interests of shareholders [17]. This is because the media is used as an important tool for external stakeholders to evaluate managers [18]. Stakeholders will not only think that the evaluation role of the media is legitimate, but also use it trigger their actions against companies with poor performance and thus affect managers' capital [19]. On the other hand, the board of directors has been recognized as the primary internal oversight force [20]. Independent directors are more likely to punish managers than inside directors because they "have the incentive to build a reputation as experts in decision control" [21]. However, there is little literature on these topics. This study integrates the upper echelons theory and agency theory, collects data on the executive profiles of the Chinese-listed companies from 2007 to 2021, and uses textual-mining analysis to combine panel data to investigate the impact of executive environmental background on green innovation.

The contributions of this study are: First, this study adds value to the literature on upper echelons theory and green innovation research. Differing from previous studies that only focus on the influence of executives' overseas experience, educational background, and functional background on corporate green strategic behavior, this study incorporates executives' environmental background as an occupational background experience into the upper echelons theory, explores the relationship between executives with environmental background and green innovation, and further improves the research content of the upper

echelons theory from a green innovation perspective, thereby making a new contribution to the upper echelons theory of Hambrick and Mason (1984) [22], as the contributions to this area of the literature in the field of green innovation are few, with some very recent exceptions. This study's framework and insights can help upper echelons theory scholars to understand the environmental context of executives as a tool to understand their green innovation strategies. This study analyzes the influence of executives with environmental protection background on the green innovation strategy from the perspective of their power structure and advances the traditional external incentive determinism of green development to the level of enterprises' independent incentive, which provides a development direction for further improving the incentive path of green development, realizing green transformation, and upgrading. Second, from the perspective of green innovation and based on agency theory, this study explores how the impact of the environmental protection background of senior executives on green innovation depends on media coverage and the independence of the board of directors. The findings of this study on the relative importance of executives' environmental protection backgrounds in green innovation also represent an important development in the study of upper echelons theory and agency theory, as executives' understanding of how firms reallocate resources and capabilities in the face of internal and external supervisory role, enriching the literature on how executive background characteristics influence how firms adjust their strategic choices to accommodate corporate green growth.

2. Literature Review and Research Hypothesis

2.1. Literature Review

This study focuses on the impact of executive characteristics on green innovation. Green innovation refers to new or improved products, processes, technology, or practice innovations that mitigate environmental damage [5]. As a vital force for green development driven by energy conservation and environmental protection, green innovation has the double advantage of combining low-carbon energy conservation and efficiency improvement, and is essential for driving a new development pattern of "win-win" for environmental quality improvement [23]. Green innovation has the characteristics of investment uncertainty and a long cycle and reflects the long-term strategic orientation of enterprises [24]. Compared to traditional innovation, green innovation is considered to have knowledge externalities that have a positive impact on the environment during the R&D and diffusion phases.

The upper echelons theory states that executives' experiences, values, and personalities will influence their vision, selective perceptions, interpretations, and ultimately firm outcomes. The literature on upper echelons theory examines how executive characteristics impact green innovation. These studies suggest that executive characteristics can affect green innovation. For example, pilot certificates for executives, better educational experiences, and transformational leadership can lead to better green innovation [25]. Another stream of the literature suggests that executive characteristics can be negative, trivial, or nonlinear in their impact on green innovation [26].

Scholars have studied the impact of executive experience on green innovation based on the upper echelons theory. For example, based on executives' military experience, political experience, academic experience, overseas experience, financial experience, hometown tenure, and richness of career experience, among other perspectives, ref. [27] found a significant effect of executive career experience on green innovation, risk-taking, and economic performance of firms [28]. However, whether the background of executives' environmental protection experience contributes to corporate environmental behavior decisions deserves further research. In addition, the literature closely related to this study focuses on the emotional level of executives' environmental protection awareness. For example, Peng and Liu (2016) [29] found that executive environmental risk awareness and environmental protection benefit awareness play different moderating roles between various stakeholders' environmental protection orientation on corporate eco-innovation.

Existing studies have not analyzed the connection to executives' environmental protection background, and studies in the literature have focused more on the impact of executives' environmental protection awareness on their green development, ignoring the analysis of the impact of executives' special experience of environmental protection background on green innovation. Therefore, this study, based on the critical perspective of executives' environmental protection background, will theoretically analyze and validate the mechanism and influencing factors of green innovation to fill the gap in the existing literature.

2.2. Research Hypothesis

2.2.1. Executive's Environmental Protection Background and Green Innovation

Based on the influence of upper echelons theory on decision-making, this study predicts that the positive impact of executives' environmental protection background on corporate green innovation is reflected in the following two aspects.

First, according to the upper echelons theory, the executive's experiential background will influence the corporate's strategic decisions [30]. This study proposed that executives' environmental protection background is a psychological preference from previous work experience in environmental protection positions. Environmental protection backgrounds are associated with individuals' environmental intentions. Individuals establish ongoing emotional ties to their previous environmental protection experiences in their behavior. As an essential component of corporate green strategy, green innovation consumes fewer resources, produces less waste, improves corporate sustainability, and reduces pollution and damage to the external environment [31]. Therefore, executives with an environmental protection background may be more concerned about the corporate's environmental protection by improving environmental performance.

Second, individuals are more likely to pursue the public interest due to the executive's environmental protection background. Individuals may develop an emotional attachment to the firm and pay more attention to the executive's reputation. They may consider economic factors and the interests of the social group when making strategic decisions [32]. An environmental protection background may stimulate pro-social motivation in individuals, prompting them to focus on goals that benefit others based on their concern for the welfare of the social group. Executives with an environmental protection background may be more concerned about the welfare of social groups and may have an ethical obligation to prevent or solve environmental problems. As a sustainable development model, green innovation benefits both the firm and the ecological environment by reducing environmental protection hazards and improving environmental protection quality [33]. Green innovation strategic decisions affect the firm and extend beyond organizational boundaries to customers, suppliers, employees' families, and other stakeholder members. Therefore, green innovation is seen as a pro-social behavior of firms [34].

Third, executives' environmental protection background enhances green innovation by enriching executives' social network resources as well as enhancing executives' risk appetite propensity. Executives with environmental protection backgrounds have worked in environmental protection functions, companies, industries, geographies, and organizations due to their previous experience. The economic behavior of executives in their social structure will be embedded in their social network relationships, forming a kind of "social capital" [35]. The background of environmental protection experience allows executives to build a wide range of social relationships at work. It also allows the market to recognize executives more fully through their environmental performance and thus have a higher level of trust in their capabilities [36]. In fact, having an environmentally friendly experience gives executives a higher environmental protection philosophy and more prosperous social network relationships that provide many different types of allocatable resources. Wernerfelt (1984) [37] pointed out that in the resource-based view (RBV), a firm is a collection of various resources, and resources are the basis for implementing a corporate's strategy. As an informal institution, social networks can facilitate the search for scarce resources and thus facilitate the development of green innovation [38].

In conclusion, executives' management skills are developed from their personal, especially career experiences that determine their idiosyncratic cognitive structures, values, and decision-making patterns [39]. Executives with environmental protection experience background will impact management psychology and style, showing irrational tendencies such as risk preference, which will affect their cognitive abilities and behavioral choices, and influence green innovation [40]. This study argued that executives from environmental protection backgrounds exhibit pro-social motivations and behaviors. While seeking economic benefits, executives from environmental protection backgrounds are more likely to protect the environment through green innovations. Thus, the following hypothesis is proposed:

Hypothesis 1. *Executive's environmental protection background positively impacts green innovation.*

2.2.2. Moderation Effect of Media Attention

Media attention refers to the extent to which media organizations (major Internet media) pay attention to the business strategy behavior of a specific object such as the listed companies in this study [41,42], "usually gauged by the sheer volume of stories or space dedicated to topics in newspapers, television news and so on". Media attention is an essential external governance factor that influences the role of executives with an environmental protection background. The media is the information vehicle or form of communication that achieves a communication purpose, and it drives the progress of an event through attention and publicity coverage [43]. The media acts as both a bystander and a facilitator of the process in the marketplace [44,45]. This study argues that the media feeds the internal information of listed companies into the capital market, and stakeholders identify and analyze the information reported by the media, forming external supervision and legitimacy pressure, thus influencing the strategic decisions of executives with the environmental protection background on green innovation.

Media attention can enhance the relationship between executives' environmental protection backgrounds and green innovation. First, the higher the level of media attention, the greater the pressure executives receive from external stakeholders to monitor them. It has been shown that high levels of media coverage may prompt firms to take risky and exploratory actions. For example, Chatterjee and Hambrick (2011) [46] found that media attention encourages managers and thus triggers risk-taking behavior. Firms will passively disclose environmental information and improve its quality to more effectively assess executives' environmental protection behavior, i.e., media attention imposes implicit constraints on executives with environmental protection backgrounds. For a corporate to maintain its reputation, maintain market share, and avoid being eliminated from the market, media reinforces executives' awareness of being influenced by their environmental protection backgrounds and enhances their willingness to take risks, thus contributing to green innovation.

Second, the media has an impact on the reputation of executives. Media attention can change corporate strategic behavior by influencing executives' reputations. Executives can obtain external resource support needed for strategic development by receiving social recognition [19]. The most important matter is gaining social recognition, and the media plays a crucial role by influencing public opinion through its coverage of events and personalities. For example, the social resources generated by the executive's idiosyncratic career experience element will be an influencing factor in strategic decisions [47]. Media coverage of green innovation strategies of executives with environmental protection backgrounds will send signals of positive corporate development to external stakeholders, which in turn will generate various resources needed for corporate development and to promote green innovation. The reputation effect of the media will enhance the company's ability to raise funds, ensure sustainable investment in green innovation, address executives' concerns about the development of green innovation, and give full play to the role of executives with environmental protection backgrounds in strategic decision-making [48]. In addition,

executives with environmental protection backgrounds will view media attention as a market-oriented signal from the perspective of strategic legitimacy, and tap into the real needs of multiple stakeholders to promote green innovation [49]. This study argues that media attention will enhance the legitimacy pressure faced by companies through monitoring and reputation influences, and increase stakeholders' attention to green innovation, thus strengthening the positive relationship between executives' environmental protection background and green innovation. Thus, the following hypothesis is proposed:

Hypothesis 2. *Media attention positively moderates the relationship between the executive's environmental protection background and green innovation.*

2.2.3. Moderation Effect of Board Independence

The board of directors plays a crucial role in corporate governance in terms of management control and oversight of decision-making [50]. The law gives the board formal authority to approve initiatives, evaluate management performance, and control management compensation [51]. Agency theory views monitoring management's actions as the board's primary responsibility to protect shareholder interests. The field of strategy research argues that the composition of the board of directors may impact the outcome of a corporate's strategic choices [52]. As board members, independent directors hold only directorships, and do not have relationships with the company and shareholders that could impede their ability to exercise impartial judgment. Independent directors come from outside the company, have no other interests with the company, and seem to lack the motivation to enhance corporate value. Nonetheless, they do not give in to managers' improper demands to protect their reputations from damage. They can maintain a more independent and objective position in monitoring managers. Independent directors are essential in mitigating conflicts of interest between managers and shareholders and overseeing executives' decisions.

This study argues that board independence can enhance the positive effect of the environmental protection background of executives on green innovation. Independent directors can improve the corporate's internal governance mechanism, including the supervisory and advisory functions. First, in terms of supervisory function, the greater the proportion of independent directors on the board of directors, the more independent directors can play a supervisory role and supervise management on behalf of shareholders [53]. When executives with environmental protection backgrounds make high-risk strategic decisions, such strategic change decisions may not be in the interest of corporate shareholders. Independent directors can identify opportunistic behaviors of executives and can monitor behaviors that are detrimental to corporate performance in the execution of executives' strategies [54]. In addition, independent directors can prevent abuse of power and overinvestment in allocating green innovation resources by executives with environmental protection backgrounds.

Second, in advisory functions, independent directors can provide advice based on their areas of expertise [55]. Independent directors with relevant professional knowledge, experience, and skills can solve problems by grasping corporate strategic decisions and improving motivation for green innovation. They can help executives with environmental protection backgrounds to find the right direction for green innovation, avoiding the risk of "success traps" that executives may overlook due to the risk of green innovation, allowing executives with environmental protection backgrounds to evaluate and make strategic decisions from their viewpoints in a centralized manner, thereby reducing irrational decisions due to the cognitive limitations of managers. In addition, due to the complexity and ambiguity of management practices, independent directors use the degree of strategy implementation as a proxy for management effectiveness [56]. This study argues that the independent board of directors plays a supervisory and advisory role in promoting executives to grasp the timing of green development, thus strengthening the positive relationship

between executives' environmental protection background and green innovation. Thus, the following hypothesis is proposed, and Figure 1 shows the theoretical research model:

Hypothesis 3. *Board independence positively moderates the relationship between the executive's environmental protection background and green innovation.*

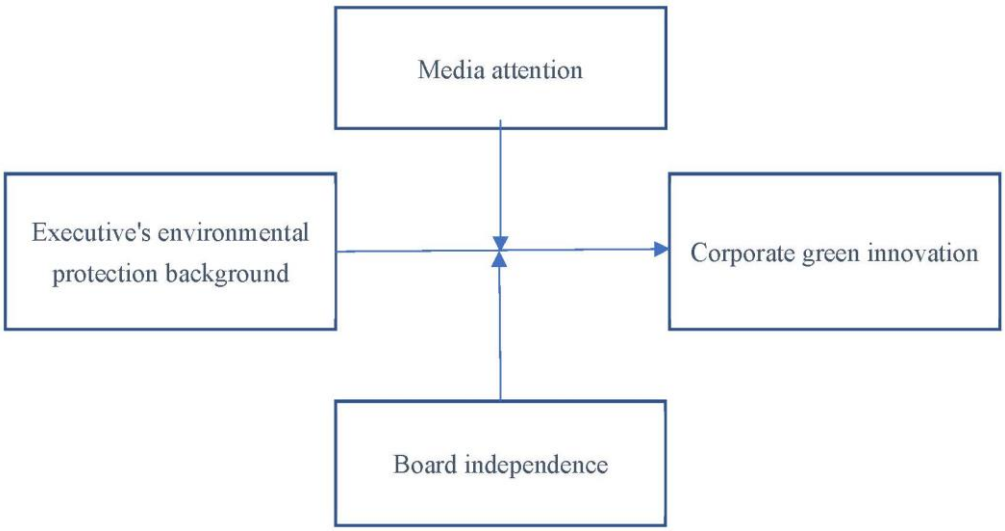

Figure 1. Theoretical research model.

3. Data and Methodology

3.1. Data and Samples

This study used panel data of Chinese-listed companies in A-shares from 2007–2021 as a research sample to test the influence of executives with environmental protection backgrounds on corporate green innovation. First, the original data on executives' environmental protection backgrounds were obtained from the publicly available executive biographical information in the China Stock Market Accounting Research Database (CSMAR) and the WIND database (WIND), and the data on executive characteristics were collected. Second, the green innovation data were obtained from the China Research Data Platform (CNRDS) and the "International Patent Classification Green List" released by the World Intellectual Property Organization (WIPO) in 2010. Third, financial and corporate governance structure data were obtained from the CSMAR database. These databases provide reliable analytical data on all listed companies in China and have been used for other management and strategy studies [57]. Furthermore, the specific data samples selection process: (i) excluded listed insurance and finance companies; (ii) excluded special treatment (ST) sample companies that had abnormal financial indicators; (iii) excluded sample companies listed less than one year; (iv) eliminated the missing samples; and (v) obtained a total of 19,975 observations. The sample calculation process in this paper is shown in Table 1. In addition, this study performed data analysis based on stata15 statistical software.

Table 1. Sample data calculation process.

Calculation Process	Number of Samples
Obtain the original sample of Chinese listed companies from the CSMAR database	27,767
Exclude listed finance and insurance company's samples	1571
Exclude special treatment (ST) samples	836
Exclude the companies listed in that year	1765
Eliminate the missing samples	3620
Effective sample size result	19,975

3.2. Variables Definition

3.2.1. Dependent Variable

Corporate green innovation (GI). Consistent with existing green innovation studies in the Chinese context and considering the availability of Chinese data, this study used green patents as an indicator of GI [58]. First, the other proxies for green innovation, such as research and development (R&D) expenditure [59], represented actual output efficiency [60]. Second, as green patents are capable of generating positive externality for environmental protection and emission control in the long term, which is helpful to sustainable growth [61], this study used the number of green patent applications by Chinese listed companies to measure green innovation, specifically, matching the patent classification numbers of invention patents and model patents of listed companies, and the patent data retrieved from China Research Data Platform (CNRDS) according to the "Green List of International Patent Classification" issued by the World Intellectual Property Organization (WIPO) in 2010. The number of green patent applications was obtained by matching the patent data retrieved from CNRDS based on the "International Patent Classification Green List" issued by WIPO in 2010. The quality of green innovation was measured by the number of green invention patent applications, and the number of green utility model patent applications measured the quantity of green innovation. The above two measures are summed up to obtain the total number of green innovations (GRInno).

3.2.2. Independent Variable

Executive environmental protection background (EP). Referring to the idea of Hao et al. (2019) [62] that the perceptions and values of executives can be inferred from the demographic characteristics of their members, the original data on the environmental protection background of executives were obtained from the biographical information published by the CSMAR database, which includes "environment", "environmental protection", "new energy", "sustainable" in the biographical of executives. "Clean energy", "ecology", "low carbon", "sustainable", "energy saving", "green" and other keywords, were used to determine that the sample has an environmental protection background. On this basis, this study counted the number of executives with environmental protection backgrounds.

3.2.3. Moderation Variables

Media attention (MA). To measure media attention, basic company statistics of news information data of sample companies were used [63]. News reports from sources other than major business publications such as China Securities Journal, Economic Observer, and Securities Times were excluded. These media outlets usually act as opinion leaders influencing other media coverage, so the sample of these publications should represent the overall coverage of a company in the media. In addition, the annual number of all news articles mentioning the company's name was counted. Finally, the total number of annual company news articles was recorded to establish this study's measure of media attention. It is worth noting that this study was followed to calculate the number of all media items related to the company.

Board independence (BI). According to Zaid et al. (2020) [64], board independence is measured by the percentage of independent directors on the overall board.

3.2.4. Control Variables

The following control variables are selected in this study: total assets (Size), fixed assets ratio (Far), Tobin's Q (TQ), return on net assets (Roe), the shareholding ratio of the largest shareholder (Top1), the gearing ratio (Debt), chairman and general manager (Dual), board size (Board), etc. The data were obtained from the CSMAR database. This study also controlled for year and industry fixed effects. Based on this, Table 2 shows the descriptive statistics of the main variables.

Table 2. Variable definitions.

Variables		Description	Reference
Dependent Variable	GRInno	Apply the number of green patent applications of listed companies plus 1 and take the natural logarithm.	Wang et al. (2022) [61]
Independent Variable	hbhjdum	If the company hires one or more executives with environmental protection backgrounds in the same year, it will score 1, and the opposite is 0.	Hao et al. (2019) [62]
	lnhbhj	The number of companies containing executives with environmental protection background in the year and add 1 to take the natural logarithm.	Hao et al. (2019) [62]
Moderation Variables	MA	The number of all media coverage related to the company.	Luo et al. (2022) [63]
	BI	The percentage of independent directors on the overall board.	Zaid et al. (2020) [64]
Control Variables	Size	The natural logarithm of total assets.	Jia et al. (2019) [65] Xu et al. (2019) [66]
	Far	Net fixed assets as a percentage of total assets.	
	TQ	Tobin's Q value.	
	Roe	Net income as a percentage of the average balance of shareholders' equity.	
	Top1	The shareholding ratio of the first largest shareholder.	
	Debt	Total corporate debts as a percentage of total assets.	
	Dual	If the chairman and the CEO are the same person, the value is 1, and the opposite is 0.	
	Board	Number of the corporate board of directors for the year.	

3.3. Models

This study used a fixed-effects panel regression model to test our hypothesis. The dependent variable was treated with a one-period lag to address potential endogeneity due to reverse causality. Therefore, the following regression models were used to test the effect of the executive's environmental protection background on green innovation, the moderating role of media attention and board independence. In addition, we performed data analysis based on stata15 statistical software, using a fixed-effects model commonly used in the previous literature for testing [67]:

$$GRInno_{i,t+1} = \alpha_0 + \alpha_1 EP_{i,t} + \alpha_k \sum Control_{it} + \sum Ind + \sum Year + \varepsilon_{i,t} \quad (1)$$

$$GRinno_{i,t+1} = \beta_0 + \beta_1 EP_{i,t} + \beta_2 MA_{i,t} + \beta_3 EP_{i,t} \times MA_{i,t} + \beta_4 BI_{i,t} + \beta_5 EP_{i,t} \times BI_{i,t} + \beta_k \sum Control_{i,t} + \sum Ind + \sum Year + \varepsilon_{i,t} \quad (2)$$

where i and t denote firm and year; GRInno is the level of green innovation, respectively; EP is the executive's environmental protection background; *MA* and *BI* are the moderating variables, which refer to the media attention and board independence; and $\sum Industry$ and $\sum Year$ represents industry fixed effect and year fixed effect, respectively.

4. Empirical Findings

4.1. Descriptive Statistics and Correlation Analysis

Table 3 provides the results of descriptive statistics and correlation tests. The mean value of GRInno is 0.394, and the standard deviation is 0.805, indicating that most of the companies in this study carried out green innovation activities during the sample period, but there were significant differences in the level of green innovation among these companies. The mean and standard deviation values of hbbjdum are 0.310 and 0.463, respectively, indicating that the overall level of executives with environmental protection backgrounds in companies was low and the percentage of executives with environmental protection backgrounds varied significantly between companies. The mean value of MA is 5.024, and the standard deviation is 1.121, indicating that listed companies generally

received media attention. The mean and standard deviation of BI are 0.379 and 0.069, respectively, indicating a relatively high percentage of independent directors in listed companies. The variables hbbjdum, lnhbbj, and GRInno are positively correlated at the 1% level, indicating that executives with environmental protection backgrounds helped to enhance the level of green innovation. Hypothesis 1 was initially verified.

Table 3. Descriptive statistics and correlation analysis.

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1. GRInno	0.394	0.805	1												
2.hbbjdum	0.310	0.463	0.129 ***	1											
3. lnhbbj	0.323	0.550	0.164 ***	0.877 ***	1										
4. MA	5.024	1.121	0.219 ***	0.052 ***	0.046 ***	1									
5. BI	0.379	0.069	0.028 ***	0.01	0.002	0.084 ***	1								
6. Size	22.015	1.235	0.236 ***	0.030 ***	0.025 ***	0.464 ***	−0.008	1							
7. Far	0.238	0.169	−0.064 ***	0.017 **	0.002	0.002	−0.065 ***	0.185 ***	1						
8. TQ	3.075	2.229	−0.084 ***	0.003	−0.004	0.045 ***	0.069 ***	−0.436 ***	−0.228 ***	1					
9. Roe	0.077	0.140	0.040 ***	0.007	0.011	0.034 ***	0.014 **	0.053 ***	−0.138 ***	0.112 ***	1				
10. Top1	0.359	0.149	0.028 ***	−0.029 ***	−0.028 ***	0.068 ***	0.023 ***	0.235 ***	0.099 ***	−0.087 ***	0.096 ***	1			
11. Debt	0.421	0.207	0.082 ***	0.018 **	0.026 ***	0.131 ***	−0.052 ***	0.509 ***	0.199 ***	−0.370 ***	−0.174 ***	0.056 ***	1		
12. Dual	0.071	0.256	−0.025 ***	0.016 **	0.016 **	−0.046 ***	−0.0110	−0.125 ***	−0.078 ***	0.098 ***	0.032 ***	−0.003	−0.104 ***	1	
13. Board	10.125	2.495	0.051 ***	0.042 ***	0.038 ***	0.166 ***	−0.100 ***	0.278 ***	0.138 ***	−0.121 ***	−0.044 ***	0.013 *	0.175 ***	−0.020 ***	1

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2. Multiple Regression Analysis

4.2.1. The Effect of Executive's Environmental Protection Background on Green Innovation

Table 4 reports the impact of whether and how corporates on green innovation hire many executives with environmental protection backgrounds. Among them, Columns (1)–(2) show the effect of whether or not a firm employs an executive with environmental protection background on green innovation, and Columns (3)–(4) show the impact of the number of executives with environmental protection background hired by a corporate on green innovation. From the regression results in Column (2), the regression coefficient between whether or not to hire executives with environmental protection backgrounds (hbbjdum) and green innovation is significantly positive, indicating that hiring executives with environmental protection background promotes green innovation. The results in Column (4) show that the regression coefficient between the number of executives with environmental protection backgrounds (lnhbbj) hired by corporates and green innovation is significantly positive at the 5% level, indicating that the more executives with environmental protection backgrounds hired by corporates, the more they can promote green innovation. Therefore, Hypothesis 1 of this study is supported.

Table 4. The regression results of environmental protection background on green innovation.

Variables	(1)	(2)	(3)	(4)
	GRInno	GRInno	GRInno	GRInno
hbbjdum	0.048 ***	0.033 *		
	(2.750)	(1.874)		
lnhbbj			0.056 ***	0.041 **
			(2.958)	(2.149)
Size	0.490 ***	0.418 ***	0.489 ***	0.418 ***
	(38.065)	(25.505)	(38.049)	(25.502)
Far	0.040	0.061	0.040	0.061
	(0.629)	(0.957)	(0.623)	(0.954)
TQ	0.108 ***	0.113 ***	0.108 ***	0.113 ***
	(25.886)	(22.589)	(25.886)	(22.600)
Roe	0.550 ***	0.607 ***	0.549 ***	0.607 ***
	(12.706)	(13.701)	(12.704)	(13.702)
Top1	−0.672 ***	−0.507 ***	−0.673 ***	−0.508 ***
	(−7.148)	(−5.340)	(−7.160)	(−5.349)
Debt	−0.038	0.056	−0.037	0.056
	(−0.676)	(0.989)	(−0.662)	(0.997)
Dual	−0.068 ***	−0.067 ***	−0.068 ***	−0.067 ***
	(−3.217)	(−3.164)	(−3.220)	(−3.170)

Table 4. *Cont.*

Variables	(1)	(2)	(3)	(4)
	GRInno	**GRInno**	**GRInno**	**GRInno**
Board	−0.005 *	−0.006 **	−0.005 *	−0.006 **
	(−1.824)	(−2.047)	(−1.852)	(−2.069)
Constant	−10.168 ***	−8.709 ***	−10.157 ***	−8.704 ***
	(−35.554)	(−24.181)	(−35.550)	(−24.193)
Industry FE	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes
N	19,975	19,975	19,975	19,975
Adj.R^2	0.501	0.507	0.501	0.507

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

As pointed out by the upper echelons theory, executives' pre-career experience continuously internalizes the mindset and behavior of executives in their later work, which in turn affects the behavioral decisions and even the strategic layout of the market. Therefore, executives with environmental protection backgrounds are more likely to integrate their environmental experience into corporate strategic decisions and pay more attention to green sustainability performance. Further, to control the fixed effect of the industry is to control the factors that are relatively constant relative to the industry. For example, there are unique differences in different industries that do not change with time, and the food industry is an industry that is less affected by the economic cycle, but the steel industry is cyclical. By controlling the fixed effect of the industry, this study can control the differences between industries, and help to estimate the regression results more reasonably [62].

4.2.2. Moderation Effect Test

Table 5 shows the regression results of the moderating effect of media attention and board independence. Columns (1)–(2) show the results of the moderating effect of media attention, and columns (3)–(4) show the results of the moderating effect of board independence. Models (1) and (2) introduce the moderating terms hbbjdum × MA and lnhbbj × MA for media attention to test whether media attention has a significant linear moderating effect. The regression results show that the coefficients of the interaction terms hbbjdum × MA and lnhbbj × MA are 0.047 and 0.042, respectively, and are significant at the 1% level, indicating that there is a significant linear moderating effect of media attention, suggesting that the positive relationship between executives' environmental protection background and green innovation is strengthened when the media attention is greater. Therefore, Hypothesis 2 of this study is supported. Models (3) and (4) introduce the first-order moderators of director independence, hbbjdum × BI and lnhbbj × BI, to test whether there is a significant linear moderating effect of director independence. The regression results show that the coefficients of the interaction terms hbbjdum × BI and lnhbbj × BI are 0.308 and 0.309, respectively, and significant at the 1% level, indicating that there is a significant linear moderating effect of board independence. When board independence is higher, the positive relationship between executive environmental protection background and green innovation is strengthened. Therefore, Hypothesis 3 of this study is supported.

Table 5. The moderating effect result of media attention and board independence.

Variables	(1)	(2)	(3)	(4)
	GRInno	**GRInno**	**GRInno**	**GRInno**
hbbjdum	0.033 *		0.034 *	
	(1.946)		(1.940)	
MA	0.147 ***	0.147 ***		0.042 **
	(16.659)	(16.660)		(2.220)
hbbjdum × MA	0.047 ***			

Table 5. *Cont.*

Variables	(1)	(2)	(3)	(4)
	GRInno	GRInno	GRInno	GRInno
	(4.225)			
lnhbbj		0.040 **		
		(2.113)		
lnhbbj × MA		0.042 ***		
		(3.958)		
BI			0.086	0.047
			(0.484)	(0.279)
hbbjdum × BI			0.308 ***	
			(3.331)	
lnhbbj × BI				0.309 ***
				(3.341)
Size	0.375 ***	0.374 ***	0.419 ***	0.419 ***
	(22.863)	(22.820)	(25.605)	(25.623)
Far	0.020	0.015	0.058	0.058
	(0.312)	(0.242)	(0.915)	(0.912)
TQ	0.097 ***	0.097 ***	0.113 ***	0.113 ***
	(18.932)	(18.919)	(22.591)	(22.599)
Roe	0.584 ***	0.583 ***	0.605 ***	0.604 ***
	(13.507)	(13.486)	(13.670)	(13.674)
Top1	−0.456 ***	−0.452 ***	−0.502 ***	−0.503 ***
	(−4.881)	(−4.846)	(−5.292)	(−5.303)
Debt	0.034	0.034	0.053	0.053
	(0.611)	(0.605)	(0.938)	(0.946)
Dual	−0.060 ***	−0.060 ***	−0.062 ***	−0.062 ***
	(−2.908)	(−2.886)	(−2.968)	(−2.978)
Board	−0.006 **	−0.006 **	−0.007 ***	−0.007 ***
	(−2.267)	(−2.300)	(−2.617)	(−2.643)
Constant	−7.688 ***	−7.673 ***	−8.700 ***	−8.693 ***
	(−21.338)	(−21.287)	(−24.237)	(−24.246)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	19,975	19,975	19,975	19,975
Adj.R^2	0.515	0.515	0.507	0.507

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2.3. Endogeneity Test

2SLS regression method. This study assesses the relationship between the hiring of executives with environmental protection backgrounds and green innovation, which may be interfered with by endogeneity issues, as listed firms with green innovation may hire more executives with environmental protection backgrounds to meet the decision-making needs of green innovation, thus creating endogeneity issues caused by reverse causality. In this study, the number of pollution incidents (IV) reported on news websites or government websites in the city where the core executives are from is used as an instrumental variable for the environmental protection background of executives, where the core executives include the chairman, vice chairman, president, general manager, and deputy general manager of the firm, and the core executives have power to choose the personnel of the firm. On the one hand, based on the executives' hometown complex, core executives tend to be concerned about pollution incidents in their hometown, which may lead them to take environmental precautionary measures for companies and motivate them to engage in green business practices, such as hiring more executives with environmental protection backgrounds to manage companies. On the other hand, pollution events in the cities where the core executives are based can only influence the strategic decisions by affecting the personal behavior of the core executives, while environmental events in the cities where

the core executives are based do not directly influence the green innovation decisions, in line with the hypothesis of correlation and exogeneity of the instrumental variables.

Table 6 reports the results of using the instrumental variable (IV) to test the influence of executives from environmental protection backgrounds on green investors. Columns (1) and (3) show the results of the first-stage regressions with IV estimated coefficients of 0.053 and 0.045, and are positive at the 1% level, indicating that there is a significant positive relationship between the occurrence of pollution incidents in the executive's place of origin and the corporate's hiring of executives with environmental protection backgrounds, consistent with theoretical expectations. Columns (2) and (4) show the results of the second-stage regression, and the results show that the effects of hiring executives with environmental protection background on green innovation are both significantly positive at the 5% level under the two-stage least squares (2SLS) estimation, which indicates the robustness of the results.

Table 6. 2SLS regression method result.

Variables	(1)	(2)	(3)	(4)
	First-Stage	Second-Stage	First-Stage	Second-Stage
	hbbjdum	GRInno	lnhbbj	GRInno
IV	0.053 ***		0.045 ***	
	(6.362)		(5.962)	
hbbjdum		0.449 **		
		(2.137)		
lnhbbj				0.519 **
				(2.128)
Size	−0.022 **	0.138 ***	−0.005	0.131 ***
	(−2.064)	(5.404)	(−0.511)	(5.153)
Far	0.018	−0.156	−0.001	−0.148
	(0.306)	(−1.183)	(−0.012)	(−1.110)
TQ	−0.003	0.119 ***	−0.004	0.120 ***
	(−0.838)	(11.304)	(−1.165)	(11.296)
Roe	0.079 *	0.754 ***	0.077 **	0.749 ***
	(1.792)	(9.501)	(2.077)	(9.295)
Top1	−0.083	−0.157	0.032	−0.211
	(−0.991)	(−0.886)	(0.416)	(−1.207)
Debt	0.009	0.315 ***	0.007	0.315 ***
	(0.197)	(2.741)	(0.165)	(2.735)
Dual	−0.004	−0.115 ***	−0.010	−0.112 **
	(−0.246)	(−2.601)	(−0.614)	(−2.533)
Board	0.005 **	−0.006	0.006 ***	−0.007
	(2.167)	(−1.056)	(2.958)	(−1.209)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Kleibergen-Paap RK LM statistic		76.764 ***		66.972 ***
Cragg-Donald Wald F statistic		126.673		113.809
Kleibergen-Paap RK Wald F statistic		40.434		35.566
N	6181	6181	6181	6181
Adj.R^2	0.667	0.055	0.669	0.049

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2.4. Robustness Test

Replacing the regression model. This study uses the Tobit model and Poisson model. The number of dependent variables, green innovation, is generally scattered in the positive range, but there are a considerable number of zero values and a non-negative integer

skewed distribution, which is often estimated using the Tobit and Poisson models. Therefore, the Tobit and Poisson models were used to test the robustness of the relationship between corporate hiring of executives with environmental backgrounds in green innovation. Columns (1) and (3) of Table 7 show the regression results of the impact of whether firms hire executives with environmental background (hbbjdum) and the number of executives with environmental protection background (lnhbbj) on green innovation when tested using the mixed Tobit model. Columns (2) and (4) show the regression results of the impact of whether firms hire executives with environmental protection background (hbbjdum) and the number of executives with environmental protection background (lnhbbj) on green innovation tested using the Poisson model. The results show that after changing the estimation method, the independent variables of corporate hiring of executives with environmental protection backgrounds are all positive at the 1% level, confirming the robustness of the previous benchmark regression results.

Table 7. Robustness test of the replacement regression model.

Variables	(1)	(2)	(3)	(4)
	Tobit	**Poisson**	**Tobit**	**Poisson**
	GRInno	**GRInno**	**GRInno**	**GRInno**
hbbjdum	0.147 ***	0.103 ***		
	(6.156)	(5.506)		
lnhbbj			0.189 ***	0.134 ***
			(9.328)	(8.564)
Size	0.743 ***	0.481 ***	0.745 ***	0.482 ***
	(56.704)	(53.725)	(56.876)	(53.863)
Far	0.009	0.030	0.023	0.040
	(0.103)	(0.428)	(0.276)	(0.567)
TQ	0.190 ***	0.108 ***	0.190 ***	0.109 ***
	(29.701)	(24.419)	(29.777)	(24.459)
Roe	2.667 ***	2.199 ***	2.657 ***	2.193 ***
	(25.493)	(26.019)	(25.445)	(25.933)
Top1	−0.769 ***	−0.560 ***	−0.758 ***	−0.546 ***
	(−9.844)	(−9.109)	(−9.725)	(−8.870)
Debt	−0.658 ***	−0.458 ***	−0.665 ***	−0.467 ***
	(−9.509)	(−8.240)	(−9.625)	(−8.388)
Dual	−0.177 ***	−0.177 ***	−0.179 ***	−0.178 ***
	(−4.067)	(−4.710)	(−4.120)	(−4.738)
Board	−0.011 **	−0.008 **	−0.011 **	−0.008 **
	(−2.334)	(−2.217)	(−2.437)	(−2.286)
Constant	−16.792 ***	−11.563 ***	−16.823 ***	−11.600 ***
	(−54.006)	(−51.057)	(−54.168)	(−51.181)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	19,975	19,975	19,975	19,975
Pseudo.R^2	0.139	0.158	0.140	0.159

Notes: ** $p < 0.05$, *** $p < 0.01$.

Replacing the measurement method of green innovation. This study classifies the application of green invention patents (GRInva) and utility patents (GRUma). As a replacement variable for the original dependent variable green innovation, the promotion effect of executives with environmental protection backgrounds on green innovation is examined. The results are shown in Table 8. The results show that the regression results of whether listed firms hire executives with environmental protection background (hbbjdum) and the number of executives hired with environmental protection background (lnhbbj) on green innovation are both significantly positive at the 5% level, indicating the robustness of the study findings.

Table 8. Robustness test of the replacement the measurement method of green innovation.

Variables	(1)	(4)	(5)	(8)
	GRInva	GRUma	GRInva	GRUma
hbbjdum	0.025 **	0.029 **		
	(2.282)	(1.978)		
lnhbbj			0.035 ***	0.026
			(3.031)	(1.631)
Size	0.170 ***	0.306 ***	0.169 ***	0.306 ***
	(17.887)	(22.475)	(17.871)	(22.448)
Far	−0.034	0.054	−0.035	0.054
	(−0.813)	(0.993)	(−0.820)	(0.992)
TQ	0.050 ***	0.120 ***	0.050 ***	0.120 ***
	(18.978)	(27.694)	(18.998)	(27.707)
Roe	0.280 ***	0.512 ***	0.280 ***	0.512 ***
	(10.259)	(11.678)	(10.239)	(11.667)
Top1	−0.210 ***	−0.326 ***	−0.211 ***	−0.326 ***
	(−3.705)	(−3.778)	(−3.719)	(−3.779)
Debt	0.004	0.162 ***	0.004	0.162 ***
	(0.123)	(3.316)	(0.134)	(3.323)
Dual	−0.022	−0.137 ***	−0.022	−0.137 ***
	(−1.523)	(−8.200)	(−1.530)	(−8.195)
Board	−0.004 **	−0.003	−0.004 **	−0.003
	(−2.166)	(−1.506)	(−2.203)	(−1.510)
Constant	−3.336 ***	−6.584 ***	−3.333 ***	−6.577 ***
	(−15.881)	(−21.812)	(−15.881)	(−21.794)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	19,975	19,975	19,975	19,975
Adj.R^2	0.346	0.442	0.346	0.442

Notes: ** $p < 0.05$, *** $p < 0.01$.

5. Conclusions and Discussion

As the main actors of environmental protection and green governance at the micro level, corporates play a crucial role in achieving sustainability goals. Based on the upper echelons theory, it is believed that executives from environmental protection backgrounds tend to integrate previous "green" cognitive experience into decision-making behavior, ensuring the improvement of their environmental and economic performance. This study focuses on whether listed companies employing executives with environmental protection backgrounds can promote green innovation and its boundary conditions. The study finds that executives with environmental protection backgrounds enhance green innovation. The positive relationship remains robust when instrumental variables and a series of robustness tests address the endogeneity issue. Further, the positive relationship between executives' environmental protection background and green innovation is strengthened when media attention and board independence are greater. The findings provide insights into the view that executive characteristics impact green innovation.

This study extends the literature on the governance effects of management characteristics and provides new empirical evidence for the study of green innovation. First, this study adds value to the literature on upper echelons theory and green innovation research. Prior research on the effects of executive characteristics on green innovation has focused on the effects of characteristics such as executive compensation, educational background, overseas experience, and executive tenure [5]. However, few studies have put the perspective of the executive's environmental protection background affecting green innovation. Therefore, this study extends the executive's environmental protection background to the field of green innovation research based on upper echelons theory. Second, it adds to the work of Khanra et al. (2022) [27] who examined the strategic management actions taken by executives in introducing green innovation initiatives, further adding to this literature by focusing

on how the executive's environmental protection background influences the boundary mechanisms of green innovation. While previous research has focused on the direct effects of executive characteristics on various strategic choices of firms, scholars have recently called for further exploration of factors that mitigate or enhance these effects [6]. Based on insights from agency theory, this study examines the moderating role of media attention and board independence. This study also supplements the previous interpretation of agency theory and introduces the role of internal and external supervision mechanism [68]. This study extends the view that integrating agency theory and upper echelons theory enriches understanding of the governance functions of these two supervisory mechanisms in the executive's environmental protection background.

6. Recommendation

To enhance corporate green governance and sustainable development, it is important to leverage the governance strengths of executives and add an "environmental barrier" to corporate business decisions. The government should guide companies to set scientific standards for executive staffing and hire executives who value corporate environmental governance, so that business development can balance financial performance with environmental performance. In addition, executives with environmental protection backgrounds should be given the same rights as their positions to ensure they have a sufficient voice in corporate decision-making to promote sustainable development. Based on the research findings, several practical recommendations are made for governments and corporates.

For the government, it must increase its policy support to encourage corporates to implement green innovation. As a way for corporates to take up social and environmental responsibility, green innovation goals are not only based on the realization of their economic benefits, but also take into account the embodiment of social responsibility, urging enterprises to improve environmental performance and enhance green innovation. The government should build a perfect green innovation system, actively guide the flow of green funds to corporates, and prompt them to eliminate their backward production methods to promote environmental protection and sustainable development of the economy. For example, in the context of low-carbon development, the government should introduce policies and measures to promote green innovation to ensure resource efficiency. It could establish a special fund for corporate green finance or credit. It should follow the principle of differentiation and formulate targeted preferential policies, according to the actual situation of corporates, to support the deep integration of green products, organizational structures, and management processes.

For corporates, it is important to emphasize the role of the environmental protection background of executives in enhancing green innovation. First, boards must consider this characteristic when selecting executives and ensuring that their decisions are consistent with corporate goals. For example, suppose corporates are under pressure for environmental legitimacy (e.g., corporate pollution). In that case, executives with environmental protection backgrounds may be an effective way to make the necessary strategic changes [48]. Executives with an environmental protection background are beneficial from an environmental protection perspective, especially in the context of green innovation, an area considered important for corporate strategy. Hiring executives with environmental protection backgrounds in listed companies helps to encourage green investors to invest in such companies. As the number of executives with environmental protection backgrounds increases, their contribution to green innovation becomes more evident. Therefore, corporates should improve their governance mechanisms. Including executives with environmental protection backgrounds in corporate management can improve management diversity, thus reducing the myopia of management and facilitating the management to make green innovation decisions.

Second, in the era of big data, corporates should promote information dissemination and corporate governance through the media, so that stakeholders can better understand the corporate and improve its information transparency. Corporates should raise the

environmental protection awareness of their executives and be more active in disclosing green innovation information. This can alleviate the information asymmetry between enterprises and stakeholders and compensate for the lack of contrast resulting from high stakeholder expectations. Corporates can gain the trust and support of stakeholders, thus promoting green innovation. Corporates should promote information dissemination and corporate governance through the media so that stakeholders can improve the transparency of information and social responsibility of corporates.

Third, since the higher the proportion of independent directors, the easier it is for executives with environmental protection backgrounds to play a role and thus promote green innovation, it is necessary to improve the corporate governance mechanism and improve the supervision mechanism on executives' decision-making process, which can be achieved through measures such as increasing the proportion of independent directors and designing an investment risk-sharing mechanism.

7. Limitations and Future Research

This study has limitations that provide avenues for future research. First, this study explores the relationship between an executive's environmental protection background and corporate green innovation based on upper echelons theory and agency theory. For example, upper echelons theory suggests that organizational strategic decisions can be viewed as a function of managerial characteristics [13]. By focusing on the factors of the executive's environmental protection background, in future, the researcher can measure the executive environmental background in various ways, such as by combining case studies and questionnaires, to determine the differences in the competencies of the executive's background and their roles. Second, although this study introduces internal board independence and media attention, we believe that future research needs to examine more moderating factors of other supervisory factors, such as managers' knowledge, ability, CEO autonomy, and institutional factors. Third, this study draws our findings from a sample of Chinese-listed companies. Because there are differences in the incentive structure of enterprises under different national institutional backgrounds [69], they may lead to differences in executives' preferences and knowledge, which in turn affect organizational strategy. Therefore, it makes sense to use samples from different countries to test the model.

Author Contributions: Writing—original draft, X.B.; Writing—review and editing, X.B. and C.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Higher Education Fund of Macau SAR Government [CP-MUST-2021–04].

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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