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The Effect of Internal Control on Green Innovation: Corporate Environmental Investment as a Mediator

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Abstract: The increasing focus on environmental, social, and corporate governance (ESG) has led to a growing interest in how firms' internal behaviors affect their contributions in promoting sustainable economic development and fulfilling social responsibility. While previous studies have often explored the impact of internal controls on corporate investment decisions, little attention has been paid to the impact of internal controls on corporate green innovation. To this end, we explored the relationship between internal control, environmental investment, and green innovation using data from 2014–2019 for A-share listed companies in Shanghai and Shenzhen, China. The regression results show that there is a significant positive relationship between internal control and corporate green innovation. The improvement of internal control has a significant positive impact on firms' active adoption of environmental protection investment. Environmental investment plays a partially mediating role in the process of internal control's influence on green innovation. This implies that the effect of internal control on green innovation further affects green innovation through the indirect effect of environmental investment, in addition to the direct effect. Moreover, through further research, we find that the above influence relationship is significantly present in both heavily polluting and non-heavily polluting enterprises, as well as in state-owned and private enterprises, but is more significant in heavily polluting firms and private firms. Finally, this study responds to the debate on whether internal controls inhibit or promote enterprise innovation. We advocate further research on this issue in the future in terms of the differences in the accountability systems and customs of firms' decision-making in different countries.

Keywords: internal control; environmental investment; green innovation; environmental sensitivity; enterprise ownership

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1. Introduction

With rapid economic development, the burden on the natural environment is getting heavier and heavier. Environmental pollution has become a serious challenge that all countries must face. In order to promote green development, many countries are accelerating the establishment of legal systems and policy orientation for green production and green consumption, and improving the economic system of green, low-carbon and circular development. This means that paying attention to environmental protection and taking the green development path has become an inevitable way for all kinds of firms to achieve long-term sustainable development. Green innovation is a realistic focus point for promoting sustainable development and could achieve a win-win situation for both economic growth and environmental protection [1]. However, firms face the double pressure of short-term costs and long-term benefits in green innovation, and the overall innovation motivation is insufficient. On the one hand, to carry out green innovation requires firms to invest high amounts of R&D funds in the short term and suffer from the instability of the innovation cycle and the uncertainty of risks, which weakens the motivation of green innovation [2].

On the other hand, the promotion of green innovation is an advance plan for the future of firms, which could bring long-term benefits, but the lag of benefits makes most firms lack the determination to invest in green innovation in the long term [3]. Therefore, how to effectively promote green innovation in firms has become an issue of great importance to both academic and practical circles.

Regarding the influencing factors of green innovation, existing studies focus on external factors, such as government and society, to explore how to enhance the motivation of firms to promote green innovation, e.g., environmental regulation [4,5], stakeholders [6,7], government regulation [8], green finance [9], and environmental taxes [10]. A few studies have also considered the impact on green innovation in terms of internal factors, such as board governance [11] and internal environmental orientation [12]. Unfortunately, few studies have examined how to motivate firms' green innovation from the perspective of internal control. As an important internal mechanism arrangement, internal control is one of the means for firms to improve the efficiency of decision-making and control innovation risks [13]. It has a significant impact on the extent to which firms decide to implement green innovation. Li and Shi (2019) [14], using a sample of Chinese A-share listed companies from 2012–2016, showed that internal control quality could significantly improve firms' innovation performance. Using a sample of Chinese manufacturing firms, Geng (2020) [15] found empirically that the executive compensation gap has a significant positive effect on green innovation. At the same time, internal control plays a significant mediating role between the executive compensation gap and green innovation.

As an important decision for firms when conducting green activities, environmental investment is also a focus of attention in the research field of green innovation. However, current research fails to examine the relationship between internal control and green innovation based on the mediating role of environmental investment. According to the resource-based theory, environmental investment is the resource base and driving force to promote green innovation in firms [16,17]. Internal control could promote environmental investment in terms of both decision rationality and implementation effectiveness. On the one hand, when firms make environmental investment decisions, internal control could reduce management self-interest through appropriate decision-making mechanisms, reduce agency costs, and ensure the rationality of environmental investment decisions. On the other hand, internal control could strengthen the supervision of the environmental investment process through project approval, fund review, and results assessment to ensure the effective implementation of environmental investment decisions [18]. Thus, could internal control improve environmental investment and thus promote green innovation? Based on this, we selected data of Chinese listed companies in Shanghai and Shenzhen A-shares from 2014–2019 and constructed a research framework of "internal control - environmental investment - green innovation." Through empirical analysis, we clarify the relationship between internal control and green innovation, and further reveal the inner mechanism of the impact of internal control on green innovation under the mediating role of environmental investment.

The potential contributions of this study are as follows: First, as mentioned earlier, in terms of the influencing factors of green innovation, previous studies have focused less on internal factors of firms and more on external institutional factors, especially those macro studies that evaluate green innovation efficiency [19,20]. In this study, we examine the impact of the internal control of firms on green innovation at the micro level and provide new perspectives and evidence to study the influencing factors of green innovation. Second, green innovation has high risks, long cycles, and double externalities, and its development process often requires greater material support [21], necessitating attention to firms' capital placement at this stage. Therefore, this study examines the mediating effect of environmental investment, which contributes to a deeper understanding of the relationship between internal control and green innovation. Third, since the environmental sensitivity of the industry [22] and the nature of the ownership of the firm [23] may affect the business model, this study further considers the differences in the impact of the firm's

internal control on green innovation under different conditions of environmental sensitivity and ownership nature, so as to provide a reference for different types of firms to improve their green innovation capability according to the situation.

The rest of the article is organized as follows: Section 2 reviews the previous literature on internal control, environmental investment, and green innovation, and presents the research hypotheses. Section 3 describes the sample data and research design. Section 4 analyzes the empirical results and performs robustness tests. Section 5 concludes the paper and provides recommendations.

2. Theoretical Basis and Research Hypothesis

2.1. Internal Control and Green Innovation

The emergence of the concept of green innovation relies on the development of traditional innovation theories. Technological progress and market demand promote enterprise innovation [24], while green innovation is the product of combining enterprise innovation with environmental protection to achieve an environmentally friendly transformation of technological innovation [25]. The study of existing innovation theories helps us to understand better what green innovation is [26]. Of course, there are differences between green innovation and the traditional innovation concept. Rennings (1998) [27] pointed out that in addition to bringing economic benefits, such as traditional innovation, green innovation can also take into account both environmental and social benefits. Bernauer and Engels (2006) [28] and Eiadat et al. (2008) [29] explained the meaning of green innovation from the perspective of strategic management. They argued that firms develop green innovation out of the need to fulfill their social responsibility, seeking to maintain or improve their business performance and achieve long-term sustainable development under increasing environmental regulatory pressure. Thus, internal factors, such as strategic management, are the key drivers of green innovation. Braum and Wield (1994) [30], who were the first to use the term "green" to modify "innovation," argued that green innovation aims to improve energy efficiency and reduce environmental pollution. Since then, many scholars have argued that green innovation refers to a range of new products, technologies, services, and management approaches that are developed in the process of reducing or avoiding environmental pollution [21]. Combining these views, this study defines green innovation as a series of production management or technology renewal processes that prevent pollution and reduce resource waste, based on the objective of ecological protection and incorporating the fulfillment of environmental protection responsibilities into the strategic management goals of firms.

Internal control is a critical inherent institutional arrangement for modern enterprises where ownership and operation are separated, and its initial purpose is to reduce the opportunities for management fraud [31]. A high level of internal control could effectively guide a firm's strategic management, information exchange, and business processes while curbing systemic risks in business operations and innovation activities. It helps reduce innovation-decision failures due to agency problems, prevent under-investment or over-investment in innovation due to information asymmetry problems, and avoid losses in established businesses due to the impact of innovation risks [14,32]. Currently, there is a controversy in academia as to whether internal control will promote or inhibit innovation. Some of the older literature argues that internal control may inhibit innovation. For example, Bargeron et al. (2010) [33] found that as the quality of internal control improved, U.S. public firms reduced their R&D investment and increased their current asset ratios. Kang et al. (2010) [34] found that professional managers significantly increased the discount rate of investment projects after implementing the Sarbanes–Oxley Act. This phenomenon was more prevalent among firms with good governance and high credit ratings. However, studies in recent years, especially when using Chinese firms as a sample, tend to conclude that internal factors, such as internal control, promote innovation [14,15]. For example, in treating corporate social responsibility (CSR) as a mediating variable, Wang et al. (2021) [35] verified the positive effect of internal control effectiveness on technological innovation

in Chinese A-share listed companies. In another study with privately listed Chinese companies, Xie et al. (2020) [36] showed that internal governance significantly increased firms' investment in innovation.

Therefore, we believe that enhanced internal control can help drive green innovation. First, high-quality internal control can optimize the organizational structure, resulting in a clear separation of powers and responsibilities between the board of directors and managers, and checks and balances between major and minor shareholders, which improves the rationality of the corporate green innovation decision-making process. This institutional arrangement, on the one hand, forces the board of directors to strengthen the supervision of managers and prevent managers from easily rejecting green innovation projects that are in the interests of shareholders due to self-interested behavior or risk aversion [37]. On the other hand, it will enable firms to make scientific decisions on green innovation projects through risk assessment mechanisms, consultation mechanisms, supervision mechanisms, and other control measures to avoid under-investment or over-investment in the projects due to the subjective will of major shareholders [38], which mitigates the decision-making errors caused by agency problems. Second, effective internal control can alleviate the information asymmetry between firms and external investors and creditors. Through high-quality information communication and disclosure, external investors can more accurately judge the profitability of green projects, increase their investment motivation, and reduce the cost of equity capital of the projects. Creditors can also reduce their risk evaluation of green projects, reduce the cost of debt capital of the projects, and thus alleviate the under-investment in the projects due to high financing costs. Thirdly, as there are risks of both process that result in uncertainty in green innovation, firms making green innovation decisions is not the same as achieving final results in innovation [29]. High-quality internal control can prevent risks in the process of innovation activities through a series of control measures, such as comprehensive budget, control activities, authorization, and approval, etc., to maximize the guarantee of achieving the firm's green innovation goals. In summary, effective internal control can mitigate the negative effects of agency problems, information asymmetry, and innovation risks on green innovation through the synergy of various control elements, and actively promote firms to achieve green innovation. Based on this, we propose the following research hypotheses:

Hypothesis 1 (H1). *Internal control has a positive effect on green innovation.*

2.2. Internal Control and Environmental Investment

Unlike other investment decisions of firms, environmental investments have strong externalities. Most existing studies have explored their impact on environmental investment at the level of external institutions, such as environmental regulations, arguing that firms' motivations to invest in environmental protection largely stems from the coercive power of administrative authority [39,40]. In other words, in order to prevent environmental risks and avoid penalties from stakeholders for environmental violations, firms are bound to increase investment in environmental protection [41]. Consequently, scholars have focused more on external influences and less on the impact of factors from within the firm on environmental investment. Of course, some scholars have also explored this from the perspective of internal governance. As extremely important members of society, firms must not only focus on their own economic interests, but also actively fulfill their social responsibilities. However, the fulfillment of corporate social responsibility is often constrained by the internal governance patterns of the firm. For example, a study by Yang et al. (2019) [42] found that elements involving internal governance and operational characteristics, such as the degree of separation of cash flow rights from controlling shareholder control rights, board size, proportion of independent directors, director compensation, redundant resources, and productivity, were all significantly and positively associated with environmental investment. This may be due to the fact that although environmental

investments can bring economic, environmental, and social benefits to the firm at the same time, the results are often that the environmental and social benefits are much higher than the economic benefits [43]. Management tends to choose self-interested behavior and make irrational investment decisions in order to maximize short-term benefits. At this point, the internal control of the enterprise becomes particularly important.

External institutional pressures influence the internal norms and behaviors of firms, which in turn act on the external in the form of spillover effects. Li's (2014) study [44] tested the spillover effect of internal control, noting that effective internal control motivates firms to fully consider stakeholders' demands and optimize the decision-making process involving stakeholders, which ultimately drives firms to fulfill their social responsibility actively. Environmental responsibility is an integral part of social responsibility [45]. Accordingly, the spillover effect of internal control could also influence corporate environmental responsibility, i.e., internal control could motivate firms to fulfill their environmental responsibility. Environmental investment is itself is an altruistic behavior and a necessary way for firms to fulfill their environmental responsibility [46], which means that a high level of internal control may motivate firms to be more proactive in their environmental responsibility and to invest more in environmental protection. Yang et al. (2020) [47] used a sample of Chinese A-share heavily polluting enterprises and found that the quality of internal control positively affects the scale of firms' environmental investments. They argued that internal control prevents major shareholders from conspiring with management to reduce external costs and motivate managers to invest more resources in environmental protection projects to meet stakeholders' expectations for the regularization of corporate environmental responsibility. Specifically, the function played by internal control in environmental investment is closely related to decision rationality and implementation effectiveness. Among them, decision rationality is determined by whether the decision-making process of environmental investment projects is reasonable, while implementation effectiveness depends on whether environmental investment projects can be implemented accurately.

In the decision-making stage of environmental investment, on the one hand, high-quality internal control could be designed at the source to guarantee the rationality of the decision-making process, mitigate agency problems, reduce information asymmetry, and avoid opportunistic behavior of management. On the other hand, internal control could optimize the efficiency of resources invested in environmental investment. The study by Fang and Jin (2013) [48] confirmed that good internal control can significantly reduce inefficient investments of firms and improve the efficiency of resource inputs. After a firm makes an environmental investment decision, coordinating the input and allocation of resources is an important part of making subsequent decisions for the firm. At this point, internal control could reasonably determine the way resources are allocated through target management, comprehensive budget, benefit analysis, and other control methods to improve the input efficiency of environmental investment. Based on a rational decision-making process, effective control of funds and risks in the implementation of environmental investment projects is the key to guarantee the accurate implementation of this investment decision. Internal control could provide assurance for the effective implementation of the project in terms of process control and risk management. Whether it is purchasing environmental protection facilities, developing environmental protection technology, or training environmental protection awareness, the use of these funds without supervision will most likely result in embezzlement and reduce the ultimate effectiveness of the environmental investment. Therefore, high-quality internal control could strengthen the control of the implementation process and optimize the use of funds [18]. In addition, internal control could regulate the key risk points that may occur during the implementation of environmental investment projects at the operational level, reducing the risk of default and improving the performance of environmental investment [49]. Based on this, the following research hypothesis is proposed in this study.

Hypothesis 2 (H2). *Internal control has a positive effect on environmental investment.*

2.3. Internal Control, Environmental Investment and Green Innovation

As previously discussed, internal control may positively contribute to corporate environmental investment and green innovation. Thus, what role does environmental investment play in the relationship between internal control and green innovation? Several studies have been conducted to demonstrate the impact of environmental investment on green innovation. For example, Xiang et al. (2020) [50] considered environmental investment as a dimension of environmental disclosure and found that it could facilitate green innovation among Chinese listed companies that are heavy polluters by broadening financing channels, promoting product sales, and enhancing media attention. Using Pakistani firms as a context, Awan et al. (2020) [51] found that knowledge acquisition capability and environmental investment play a mediating role in the impact of buyer-driven knowledge transfer activities on green product innovation and green process innovation, respectively. There are also many more macro studies that directly use the amount of environmental investment as a share of GDP or total industrial output value as a proxy variable for environmental regulation [52,53], and use it to study its effect on the efficiency of green innovation. Thus, it is reasonable to assume that environmental investment may play a mediating role between internal control and green innovation. In terms of the relationship between internal control, corporate environmental investment, and green innovation, high-quality internal control is oriented to promote corporate social responsibility and sustainable development, which is the institutional foundation that drives firms to fulfill their environmental responsibility [54]. Internal control influences a firm's environmental investment decision-making process, and environmental investment could provide resources to support environmental technology upgrading and renewal, green R&D, and thus promote green innovation.

On the one hand, based on signaling theory, high-quality internal control is essentially a good information transmission signal. Especially for those investors who are actively concerned about the firm, they could quickly catch this good signal and increase their investment in the firm and its environmental protection projects, so that the firms' environmental protection projects could collect more funds and further promote the green innovation of the firm. On the other hand, according to the resource-based theory, green innovation cannot be achieved without the use and allocation of various resources. Effective internal control is a high-quality resource that firms have. Firms follow the risk assessment mechanism, decision-making mechanism, authorization and approval mechanism, and other control procedures in the internal control system, and will make positive environmental investment decisions based on the strategic goals of corporate social responsibility and sustainable development. At the same time, environmental protection training, financial support, and investment in R&D facilities during the implementation of environmental investment projects in turn provide human, financial, and physical resources to promote green innovation. Therefore, in the context of high-quality internal control, environmental investment is not only positively influenced by good signals of internal control, but also provides various necessary basic resources for green innovation activities, and could play a certain mediating role between internal control and green innovation. In summary of the above analysis, the following research hypothesis is proposed in this study:

Hypothesis 3 (H3). *Environmental investment plays a mediating role in the impact of internal control on green innovation.*

The analysis framework of the research is shown in Figure 1 below.

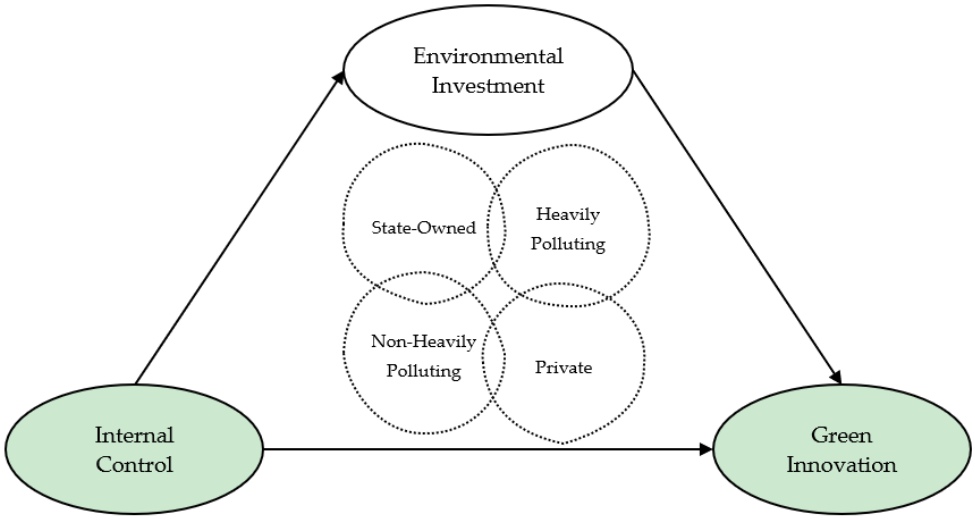

Figure 1. Analysis framework.

3. Research Design

3.1. Sample Selection and Data Sources

We draw on common practice in this research area and use publicly disclosed data from listed companies for our study. Because the amount of environmental investment is not a matter that Chinese listed companies must disclose to the public, considering the difficulty of obtaining data, we only use companies listed in China's Shanghai and Shenzhen A-shares that have disclosed environmental investment data from 2014–2019 as the research object, and screen the samples according to the following criteria:

(1) Excluding ST and *ST listed companies. According to the relevant Chinese regulations, when a listed company loses money for two consecutive years or its net asset per share is lower than the par value of the stock, its stock name will be marked with "ST,", and its stock price will be limited to a daily increase or decrease of 5% in order to reduce the investment risk. If the company loses money for three consecutive years, its stock name will be marked with "*ST,", indicating the risk of delisting.
(2) Excluding financial listed companies. Considering that financial companies have certain peculiarities in the nature of their business and financial indicators compared to other companies, comparing them together may create bias.
(3) Excluding listed companies that did not disclose environmental investment data during the sample observation period.
(4) Excluding listed companies with abnormal or missing data in the sample.

After the above elimination and screening, 1675 samples were finally obtained. The data are obtained from four main aspects: First, green innovation data, which came from the open platform China National Intellectual Property Administration (CNIPA) and were obtained by manual collation after retrieval. Second, environmental investment data, which came from the annual reports of listed companies, sustainability reports, social responsibility reports, and environmental reports, and these data were obtained through manual collation. Third, the data of internal control, which were obtained from the database of DIBO. Fourth are the data of other control variables, mainly collected through the CSMAR database and WIND database.

3.2. Variable Definition

3.2.1. Explained Variable: Green Innovation (TGreen)

In this study, we retrieved the invention and utility model patent applications of listed companies on the CNIPA's online platform, and used the "International Patent Green Classification List" published by the World Intellectual Property Organization (WIPO) in

2010 to match with the patent information retrieved from the CNIPA's online platform to obtain the green patent data of listed companies. This study refers to the practice of Wang and Wang (2021) [9] and uses the total number of green patent applications of listed companies to measure green innovation. Specifically, the number of patent applications for both green invention patents and green utility model patents of listed companies are summed up. In order to avoid the problem of the right skew of the data, we then add one to the above total number of green patent applications and take the natural logarithm as the measure of green innovation.

3.2.2. Explanatory Variable: Internal Control Level (ICI)

Based on the definition by Fan and Xiao (2014) [55], this study defines internal control as the process performed by senior management and all employees of a firm to safeguard the safety of the firm's assets, the compliance of the business process, the truthfulness and reliability of accounting information, and the effectiveness and efficiency of business activities. Drawing on Chen et al. (2018) [56], we use the DIBO internal control index from the DIBO database, dividing the value by 100 and then standardizing it.

3.2.3. Mediating Variable: Environmental Investment (EPI)

Referring to the definition of Tang et al. (2013) [46], the EPI referred to in this study is the funds invested by firms to upgrade environmental protection technology and transform environmental protection facilities in order to achieve environmental protection goals, which specifically includes investment in the development and upgrading of environmental protection technology, construction, maintenance and transformation of environmental protection facilities, and training of environmental protection awareness, etc. In this study, the amount of environmental investment is added by one and taken as the natural logarithm, which is used as a measure of firms' environmental investment.

3.2.4. Control Variables

Drawing on the studies of Li and Xiao (2020) [57] and Xie (2020) [58], we select the debt to asset ratio (Lev), increase rate of main business revenue (Growth), the nature of enterprise ownership (State), and CEO duality (Dual) as control variables. The relevant definitions and measures of each variable are shown in Table 1.

Table 1. Related variable definitions.

Type	Names	Symbols	Definition
Explained variable	Green Innovations	TGreen	Natural logarithm of the total number of green patent applications after adding 1
Explanatory variable	Internal Control Level	ICI	DIBO Internal Control Index/100
Mediating variable	Environmental Protection Investment	EPI	The amount of environmental investment is added by 1 and taken as the natural logarithm
Control variables	Debt to Asset Ratio	Lev	Total liabilities/total assets
	Operating Revenue Growth Rate	Growth	Change in operating income for the current period/operating income for the previous period
	Nature of Enterprise Ownership	State	State-owned enterprises take 1, private enterprises take 0
	CEO Duality	Dual	Take 1 if the chairman and CEO are the same person, otherwise take 0
	Management Shareholding	Mast	Management shareholding ratio
	Proportion of Independent Directors	Indir	Number of independent directors/number of all directors

Table 1. *Cont.*

Type	Names	Symbols	Definition
Control variables	Firm Market Value	TobinQ	Total market value/replacement cost of assets
	Fixed Assets Ratio	Ppe	Fixed assets/Total assets
	Top 10 Shareholders' Shareholdings	Top10	The sum of the shareholding ratio of the top 10 shareholders
	Cash Flow Sufficiency	Flow	Net cash flow from operations/total assets
	Firm Age	Age	Year of observation minus year of firm establishment
	Year	Year	Year dummy variables
	Industry	Ind	Set industry dummy variables according to CSRC standards

3.3. Model Building

We constructed the following three regression models according to the research hypotheses. Model 1 examines the relationship between internal control and green innovation. Model 2 examines the relationship between internal control and environmental investment. Model 3 examines the mediating effect of environmental investment between internal control and green innovation:

$$TGreen_{i,t} = \alpha_0 + \alpha_1 ICI_{i,t} + \alpha_2 Lev_{i,t} + \alpha_3 Growth_{i,t} + \alpha_4 State_{i,t} + \alpha_5 Dual_{i,t} + \alpha_6 Mast_{i,t} + \alpha_7 Indir_{i,t} + \alpha_8 TobinQ_{i,t} + \alpha_9 Ppe_{i,t} + \alpha_{10} Top10_{i,t} + \alpha_{11} Flow_{i,t} + \alpha_{12} Age_{i,t} + \sum Year + \sum Ind + \varepsilon_{i,t} \quad (1)$$

$$EPI_{i,t} = \beta_0 + \beta_1 ICI_{i,t} + \beta_2 Lev_{i,t} + \beta_3 Growth_{i,t} + \beta_4 State_{i,t} + \beta_5 Dual_{i,t} + \beta_6 Mast_{i,t} + \beta_7 Indir_{i,t} + \beta_8 TobinQ_{i,t} + \beta_9 Ppe_{i,t} + \beta_{10} Top10_{i,t} + \beta_{11} Flow_{i,t} + \beta_{12} Age_{i,t} + \sum Year + \sum Ind + \varepsilon_{i,t} \quad (2)$$

$$TGreen_{i,t} = \gamma_0 + \gamma_1 ICI_{i,t} + \gamma_2 EPI_{i,t} + \gamma_3 Lev_{i,t} + \gamma_4 Growth_{i,t} + \gamma_5 State_{i,t} + \gamma_6 Dual_{i,t} + \gamma_7 Mast_{i,t} + \gamma_8 Indir_{i,t} + \gamma_9 TobinQ_{i,t} + \gamma_{10} Ppe_{i,t} + \gamma_{11} Top10_{i,t} + \gamma_{12} Flow_{i,t} + \gamma_{13} Age_{i,t} + \sum Yaer + \sum Ind + \varepsilon_{i,t} \quad (3)$$

We test for mediation effects using the more commonly used stepwise test method. If the coefficient $\alpha 1$ of the explanatory variable ICI in model 1 is significant and positive, H1 will be supported. If the coefficient $\beta 1$ of the explanatory variable ICI in model 2 is significant and positive, H2 will be supported. Under the premise that the results of both model 1 and model 2 are valid, we can continue to test the coefficient $\gamma 2$ of the mediating variable EPI in model 3. If $\gamma 2$ is not significant, further judgment is needed using a Sobel test. If $\gamma 2$ is significant, we need to continue to analyze the coefficient $\gamma 1$ of the explanatory variable ICI in model 3. If $\gamma 1$ is not significant, it means that EPI plays a full mediating effect in the influence of internal control on green innovation. If $\gamma 1$ is significantly positive and the value of $\gamma 1$ is smaller than the value of $\alpha 1$, it indicates that environmental investment plays a partially mediating role in the effect of internal control on green innovation. Meanwhile, the formula "$\beta 1 * \gamma 2 / (\beta 1 * \gamma 2 + \gamma 1)$" can be used to measure the proportion of the mediating effect to the total effect.

4. Empirical Analysis

4.1. Descriptive Statistics

Table 2 shows the results of descriptive statistics for each variable. From the results of descriptive statistics of the main variables, it can be found that the median and standard deviation of green innovation (TGreen) are 0.000 and 1.258, respectively, indicating that there are some differences in green innovation among different sample firms, while more than half of the sample did not apply for green patents, indicating that it is difficult to apply for green patents and the overall level of green innovation of Chinese listed companies is low. The minimum and maximum values of internal control (ICI) are 0.000 and 9.084, respectively, and the average value is 6.325, implying that most of the sample firms pay more attention to the internal control system and operation. The maximum and minimum values of environmental investment (EPI) are 18.736 and 0.049, respectively, with

a significant difference between the two and a standard deviation of 2.419, which further indicates that the behavior of environmental investment varies greatly among the sample firms. The least discrete of the sample data among the control variables are the proportion of independent directors (Indir), with a standard deviation of 0.061, and the most discrete are the concentration of equity (Top10), with a standard deviation of 15.760, indicating a wide disparity in the holdings of the top ten shareholders of different sample firms.

Table 2. Descriptive statistics (n = 1675).

Variables	Max	Min	Mean	Median	SD
TGreen	7.342	0.000	0.825	0.000	1.258
ICI	9.084	0.000	6.325	6.648	1.603
EPI	18.736	0.049	7.755	7.877	2.419
Lev	0.996	0.037	0.466	0.472	0.195
Growth	56.174	−0.862	0.250	0.093	2.175
State	1.000	0.000	0.524	1.000	0.500
Dual	1.000	0.000	0.194	0.000	0.396
Mast	0.811	0.000	0.072	0.000	0.148
Indir	0.800	0.000	0.376	0.364	0.061
TobinQ	9.799	0.082	1.512	1.075	1.389
Ppe	0.800	0.000	0.295	0.278	0.169
Top10	98.588	16.235	60.115	59.593	15.760
Flow	0.406	−0.204	0.065	0.062	0.065
Age	38.000	6.000	18.681	19.000	4.793

4.2. Correlation Analysis

The results of the correlation analysis of the variables are presented in Table 3. It can be seen that there is a significant positive correlation between internal control (ICI) and green innovation (TGreen) at the 1% level, which tentatively confirms that internal control can positively influence green innovation. There is a significant positive correlation between internal control (ICI) and environmental investment (EPI) at the 5% level, indicating that high quality internal control can promote the environmental investment behavior of firms. Environmental investment (EPI) is significantly and positively correlated with green innovation (TGreen) at the 1% level, implying that firms increase their environmental investment to access innovation resources to further promote green innovation. In addition, none of the correlation coefficients among the variables exceed 0.5, there is no high correlation phenomenon, and there is no serious problem of multicollinearity.

Table 3. Correlation analysis.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.TGreen	1													
2.ICI	0.17 ***	1												
3.EPI	0.18 ***	0.05 **	1											
4.Lev	0.17 ***	−0.13 ***	0.24 ***	1										
5.Growth	−0.03	−0.04	0.01	0.06 **	1									
6.State	0.08 ***	−0.06 ***	0.22 ***	0.25 ***	−0.03	1								
7.Dual	0.03	0.04 *	−0.09 ***	−0.10 ***	0.02	−0.28 ***	1							
8.Mast	−0.05 **	0.05 **	−0.21 ***	−0.25 ***	0.01	−0.48 ***	−0.23 ***	1						
9.Ind	0.08 ***	0.04 *	−0.01	0.04	0.01	−0.01	0.05 **	0.01	1					
10.TobinQ	−0.17 ***	0.01	−0.38 ***	−0.38 ***	−0.02	−0.27 ***	0.11 ***	0.28 ***	0.01	1				
11.Ppe	−0.06 **	−0.20 ***	0.38 ***	0.11 ***	0.01	0.21 ***	−0.08 ***	−0.17 ***	−0.09 ***	−0.21 ***	1			
12.Top10	0.09 ***	0.14 ***	0.14 ***	0.01	0.07 ***	0.09 ***	−0.03	0.03	0.09 ***	−0.05 **	0.01	1		
13.Flow	0.07 ***	0.09 ***	0.16 ***	−0.19 ***	0.02	−0.02	0.01	0.04 *	0.01	0.13 ***	0.23 ***	014 ***	1	
14.Age	−0.02	−0.05 **	0.05 **	0.04	0.02	0.11 ***	−0.04 *	−0.18 ***	−0.09 ***	−0.12 ***	0.03	−0.18 ***	−0.01	1

Note: ***, **, and *, respectively, denote significance at the 1%, 5%, and 10% levels.

4.3. Regression Analysis

4.3.1. Internal Control, Environmental Investment, and Green Innovation

Table 4 reports the test results of the main regression model. Model 1 is the regression of internal control (ICI) on green innovation (TGreen), and the regression coefficient of ICI

is 0.156 is and significant at the 1% level, indicating that the improvement of internal control of firms can promote green innovation, and H1 is verified. That is, the more effective the operation of internal control of firms, the better the basic environment for carrying out green innovation, and the more conducive it is to the achievement of green innovation results. Model 2 is the regression of internal control (ICI) on environmental investment (EPI), and the regression coefficient is 0.113, which is significant at the 1% level, indicating that the enhancement of internal control can significantly increase the environmental investment of firms, and H2 is supported. That is, with the improvement of internal control mechanism, it helps firms to make rational investment of funds in environmental protection projects through rational decision making. With H1 and H2 supported, the mediating effect of environmental investment (EPI) in model 3 is tested and the results show that the regression coefficient of environmental investment (EPI) on green innovation (TGreen) is 0.109, which is significant at the 1% level, and the regression coefficient of internal control level (ICI) on green innovation (TGreen) is 0.144, which is also significant at the 1% level. Moreover, the regression coefficient of ICI in model 3 (0.144) is smaller than the regression coefficient of ICI in model 1 (0.156), which indicates that environmental investment plays a partially mediating role in the effect of internal control on green innovation, and H3 is valid. Therefore, internal control not only affects green innovation directly, but also can play an indirect role on green innovation through the mediating variable of environmental investment, and the proportion of the mediating effect of environmental investment to the total effect is 7.69%.

Table 4. Regression results of internal control, environmental investment, and green innovation.

Variables	(1)	(2)	(3)
	TGreen	EPI	TGreen
ICI	0.156 *** (6.49)	0.113 *** (5.25)	0.144 *** (5.96)
EPI	/	/	0.109 *** (3.94)
Lev	0.187 *** (6.43)	0.096 *** (3.70)	0.176 *** (6.08)
Growth	−0.042 * (−1.84)	−0.005 (−0.26)	−0.042 * (−1.82)
State	0.073 ** (2.52)	0.055 ** (2.15)	0.067 ** (2.32)
Dual	0.057 ** (2.39)	−0.001 −.04)	0.057 ** (2.41)
Mast	−0.019 (−0.69)	−0.068 *** (−2.79)	−0.011 (−0.42)
Indir	0.046 ** (1.96)	−0.006 (−0.30)	0.046 ** (2.00)
TobinQ	−0.132 *** (−4.33)	−0.228 *** (−8.42)	−0.107 *** (−3.46)
Ppe	−0.114 *** (−4.11)	0.294 *** (11.92)	−0.145 *** (−5.07)
Top10	0.066 *** (2.66)	0.096 *** (4.32)	0.056 ** (2.24)
Flow	0.106 *** (4.30)	0.115 *** (5.24)	0.094 *** (3.78)
Age	−0.021 (−0.82)	−0.014 (−0.62)	−0.020 (−0.76)
Year	YES	YES	YES
Ind	YES	YES	YES
R2	0.1599	0.3334	0.1678

Note: ***, **, and *, respectively, denote significance at the 1%, 5%, and 10% levels.

4.3.2. Regression Grouped by Environmental Sensitivity of Industry

The environmental sensitivity of the industry in which a firm operates may influence the green innovation of the firm. Industries with different environmental sensitivities may have different expectations for green innovation, resulting in possible differences in the promotion of green innovation by internal controls. Based on this, this study classifies the sample firms into heavily polluting industries and non-heavily polluting industries according to their environmental sensitivity, and performs group regressions. The basis for the classification is derived from the Guidelines on Environmental Information Disclosure of Listed Companies issued by the Ministry of Ecology and Environment of China, which defines 16 categories of heavily polluting industries, such as the mining industry, chemical industry, and thermal power generation industry.

According to the regression results in Table 5, internal control significantly and positively affects green innovation in both heavily polluting and non-heavily polluting enterprises, and environmental investment plays a partial mediating effect in the process of internal control affecting green innovation, further validating the hypothesis. However, the regression coefficients of internal control of heavily polluting firms are larger than those of non-heavily polluting enterprises, i.e., the internal control of the heavily polluting enterprises has a more significant impact on green innovation. This may be due to the fact that heavily polluting enterprises face a stronger practical need for green innovation. Moreover, the improvement of internal control mechanisms in heavily polluting enterprises has a more pronounced effect on green innovation decisions than in non-heavily polluting enterprises. Once heavily polluting enterprises strengthen the quality of their internal controls, the growth of their green innovation will also be more pronounced.

Table 5. Regression results after grouping by environmental sensitivity of industry.

Variables	Heavily Polluting Industry (n = 947)			Non-Heavily Polluting Industry (n = 728)		
	(1)	(2)	(3)	(1)	(2)	(3)
	TGreen	EPI	TGreen	TGreen	EPI	TGreen
ICI	0.147 *** (4.71)	0.133 *** (4.65)	0.120 *** (3.86)	0.120 *** (3.38)	0.140 *** (4.22)	0.103 *** (2.90)
EPI	/	/	0.204 *** (5.79)	/	/	0.118 *** (2.94)
Lev	0.089 ** (2.35)	0.119 *** (3.45)	0.064 * (1.72)	0.247 *** (5.72)	0.136 *** (3.37)	0.231 *** (5.33)
Growth	−0.064 ** (−2.17)	−0.021 (−0.76)	−0.060 ** (−2.06)	−0.033 (−0.95)	0.014 (0.43)	−0.034 (−1.01)
State	0.112 *** (2.96)	0.042 (1.21)	0.103 *** (2.78)	0.031 (0.74)	0.060 (1.50)	0.024 (0.57)
Dual	−0.012 (−0.38)	−0.048 * (−1.68)	−0.002 (−0.07)	0.114 *** (3.23)	0.052 (1.57)	0.108 *** (3.07)
Mast	0.042 (1.16)	−0.050 (−1.51)	0.052 (1.47)	−0.059 (−1.50)	−0.119 *** (−3.24)	−0.045 (−1.14)
Indir	0.069 ** (2.34)	−0.003 (−0.10)	0.070 ** (2.39)	−0.002 (−0.05)	0.020 (0.62)	−0.004 (−0.12)
TobinQ	−0.146 *** (−3.79)	−0.291 *** (−8.25)	−0.087 ** (−2.21)	−0.079 * (−1.70)	−0.172 *** (−3.94)	−0.059 (−1.25)
Ppe	0.085 ** (2.41)	0.223 *** (6.91)	0.039 (1.11)	−0.235 *** (−5.46)	0.270 *** (6.70)	−0.267 *** (−6.04)
Top10	0.209 *** (6.64)	0.119 *** (4.12)	0.185 *** (5.91)	−0.066 * (−1.76)	0.084 ** (2.39)	−0.076 ** (−2.02)

Table 5. *Cont.*

Variables	Heavily Polluting Industry (n = 947)			Non-Heavily Polluting Industry (n = 728)		
	(1)	(2)	(3)	(1)	(2)	(3)
	TGreen	EPI	TGreen	TGreen	EPI	TGreen
Flow	0.107 *** (3.38)	0.142 *** (4.91)	0.078 ** (2.48)	0.095 ** (2.54)	0.073 ** (2.10)	0.086 ** (2.32)
Age	−0.012 (−0.36)	−0.026 (−0.84)	−0.007 (−0.20)	−0.028 (−0.75)	0.001 (0.04)	−0.028 (−0.76)
Year	YES	YES	YES	YES	YES	YES
Ind	YES	YES	YES	YES	YES	YES
R2	0.2116	0.3396	0.2392	0.2362	0.3292	0.2456

Note: ***, **, and *, respectively, denote significance at the 1%, 5%, and 10% levels.

4.3.3. Regression Grouped by Nature of Ownership

Since the difference in the nature of enterprise ownership may also affect the development of green innovation, we further explored whether the nature of enterprise ownership may have an impact on the relationship between internal control and green innovation. Table 6 reports the grouped regression results for state-owned and private enterprises. The results show that the positive effect of internal control on green innovation exists in both state-owned and private enterprises, but the improvement of internal control in private enterprises has a more pronounced effect on promoting green innovation compared to state-owned enterprises. This may be due to the fact that private enterprises have more efficient decision-making mechanisms and flexible organizational structures, and the improvement of internal control systems has a more significant incentive effect on green innovation. In addition, environmental investment plays a partially mediating role in the process of internal control influencing green innovation in both state-owned and private enterprises, further validating the hypothesis.

Table 6. Regression results after grouping by nature of ownership.

Variables	State-Owned Enterprises (n = 878)			Private Enterprises (n = 797)		
	(1)	(2)	(3)	(1)	(2)	(3)
	TGreen	EPI	TGreen	TGreen	EPI	TGreen
ICI	0.138 *** (4.07)	0.112 *** (3.63)	0.126 *** (3.71)	0.139 *** (3.94)	0.070 ** (2.21)	0.133 *** (3.76)
EPI	/	/	0.107 *** (2.85)	/	/	0.088 ** (2.21)
Lev	0.090 ** (2.23)	0.063 * (1.72)	0.083 ** (2.07)	0.273 *** (6.66)	0.115 *** (3.11)	0.263 *** (6.39)
Growth	−0.046 (−1.47)	−0.026 (−0.91)	−0.043 (−1.38)	−0.037 (−1.07)	0.010 (0.33)	−0.038 (−1.10)
Dual	0.098 *** (3.14)	0.004 (0.12)	0.098 *** (3.14)	0.029 (0.85)	−0.012 (−0.37)	0.031 (0.89)
Mast	0.013 (0.42)	−0.053 * (−1.83)	0.019 (0.60)	−0.036 (−0.98)	−0.075 ** (−2.28)	−0.029 (−0.80)
Indir	0.062 * (1.88)	0.037 (1.23)	0.058 * (1.77)	0.029 (0.85)	−0.077 ** (−2.49)	0.036 (1.05)
TobinQ	−0.181 *** (−4.39)	−0.253 *** (−6.70)	−0.154 *** (−3.65)	−0.061 (−1.39)	−0.204 *** (−5.08)	−0.044 (−0.97)

Table 6. *Cont.*

Variables	State-Owned Enterprises (n = 878)			Private Enterprises (n = 797)		
	(1)	(2)	(3)	(1)	(2)	(3)
	TGreen	EPI	TGreen	TGreen	EPI	TGreen
Ppe	−0.108 *** (−2.81)	0.288 *** (8.21)	−0.138 *** (−3.48)	−0.124 *** (−3.24)	0.278 *** (8.03)	−0.149 *** (−3.73)
Top10	0.148 *** (4.21)	0.119 *** (3.71)	0.135 *** (3.83)	−0.047 (−1.27)	0.046 (1.38)	−0.051 (−1.38)
Flow	0.070 ** (2.07)	0.110 *** (3.55)	0.059 * (1.71)	0.137 *** (3.73)	0.142 *** (4.28)	0.125 *** (3.36)
Age	0.051 (1.38)	−0.054 (−1.62)	0.056 (1.54)	−0.113 *** (−3.01)	0.030 (0.88)	−0.115 (−3.08)
Year	YES	YES	YES	YES	YES	YES
Ind	YES	YES	YES	YES	YES	YES
R2	0.2067	0.3394	0.2142	0.1460	0.3045	0.1514

Note: ***, **, and *, respectively, denote significance at the 1%, 5%, and 10% levels.

4.4. Robustness Test

In order to test the robustness of the above regression results, the following tests were conducted in this study. First, the green innovation variable was changed, and the number of green invention patent applications of listed companies was used as a proxy for green innovation in the regression analysis. Invention patent is a category with the highest requirement for innovation among all patent types, and using the number of invention patent applications instead of total patent applications can reflect the quality of green innovation. According to the robustness test results in Table 7, after changing the measurement method of green innovation, model 1, model 2, and model 3 are validated and the conclusions are consistent with the previous regression results. Second, the Sobel test is used. The total effect of internal control on green innovation consists of a direct effect and an indirect effect, and the indirect effect means that internal control can promote green innovation by increasing environmental investment. We used the Sobel test to verify the mediation effect of environmental investment again, and the results are shown in Table 8. It can be seen that the indirect effect of environmental investment accounts for 5.25% of the total effect, and the indirect effect is significant at the 5% level, further confirming the existence of the mediation effect of environmental investment.

Table 7. Robustness test 1.

Variables	(1)	(2)	(3)
	TGreen	EPI	TGreen
ICI	0.154 *** (6.33)	0.113 *** (5.25)	0.140 *** (5.75)
EPI	/	/	0.121 *** (4.35)
Lev	0.163 *** (5.56)	0.096 *** (3.70)	0.151 *** (5.17)
Growth	−0.037 (−1.60)	−0.005 (−0.26)	−0.036 (−1.58)
State	0.089 *** (3.05)	0.055 ** (2.15)	0.082 *** (2.84)
Dual	0.068 *** (2.82)	−0.001 (−0.04)	0.068 *** (2.84)

Table 7. *Cont.*

Variables	(1)	(2)	(3)
	TGreen	EPI	TGreen
Mast	−0.024 (−0.88)	−0.068 *** (−2.79)	−0.016 (−0.58)
Ind	0.054 ** (2.31)	−0.006 (−0.30)	0.055 ** (2.35)
TobinQ	−0.130 *** (−4.24)	−0.228 *** (−8.42)	−0.102 *** (−3.29)
Ppe	−0.130 *** (−4.65)	0.294 *** (11.92)	−0.165 *** (−5.71)
Top10	0.069 *** (2.76)	0.096 *** (4.32)	0.058 ** (2.30)
Flow	0.107 *** (4.30)	0.115 *** (5.24)	0.093 *** (3.73)
Age	−0.021 (−0.80)	−0.014 (−0.62)	−0.019 (−0.74)
Year	YES	YES	YES
Ind	YES	YES	YES
R2	0.1463	0.3334	0.1561

Note: ***, **, and *, respectively, denote significance at the 1%, 5%, and 10% levels.

Table 8. Robustness test 2.

Projects	Regression results
Indirect effects	0.0001 ** (2.02)
Direct effect	0.0012 *** (6.61)
Total effect	0.0013 *** (6.89)
Indirect effect to total effect ratio	5.25%

Note: *** and **, respectively, denote significance at the 1% and 5% levels.

5. Conclusions

With the increasing emphasis on environmental, social, and corporate governance (ESG), the relationship between internal control and green innovation is bound to become a hot issue for current and future research. While part of the original intent of internal control may have been to prevent risk, as Alan Greenspan worries, the pressures created by internal controls may diminish managers' enthusiasm, become more conservative, and adversely affect corporate innovation and growth [59]. Many studies using U.S. samples have indeed also found that firms with higher levels of internal controls have significantly lower patent filings and patent citations [60]. However, from another perspective, internal control not only controls the innovation risk borne by the firm through a well-developed decision-making mechanism and monitoring mechanism, but also seems to reduce the risk previously borne by individual decision-makers or principals in the event of a decision failure and may instead prompt management to propose or approve more innovation projects. The different institutions in China and Western countries make the same type of research possible to produce different conclusions. To this end, this study empirically investigated the relationship between internal control and green innovation and examined the mediating effect of environmental investment using 1,675 sets of sample data from Chinese A-share firms in Shanghai and Shenzhen from 2014 to 2019.

The results of the empirical analysis show that: (1) internal control has a significant positive effect on green innovation, which is similar to the findings of Geng (2020) [15], supporting the conclusion that internal control is beneficial to innovation. This result suggests that based on the synergy of various control processes, high-quality internal control can mitigate agency problems, information asymmetry problems, and innovation risks of firms, which is beneficial to enhance green innovation. Next: (2), in the same conclusion as Yang et al. (2020) [47], internal control has a significant positive effect on environmental investment, confirming that adequate internal control can motivate firms to invest more in environmental protection. The effect of internal control on environmental investment can be seen through both decision rationality and implementation effectiveness. Similar to the effect on green innovation, high-quality internal control not only facilitates firms to actively launch environmental investment projects, but also guarantees the effective implementation of the projects through various control measures. Further: (3) environmental investment has a partly mediating effect in the process of internal control influencing green innovation, further explaining its intrinsic mechanism of action. This implies that, in addition to the direct effect of internal control on green innovation, it further affects green innovation through the indirect effect of environmental investment. Finally: (4) the positive effect of internal control on green innovation and the mediating effect of environmental investment remains significant across different environmental sensitivities of industries and different natures of enterprise ownership, but the effect of internal control on green innovation is more pronounced in heavily polluting enterprises and private enterprises, supporting the findings of previous studies [22,23].

The findings of this study may have the following implications. On the one hand, firms should pay attention to internal control in business management and actively perform its beneficial functions for green innovation. Improving internal control should not only focus on the decision-making process, but also supervise the implementation process, thus mitigating the agency problems, reducing the risk of environmental investment, optimizing the innovation environment, and enhancing the green innovation capability of firms. On the other hand, green innovation does not develop in isolation, and it cannot be separated from the support of environmental investment. Firms should reshape their perception of environmental investment, not only to realize the economic benefits of environmental protection investment, but also to realize the environmental and social benefits it can bring. Firms should actively fulfill their environmental responsibilities and further enhance green innovation while meeting the requirements of stakeholders.

The present study still has some limitations. Particularly noteworthy is the inconsistency of the study findings. The available evidence does not provide a reasonable explanation for why similar studies produce very different findings when using firms from different countries as a sample. One possible explanation we can offer is based on the concept of groupthink. As Dutch scholars Kroon et al. (1991) [61] found in an earlier experimental study of management team decision-making processes, accountability reduces the tendency to groupthink, prevents collective avoidance, and stimulates group members to positively influence the decision-making process, while individual accountability reduces the tendency to groupthink more than collective accountability. However, in the particular Chinese context, managers are already accustomed to issuing decisions that are actually made by a single person or a few people in the name of collective decision-making to reduce individual risk. With the strengthening of internal control, the decision-making process that was controlled by a single party or a few individuals becomes a process where more people negotiate together and check and balance each other. This makes the decision consequences that would otherwise be borne by only a very few individuals into consequences that are borne by the entire collective. That is, individual responsibility is somehow transformed into collective responsibility, which in turn motivates conservative Chinese managers to be more willing to take risks. It is clear that the accountability systems and customs of decision-making vary significantly across countries. Therefore, we suggest that future

research could enhance the exploration of the deeper causes of this phenomenon in order to eliminate the contradictions in research findings.

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