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From Green Ideas to Green Savings: Assessing the Financial Impact of Green Innovations on Audit Fees

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Abstract: Green innovation is an important approach to achieving ecologically sustainable development. However, the paradox surrounding enterprises' willingness to engage in green innovation persists in discussions. Using a sample of listed firms from 2010–2021 in the Chinese A-shares market, this study analyzed the impact of green innovation diversity on audit fees and the underlying mechanisms involved. Our findings reveal that (1) a higher green innovation diversity is associated with a reduction in external audit fees; (2) green innovation diversity impacts audit fees through information transparency and corporate environmental performance; and (3) the effect of green innovation diversity on audit fees is more pronounced in firms with lower scales, higher government subsidies, and lower pollution intensity. These findings provide valuable insights into promoting firms' engagement in green innovation activities and shed light on the challenges faced by audit firms when assessing and auditing green innovation.

Keywords: green innovation diversity; audit fees; information transparency; environmental performance

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1. Introduction

Ecologically sustainable development has increasingly gained global attention. In China, green innovation has become the predominant approach to achieving economic growth within resource constraints. However, there is a paradox in green innovation. Green innovation is undoubtedly a crucial source of value creation for enterprises, but its high-risk and long-cycle nature can hinder enterprises' willingness to adopt and embrace it [1,2]. Therefore, exploring the positive market reaction resulting from green innovation can facilitate the green transformation of enterprises and the realization of benefits for both the economy and the environment.

The economic consequences of green innovation are a research hotspot in the fields of management and environmental science. Green innovation can improve a firm's competitiveness [3,4] and financial performance [5–8] and elicit support and recognition from the government and society [9–13]. However, green innovation could expose firms to greater risks and uncertainties [2], thus influencing their economic performance [14,15]. To resolve these conflicting views, this study explores green innovation in more depth and examines its economic consequences from fresh angles. We define the diversity of green innovation by utilizing the classification code matrix of the green patent portfolios and explore the consequences of green innovation from the perspective of auditors.

This study examined the impact of green innovation diversity on audit fees using a sample of 4901 listed Chinese firms from 2010 to 2021. We found that green innovation diversity is associated with a reduction in external audit fees. Moreover, the relationship between them operates through the improvement of information transparency and corporate environmental performance. A heterogeneity analysis showed that the effect of green innovation on audit fees is more considerable in smaller firms, those with higher government subsidies, and in greener industries.

This study contributes to the growing literature about the quality of green innovation. Most previous studies on green innovation have primarily relied on the quantity of green patent applications as a measure [6,7], paying little attention to the green patent portfolios. However, merely considering the quantity of patents is insufficient to reveal the differences in innovation levels and technology among enterprises. Conversely, analyzing patent portfolios helps assess a firm's knowledge breadth and innovation capabilities in various green innovation domains. Therefore, we adopt green patent portfolios to analyze the quality of green innovation, providing critical insights into a firm's performance and development potential. Moreover, this study has expanded the literature about green innovation and external audit. From a regulatory perspective, green credit policy and environmental administrative penalties significantly affect audit fees [16,17]. Based on the above research, this study further explores the impact of green innovation on audit fees, focusing on the diversity of green patent portfolios at the firm level. It provides valuable insights into the influence of green innovation on firm finances and the audit process, as well as the challenges encountered by audit firms in evaluating and auditing green innovation. Finally, the findings contribute to promoting the development of green innovation. Our findings demonstrate that external stakeholders—represented by audit firms—regard enterprise green innovation as a positive expression of social responsibility, thereby promoting cost effectiveness within the enterprise.

The remainder of this paper is structured as follows: Section 2 reviews the literature and provides hypotheses development. Section 3 describes the research design. Section 4 provides the empirical analysis. Section 5 discusses the findings. Section 6 concludes the paper.

2. Literature Review and Hypotheses Development

Green innovation, as a form of environmentally oriented innovation activity, has been receiving growing attention from businesses and policymakers worldwide. Green innovation enables countries to develop energy-saving products and adopt carbon-free technologies [18], ultimately leading to the sustainable transformation of their economic structure [18,19]. Researchers posit that green innovation can enhance a firm's green competitiveness and improve financial performance [5–8]. Further, green innovation can also elicit support and recognition from the government and from society [9], thereby enhancing the company's reputation [10,11], strengthening the trust between employees and the firm [10], attracting investment and customers [12,13], and reducing the crash risk [20]. Moreover, green firms and those not subject to environmental penalties face less audit scrutiny [16,17]. Although green innovation can enhance a firm's sustainability, it is associated with high investment and research and development (R&D) expenses and carries a significant risk of failure [21]. With its need for higher R&D costs, green innovation could expose companies to greater risks and uncertainties [2]. Moreover, the ongoing enhancement of government environmental policies and standards might impose limitations and challenges on companies' production and operations, thus influencing their economic performance [22]. The aforementioned studies all indicate that green innovation is undoubtedly a vital driver of sustainability for enterprises, but its high risk and opportunity cost can hinder enterprises' willingness to embrace it.

Green innovation presents new opportunities for enterprises to pursue sustainable development, considerably impacting their operations and financial standing. These financial changes directly influence the scope of audit services and fees paid to audit firms. While prior research has primarily examined the impact of green policy implementation on auditing [16,17], this study expands on that by analyzing how the diversity of green patent portfolios at the firm level affects audit fees.

As organizations strive to achieve sustainability goals through green innovation, auditors are confronted with novel duties encompassing the assessment of environmental performance, assurance provision concerning disclosures, and the resolution of challenges associated with greenwashing. When facing complex tasks, the auditor will increase audit procedures and adopt a "cost compensation mechanism" to offset audit costs by charging higher audit fees. Specifically, the increasing level of diversity of corporate green innovation could lead to greater complexity in the work of auditors. More frequent and complex innovation activities result in a greater investment required by auditors in R&D work, thereby leading to higher audit fees [23,24]. When auditing firms with low levels of innovation diversity, auditors could draw upon their accumulated experience and knowledge from prior auditing engagements [25]. Contrastingly, when auditing firms operating in pioneering fields of innovation, particularly those engaged in green innovation, auditors may encounter challenges stemming from insufficient experience [26]. Therefore, to offset potential losses, auditors will charge higher audit fees for firms with high innovation diversity [23]. In summary, when auditing firms with high levels of green innovation diversity, auditors need to exert more effort to deal with the increased complexity of business, lack of auditor experience, and audit litigation risk. Based on the above analysis, this study set forth the following hypothesis:

H_1. *Corporate green innovation diversity will increase external audit fees.*

As the level of green innovation diversity increases, companies are more likely to adopt distinct and advanced environmental management practices, leading to improved environmental performance and a reduction in environmental risks [8,13]. This enhancement in environmental stewardship is expected to result in greater transparency and reliability in the financial reporting of these companies, consequently mitigating audit risks and potentially reducing audit costs. When auditors assess firms with a high degree of green innovation diversity, the presence of well-established environmental management systems facilitates the verification of disclosed environmental information [27–30]. Consequently, auditors may need to spend less time and effort on substantive procedures related to environmental risks, leading to lower audit fees. Moreover, companies with higher green innovation diversity are perceived by investors and stakeholders as responsible and sustainable entities [11,31]. This positive perception could lower the perceived audit risk associated with these companies [16,17], resulting in a decrease in the audit risk premium charged by auditors. In summary, the higher transparency and reduced environmental risks associated with higher green innovation diversity could lead to a more efficient and less time-consuming audit process, thus reducing audit fees. Based on the above analysis, this study set forth the following hypothesis:

H_2. *Corporate green innovation diversity will reduce external audit fees.*

3. Research Design

3.1. Data and Sample

We selected 2010–2021 data from mainland China-based firms represented by Chinese A-shares (Chinese A-shares are stocks that are publicly listed firms on the Shanghai (SSE), and Shenzhen (SZSE) stock exchanges) as our research sample. We collected patent data from the website of the State Intellectual Property Office of China (the website of the State Intellectual Property Office of China is https://www.cnipa.gov.cn/ (accessed on 6 June 2022)) using Python 3.7 (the website of Python 3.7 is www.python.org (accessed on 12 July 2020)). The International Patent Classification was used to determine the classification of patents according to the Chinese patent classification system. The features of financial performance and corporate governance were obtained from the China Stock Market and Accounting Research (CSMAR) database. After excluding firms in the financial and real estate sectors, special treatment firms (the special treatment firms refer to listed firms that are experiencing financial distress and have had a special treatment (ST) "cap" imposed on them by the China Securities Regulatory Commission), and those with missing values, the final sample consisted of 36,848 firm-year observations of 4901 firms. To eliminate the impact of extreme values, we truncated continuous variables at the 1% level in both tails.

3.2. Variable Definition

3.2.1. Independent Variable

Firms' green innovation diversity was measured using the level of diversity of firms' green patent portfolios. According to Custódio et al. [32], we calculated the distribution range of a firm's green patent portfolio using the Herfindahl index at the IPC4 classification level (the International Patent Classification Expert Committee has compiled a list of environmentally sound technologies patent classification codes based on the United Nations Framework Convention on Climate Change) to measure green innovation diversity.

$$Green\_diversity_i = 1 - \sum_k^n \alpha_i^2 \quad (1)$$

In Equation (1), α_i denoted the proportion of patents filed under the IPC4 classification in the patent portfolio of Firm *i*. A higher value of *Green_diversity* implies a wider breadth of knowledge utilized, resulting in a higher level of diversification and a lower concentration of patent activity across different technology categories. This translates into greater difficulty for other firms to replicate the patented product, leading to a more pronounced technological monopoly and higher patent quality. For example, if Firm A has five patents with a patent matrix of (1/5, 1/5, 1/5, 1/5, 1/5), its *Green_diversity* is 4/5 based on the formula of $1 - 5 \times (1/5)^2$. If Firm B has also applied for five patents but all of them are only in one technology field, its patent matrix would be (5/5, 0, 0, 0, 0), resulting in a *Green_diversity* of 0 based on the formula of $1 - (5/5)^2$. Evidently, Firm A's exploration in new technology areas leads to higher innovation diversity and higher quality of innovation than that of Firm B.

3.2.2. Dependent Variable

The dependent variable in this study was external audit *fees (Fee)*. Following Lim and Monroe [33], we measured audit fees as the natural logarithm of the sum of the domestic and foreign audit fees paid by the firm in the current year.

3.2.3. Control Variables

Drawing on previous research [34,35], we controlled for several factors that could influence a firm's external audit fees, including firm size (*Size*), leverage (*Lev*), return on assets (*ROA*), whether the firm is audited by a Big 4 accounting firms (*Big4*), book-to-market ratio (*BM*), proportion of independent directors (*Inddir*), number of supervisors on the supervisory board (*Supervisor*), and number of directors on the board (*Director*). In addition, we included industry dummies (*Industry*) and year dummies (*Year*) in our regression analysis to control for industry and macroeconomic factors. The variable definitions are presented in Table 1.

Table 1. Variable Definitions.

Symbol	Explanation	Definition
Fee	audit fees	The natural logarithm of the combined domestic and foreign audit fees
Green_diversity	green innovation diversity	$Green\_diversity_i = 1 - \sum_k^n \alpha_i^2$ where α_i denotes the proportion of patents filed under the IPC4 classification in the patent portfolio of Firm *i*.
Size	firm size	The natural logarithm of total assets
LEV	financial leverage	The ratio of total liabilities to total assets
ROA	return on assets	The ratio of net income to total assets

Table 1. *Cont.*

Symbol	Explanation	Definition
Big4	prominence of audit firm	It equals to 1 if the audit firm is recognized as the "Big Four" (and 0 otherwise)
BM	book-to-market ratio	The ratio of the firm's current book value to market value
State	property of ownership	It equals to 1 if the firm is stated owned (and 0 otherwise)
Duality	CEO duality	It equals to 1 if CEO and Chairman are the same person (and 0 otherwise)
Inddir	independent directors	The percentage of board members who are independent directors
Supervisor	manager size	The natural logarithm of the number of managers
Director	board size	The natural logarithm of the number of directors

3.3. Regression Models

To investigate the impact of green innovation diversity on external audit fees, we constructed the following model:

$$Fee_{i,t} = \alpha_0 + \beta_1 Green\_diversity_{i,t} + \beta_2 Con_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (2)$$

In Model (2), *Fee* represented external audit fees, and *Green_diversity* represented an enterprise's green innovation diversity. *Con* represented the remaining control variables. If β_1 is significantly greater than 0, it indicates that green innovation diversity increases external audit fees, supporting H_1. Conversely, if β_1 is significantly less than 0, it indicates that green innovation diversity reduces external audit fees, supporting H_2.

4. Empirical Analysis

4.1. Descriptive Statistics

Table 2 presents the results of the descriptive statistics for the variables. The mean of green innovation diversity (*Green_diversity*) was 0.08 with a standard deviation of 0.21, indicating that the overall level of green innovation diversity was generally low among Chinese enterprises and there was significant variation among different firms. The maximum and minimum values of external audit fees (*Fee*) were 16.22 and 12.54, respectively, with a standard deviation of 0.69, suggesting a large difference in audit fees paid by different firms.

Table 2. Descriptive Statistics.

Variable	Obs.	Mean	SD	Min	Median	Max
Fee	36,848	13.80	0.69	12.54	13.71	16.22
Green_diversity	36,848	0.08	0.21	0.00	0.00	0.82
Size	36,848	22.13	1.30	19.61	21.95	26.15
LEV	36,848	0.42	0.21	0.05	0.41	0.95
ROA	36,848	0.04	0.07	-0.33	0.04	0.20
Big4	36,848	0.06	0.23	0.00	0.00	1.00
BM	36,848	0.62	0.25	0.10	0.62	1.17
State	36,848	0.34	0.47	0.00	0.00	1.00
Duality	36,848	0.29	0.45	0.00	0.00	1.00
Inddir	36,848	0.38	0.05	0.33	0.36	0.57
Supervisor	36,848	1.22	0.23	1.10	1.10	1.95
Director	36,848	2.12	0.20	1.61	2.20	2.71

4.2. Empirical Results

4.2.1. Baseline Results

We tested our main hypothesis using the empirical Model (2) and present the regression results in Table 3. Column (1) of Table 3 shows the regression results for the relationship between green innovation diversity (*Green_diversity*) and external audit fees (*Fee*), without controlling for industry and year effects. The results indicated a significant negative correlation between *Green_diversity* and *Fee* ($\beta = -0.041$, $p < 0.05$). To further verify the negative relationship between *Green_diversity* and *Fee*, we controlled for industry and year effects in the regression model, and the results are presented in Column (2) of Table 3. The coefficient of *Green_diversity* was negative and significant ($\beta = -0.054$, $p < 0.01$). These findings demonstrate that green innovation diversity can reduce the audit costs and risks of auditors [8], thereby decreasing external audit fees. Thus, H_2 was verified.

Table 3. The Diversity of Green Innovation and External Audit Fees.

Variable	(1)	(2)
	Fee	***Fee***
Green_diversity	−0.041 **	−0.054 ***
	(−2.03)	(−2.72)
Size	0.407 ***	0.377 ***
	(62.51)	(53.81)
LEV	−0.015	0.144 ***
	(−0.48)	(4.90)
ROA	−1.125 ***	−0.824 ***
	(-20.08)	(−15.31)
Big4	0.602 ***	0.619 ***
	(20.50)	(20.50)
BM	−0.202 ***	−0.178 ***
	(−9.12)	(−7.23)
State	−0.101 ***	−0.069 ***
	(−6.81)	(−4.74)
Duality	0.024 **	0.009
	(2.54)	(1.05)
Inddir	0.041	0.085
	(0.37)	(0.81)
Supervisor	−0.077 **	−0.024
	(−2.54)	(−0.83)
Director	−0.041	0.038
	(−1.17)	(1.12)
Year/Industry	Not Control	Control
Constant	5.136 ***	5.194 ***
	(31.81)	(32.05)
Observations	36,848	36,848
R-squared	0.623	0.666

Note: The values between parentheses are t-statistics; ** and *** indicate significance at the 5% and 1% levels, respectively. Control indicates that the variables are controlled.

4.2.2. Robustness Tests

(1) Endogeneity Problem: The Heckman Two-Stage Regression Model

The decision of the firms to engage in a high level of green innovation diversity may not be random, as certain factors could make some firms more inclined toward implementing such innovations. To address potential self-selection bias, the Heckman two-stage model was used. In the first stage, Model (3) estimated the probability of different firms engaging in high-diversity green innovation, yielding the inverse Mills ratio (INVMR). Model (3) incorporated factors that influence green innovation diversity by firms, including shareholding ratio of institutional investors (*Inst*), corporate social responsibility (*CSR*), industry competition intensity (*HHI*), loss status (*Loss*), equity restriction (*Eq_Balance*), management shareholding ratio (*Ma_Share*), government subsidies (*Sub*), and cost leadership (*Cost*). In the first stage of the Heckman two-stage model, we employed probit estimation to categorize firms into two groups in Models (3) and (4). This categorization was based on the industry median of green innovation diversity (*Green_diversity*). Firms above the median were classified as having a high level of innovation diversity, while those below it were considered to have a low level.

$$\begin{aligned} Probit_{Green\_diversity_{i,t}} = \gamma_0 + \gamma_1 Inst_{i,t} + \gamma_2 CSR_{i,t} + +\gamma_3 HHI_{i,t} + \gamma_4 Loss_{i,t} \\ + \gamma_5 Eq\_Balance_{i,t} + \gamma_6 Ma\_Share_{i,t} + \gamma_7 Sub_{i,t} \\ + \gamma_8 Cost_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \end{aligned} \quad (3)$$

Column (1) of Table 4 shows the estimated results of Model (3). In the second stage, the INVMR generated by the first stage was used in the regression Model (4).

$$\begin{aligned} Fee_{i,t} = \beta_0 + \beta_1 Green\_diversity_{i,t} + \beta_2 INVMR + \beta_3 Con_{i,t} + \sum Year \\ + \sum Industry + \varepsilon_{i,t} \end{aligned} \quad (4)$$

Table 4. The Results of Robustness Test.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	$Probit_{Green\_diversity}$	*Fee*	*Fee*	*Fee*	*Fee*
Ma_share	0.193 *** (3.53)				
Loss	−0.113 *** (−3.08)				
Sub	15.994 *** (12.27)				
Growth	−0.029 (−1.29)				
CSR	0.001 * (1.67)				
Inst	0.449 *** (9.68)				
HHI	−0.332 *** (−5.88)				
Cost	−0.885 (−0.14)				
Green_diversity		−0.053 ** (−2.52)		−0.022 *** (−3.28)	
INVMR		0.072 * (1.86)			
L2_Green_diversity			−0.060 *** (−2.58)		
L.Fee				0.808 *** (115.63)	
Citegreen_diversity					−0.017 ** (−2.26)
Size		0.386 *** (48.94)	0.382 *** (47.52)	0.082 *** (25.09)	0.313 *** (89.61)
LEV		0.115 *** (3.48)	0.175 *** (5.20)	0.081 *** (8.73)	0.102 *** (7.72)
ROA		−0.711 *** (−11.06)	−0.926 *** (−15.81)	−0.034 (−1.49)	−0.396 *** (−15.98)
Big4		0.623 *** (18.57)	0.593 *** (17.86)	0.119 *** (12.71)	0.299 *** (22.92)
BM		−0.176 *** (−6.09)	−0.193 *** (−6.48)	−0.047 *** (−5.99)	−0.029 *** (−2.87)
State		−0.062 *** (−3.90)	−0.059 *** (−3.73)	−0.035 *** (−9.13)	0.035 *** (3.80)
Duality		0.010 (0.99)	0.008 (0.76)	0.004 (1.27)	−0.001 (−0.16)
Inddir		0.001 (0.01)	0.058 (0.49)	−0.026 (−0.83)	0.022 (0.48)
Supervisor		−0.020 (−0.63)	−0.024 (−0.73)	−0.019 ** (−2.56)	−0.014 (−0.90)

Table 4. *Cont.*

Variable	(1)	(2)	(3)	(4)	(5)
	$Probit_{Green\_diversity}$	*Fee*	*Fee*	*Fee*	*Fee*
Director		0.008	0.043	−0.005	0.065 ***
		(0.23)	(1.11)	(−0.57)	(4.26)
Year/Industry		Control	Control	Control	Control
Constant	−1.281 ***	4.956 ***	5.260 ***	0.921 ***	6.220 ***
	(−29.15)	(24.74)	(28.29)	(16.80)	(65.50)
Observations	27,578	27,578	26,661	30,961	36,848
R-squared		0.665	0.651	0.902	0.636

Note: The values between parentheses are t-statistics; *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Control indicates that the variables are controlled.

As shown in Column (2) of Table 4, the coefficient of the INVMR estimated by the Heckman self-selection model was significantly positive (β = 0.072, $p < 0.1$), indicating the presence of selection bias in the sample, which needed to be corrected by the Heckman self-selection model. Column (2) of Table 4 also shows the effect of green innovation diversity on audit fees after correcting for self-selection bias by the INVMR. After incorporating the INVMR, the coefficient of *Green_diversity* remained significantly positive (β = −0.053, $p < 0.05$). The results once again verify the establishment of H_2; that is, the higher the level of diversity of a firm's green innovation, the lower the fees charged by auditors for that firm. The use of INVMR accounted for potential endogeneity in the relationship between green innovation diversity and audit fees and enhanced the robustness of the findings.

(2) Extending the Observation Period of the Output of Corporate Green Innovation

To ensure the robustness of the results, this section extended the observation period of the output of corporate green innovation. According to Lerner and Wulf [36], it takes two years for the output of corporate innovation to be more accurately observed. Following their approach, we adopted a two-year observation period to examine the relationship between the level of green innovation diversity and audit fees. As shown in Column (3) of Table 4, the coefficient of green innovation diversity (*L2_Green_diversity*) was significantly negative (β = −0.060, $p < 0.01$), which once again validates the inhibitory effect of green innovation diversity on audit fees.

(3) Controlling for the Stickiness of Audit Fees

To control for the stickiness of audit fees, which could lead to a significant positive correlation between the audit fees of the previous period and the current period, the following measures were taken: (1) controlling for the previous year's audit fees (*L.Fee*) and (2) using a change model. The regression results are presented in Column (4) of Table 4. The coefficient of green innovation diversity (*Green_diversity*) was significantly negative (β = −0.022, $p < 0.01$). The results indicate that green innovation diversity can reduce audit fees thus validating the robustness of our conclusions.

(4) Changing the measurement for the diversity of green innovation

In the primary examination, this study measures green innovation diversity based on all the company's green patents. However, certain patents could have been filed but not actually put into practice. To gauge the quality of a patent, it is valuable to consider its citation. Hence, we computed the green diversity of cited patents as an indicator of green innovation diversity (*Citegreen_diversity*). As shown in Column (5) of Table 4, the coefficient of *Citegreen_diversity* was significantly negative (β = −0.017, $p < 0.05$), which validates the robustness of our conclusions.

4.2.3. Mechanisms of Information Transparency and Environmental Performance

As previously mentioned in Section 2, green innovation diversity primarily reduces audit fees by improving the quality of corporate information disclosure and environmental performance. To assess the validity of these mechanisms, we employed the three-step mediation analysis approach put forth by Baron and Kenny [37]. Specifically, we constructed

Model (5) and Model (6) as extensions of Model (2). Our findings contribute to the literature on green innovation and audit fees by clarifying the specific pathways through which green innovation diversity and audit fees are related.

$$MV_{i,t} = \alpha_0 + \alpha_1 Green\_diversity_{i,t} + \alpha_2 Con_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (5)$$

$$Fee_{i,t} = \beta_0 + \beta_1 MV_{i,t} + \beta_2 Green\_diversity_{i,t} + \beta_3 Con_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (6)$$

In Model (5), *MV* represented information transparency (*Intrans*) and environmental performance (*EP*). The measurement of information transparency (*Intrans*) draws upon the framework developed by Lang et al. [38], which combines various indicators such as earnings quality, disclosure quality ratings assigned by the Shenzhen Stock Exchange, analyst coverage, and analyst forecast accuracy to assess the overall transparency of a firm's information. We constructed a composite index, referred to as *Intrans*, based on these indicators. A higher value of *Intrans* indicates a greater level of information transparency for the firm. This approach offers a more comprehensive assessment of information transparency than any single indicator alone. As for the measurement of environmental performance, International Organization for Standardization (ISO) 14001 certification is the most widely used voluntary environmental regulation project in China. Compared with noncertified enterprises, enterprises that have obtained ISO 14001 certification often have more complete environmental risk management systems and better environmental performance [39,40]. Therefore, we chose whether a firm has obtained ISO 14001 certification as a proxy variable for environmental performance.

(1) Information Transparency

Column (1) and Column (2) of Table 5 report the results of the information transparency mechanism regression analysis. As shown in Column (1) of Table 5, the coefficient of green innovation diversity (*Green_diversity*) on information transparency (*Intrans*) was significantly positive (β = 0.018, $p < 0.01$), indicating that green innovation diversity can significantly improve the quality of information disclosure. In Column (2) of Table 5, the coefficient of information transparency (*Intrans*) on audit fees (*Fee*) was significantly negative (β = −0.246, $p < 0.01$), suggesting that information transparency can significantly reduce audit fees. Moreover, the coefficient of green innovation diversity (*Green_diversity*) in Column (2) remained significantly negative (β = −0.051, $p < 0.01$). These findings suggest that the improved information transparency resulting from green innovation diversity is a significant mechanism through which audit fees are reduced. Consistent with our theoretical analysis, green innovation diversity has become a critical driver of information disclosure for firms, which can enhance information transparency and reduce the costs of auditors' access to information and audit failure. Ultimately, this can lead to a reduction in audit fees.

Table 5. The Mechanism of Information Transparency and Environmental Performance.

Variable	(1)	(2)	(3)	(4)
	Intrans	***Fee***	***EP***	***Fee***
Intrans		−0.246 ***		
		(−8.17)		
Green_diversity	0.018 ***	−0.051 ***	0.286 ***	−0.053 ***
	(3.76)	(−2.58)	(5.38)	(−2.69)
EP				−0.024 **
				(−2.44)
Size	0.087 ***	0.400 ***	0.028	0.378 ***
	(52.99)	(48.92)	(1.63)	(52.15)

Table 5. *Cont.*

Variable	(1)	(2)	(3)	(4)
	Intrans	***Fee***	***EP***	***Fee***
LEV	−0.102 ***	0.112 ***	−0.100	0.135 ***
	(−12.91)	(3.67)	(−1.16)	(4.50)
ROA	0.710 ***	−0.624 ***	1.016 ***	−0.802 ***
	(43.12)	(−10.75)	(5.39)	(−14.58)
Big4	0.271 ***	0.689 ***	−0.041	0.619 ***
	(39.76)	(21.23)	(−0.60)	(20.08)
BM	−0.235 ***	−0.232 ***	0.146 **	−0.169 ***
	(−35.80)	(−8.40)	(2.11)	(−6.61)
State	−0.001	−0.069 ***	−0.027	−0.069 ***
	(−0.17)	(−4.58)	(−0.66)	(−4.62)
Duality	0.006 **	0.011	0.002	0.009
	(2.36)	(1.14)	(0.06)	(1.00)
Inddir	−0.035	0.082	0.057	0.080
	(−1.24)	(0.76)	(0.17)	(0.75)
Supervisor	−0.010	−0.026	0.008	−0.023
	(−1.46)	(−0.87)	(0.11)	(−0.78)
Director	0.017 **	0.033	0.245 ***	0.038
	(2.01)	(0.97)	(2.58)	(1.10)
Year/Industry	Conotrol	Conotrol	Conotrol	Conotrol
Constant	−1.456 ***	4.812 ***	−2.537 ***	5.163 ***
	(−37.48)	(26.65)	(−5.78)	(30.89)
Observations	33,356	33,356	35,044	35,046
R−squared	0.531	0.668		0.670
Pseudo R−squared			0.0917	

Note: The values between parentheses are t-statistics; ** and *** indicate significance at the 5% and 1% levels, respectively. Control indicates that the variables are controlled.

(2) Environmental Performance

Column (3) and Column (4) of Table 5 present the results of the environmental performance mechanism regression analysis. As shown in Column (3) of Table 5, the coefficient of green innovation diversity (*Green_diversity*) on environmental performance (*EP*) was significantly positive (β = 0.286, $p < 0.01$). This finding provides empirical evidence supporting a positive relationship between the level of green innovation diversity and environmental performance. In Column (4) of Table 5, the coefficient of *EP* on audit fees (*Fee*) was significantly negative (β = −0.024, $p < 0.05$). This suggests that environmental performance can significantly reduce audit fees. Additionally, the regression coefficient of *Green_diversity* remained significantly negative (β = −0.053, $p < 0.01$). This suggests that by enhancing a firm's environmental performance, a high level of green innovation diversity can reduce audit fees. These results are consistent with our theoretical prediction that improving the quality of green innovation can effectively enhance environmental performance and reduce audit costs and risks of auditors owing to environmental risks of the firm [8], thus reducing audit fees.

4.2.4. Heterogeneity Analysis

To further analyze the heterogeneity of the impact of green innovation diversity on audit fees, we investigated the effects of firm scale, government subsidies, and industry category.

(1) Firm Scale

Firm scale exhibits a strong association with audit fees owing to the increased complexity of business operations and related-party relationships for larger firms. Consequently, auditors are required to perform more extensive audit procedures and incur higher expenses for larger firms, resulting in a decreased responsiveness of audit fees to green innovation diversity in these firms. To examine this hypothesis, we employed total employment (*Emp*) and total sales (*Sales*) to measure firm scale and examined their potential moderating effects on the relationship between green innovation diversity and audit fees. The results of our analysis are presented in Column (1) and Column (2) of Table 6, respectively. As shown in Column (1) of Table 6, the coefficient of *Emp* × *Green_diversity* was significantly positive (β = 0.063, $p < 0.01$). Moreover, As shown in Column (2) of Table 6, the coefficient of *Sales* × *Green_diversity* was also significantly positive (β = 0.030, $p < 0.05$). The findings indicate that smaller firms exhibiting higher levels of green innovation diversity encounter a more substantial decrease in audit fees compared to larger firms.

Table 6. The Results of Heterogeneity Test.

Variable	**(1)**	**(2)**	**(3)**	**(4)**
	Fee	***Fee***	***Fee***	***Fee***
Green_diversity	−0.568 *** (−4.93)	−0.630 *** (−2.70)	−0.038 * (−1.70)	−0.092 *** (−3.83)
Emp×Green_diversity	0.063 *** (4.17)			
Emp	0.068 *** (10.81)			
Sales×Green_diversity		0.030 ** (2.36)		
Sales		0.042 *** (9.29)		
Sub×Green_diversity			−2.706 ** (−2.12)	
Sub			0.984 *** (3.81)	
Ifhp×Green_diversity				0.124 *** (2.90)
Ifhp				−0.186 *** (−3.01)
Size	0.317 *** (37.73)	0.333 *** (40.15)	0.377 *** (53.89)	0.379 *** (51.56)
LEV	0.123 *** (4.24)	0.142 *** (4.83)	0.140 *** (4.76)	0.139 *** (4.55)
ROA	−0.883 *** (−16.46)	−0.885 *** (−16.69)	−0.835 *** (−15.47)	−0.795 *** (−14.09)
Big4	0.599 *** (20.17)	0.572 *** (18.59)	0.618 *** (20.47)	0.621 *** (19.76)
BM	−0.170 *** (−7.00)	−0.154 *** (−6.28)	−0.176 *** (−7.17)	−0.175 *** (−6.72)
State	−0.072 *** (−5.03)	−0.066 *** (−4.56)	−0.070 *** (−4.78)	−0.068 *** (−4.52)
Duality	0.008 (0.94)	0.006 (0.71)	0.010 (1.07)	0.010 (1.07)
Inddir	0.053 (0.51)	0.123 (1.18)	0.082 (0.78)	0.096 (0.88)
Supervisor	−0.039 (−1.36)	−0.025 (−0.85)	−0.025 (−0.84)	−0.019 (−0.65)
Director	0.017 (0.51)	0.035 (1.05)	0.038 (1.13)	0.031 (0.89)
Year/Industry	Control	Control	Control	Control
Constant	6.048 *** (34.42)	5.381 *** (32.88)	5.192 *** (32.05)	5.146 *** (30.27)
Observations	36,837	35,599	36,848	33,367
R−squared	0.673	0.666	0.666	0.666

Note: The values between parentheses are t-statistics; *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Control indicates that the variables are controlled.

(2) Government Subsidies

Government subsidies can act as both an external monitoring mechanism and an endorsement of firms' R&D activities, which could reduce audit risk. First, government agencies supervise the enterprises receiving subsidies to ensure that the subsidies are used effectively. This increases the transparency of the information available to auditors and can reduce their workload. Second, governments tend to disburse subsidies to firms with a greater likelihood of achieving innovation success. This trend has resulted in firms receiving subsidies exhibiting elevated rates of innovation success and reduced levels of audit risk. To investigate the impact of government subsidies on the relationship between green innovation diversity and audit fees, we introduced government subsidies (*Sub*) and its interaction term with green innovation diversity (*Sub* × *Green_diversity*) in Model 1. The results presented in Column (3) of Table 6 reveal that the coefficient of *Sub* × *Green_diversity* was significantly negative ($\beta = -2.706$, $p < 0.05$). This finding suggests that auditors tend to charge lower audit fees for firms with a higher level of diversity of green innovation that have received more government subsidies. This tendency is owing to auditors perceiving such firms to possess reduced innovation risk.

(3) Industry Category

Industry category can also influence the impact of the level of green innovation diversity on audit fees. Studies have demonstrated that as social issues such as environmental pollution become more severe, firms tend to voluntarily disclose information related to environmental and social responsibility to obtain environmental legitimacy [41]. Firms with high levels of pollution tend to face greater environmental risk and social monitoring pressures. Therefore, auditors may need to collect more evidence to verify the quality of the disclosed green patents for firms with high levels of pollution and charge higher audit fees accordingly. To examine this hypothesis, we introduced a binary dummy variable to identify firms operating in pollution-intensive industries. This dummy variable, labeled as "*Ifhp*", takes a value of 1 if the firm belongs to a pollution-intensive industry and 0 otherwise. The results presented in Column (4) of Table 6 reveal that the coefficient of the interaction term (*Ifhp* × *Green_diversity*) was significantly positive ($\beta = 0.124$, $p < 0.01$), suggesting that the impact of the level of green innovation diversity on audit fees is weaker in pollution-intensive industries owing to the need for auditors to incur additional costs to verify the quality of the green patents disclosed by these firms.

5. Discussion

The findings of this study provide comprehensive insights into the impact of green innovation diversity on audit fees and shed light on the underlying mechanisms involved. The empirical results consistently demonstrate a significant negative relationship between green innovation diversity and audit fees. This implies that companies with higher levels of green innovation diversity experience lower audit fees.

In examining the mechanisms behind this relationship, two key factors emerge. (1) Companies with higher levels of green innovation diversity tend to improve their information transparency, which attracts investors and leads to green premiums [12,13]. Consequently, the cost of acquiring information for auditors decreases. (2) As companies achieve higher levels of green innovation diversity and improve their environmental performance [42–44], auditors can lower the cost of evaluating environmental risks and reduce audit fees.

Our analysis revealed several additional findings in heterogeneity analysis. (1) The impact of green innovation diversity on audit pricing is more significant for small-scale enterprises. This is because smaller companies generally have simpler business structures, leading to streamlined audit procedures and lower costs for auditors [45]. (2) For companies that receive significant subsidies, the government's approval and supervision result in substantially lower audit fees [46]. (3) Compared to pollution-intensive firms, greener enterprises with higher innovation diversity can more effectively reduce audit fees. Auditors can be relieved from concerns about the company engaging in information modification owing to environmental pressures [41]. By delving into these detailed findings, this study provides an extensive understanding of the relationship between green innovation diversity and audit fees, highlighting the importance of promoting and embracing green innovation for both companies and auditors.

This study has several limitations that should be considered in future research. It is important to recognize that different stakeholders of enterprises could have varying attitudes toward green innovation. Our investigation was focused solely on auditors' responses, but further studies should aim to examine a broader range of economic consequences involving multiple stakeholders. Moreover, green innovation encompasses various attributes beyond diversity, such as sustainability. It is crucial to acknowledge and investigate these other attributes of green innovation. Future studies should explore the economic consequences associated with these additional attributes.

6. Conclusions

We selected the listed firms in the Chinese A-shares market from 2010 to 2021 as our sample to investigate the influence of green innovation diversity on external audit fees. The main conclusions are as follows. (1) Our findings confirmed that a higher level of green innovation diversity is associated with a reduction in external audit fees. (2) We further examined the mechanisms underlying this relationship and found that it operates through the improvement of information transparency and corporate environmental performance. (3) Additionally, the effect of green innovation on audit fees is more pronounced in firms with smaller scales, higher government subsidies, and lower pollution intensity. Our findings revealed that green innovation diversity can generate substantial economic advantages for society. Therefore, the government should provide adequate support to promote the diversity of green innovation of enterprises.

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