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Green innovation and the cost of equity: evidence from China

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Abstract

Purpose – This paper aims to examine the association between green innovation and the cost of equity in China. This study relies on the investors' base perspective and shareholders' perceived risk perspective to investigate the relation between green innovation and the cost of equity in China.

Design/methodology/approach – The paper uses firm-fixed effect regression for a sample of Chinese public companies for the period 2008–2018.

Findings – The authors find a negative relationship between green innovation and the cost of equity capital. This negative association is found to be more pronounced for less financially constrained firms, during periods of high economic policy uncertainty, and for firms with a strong internal control environment. Finally, the paper shows that the negative association became more pronounced after the passage of the Environmental Protection Law of China in 2012. The results remain robust to possible endogeneity concerns.

Originality/value – This study contributes to the green innovation literature by documenting that shareholders favorably view firms implementing green innovation policies. The study also has policy implications for Chinese regulators in improving the green credit policy.

Keywords Green innovation, Cost of equity, Environmental protection, Financial constraint

Paper type Research paper

1. Introduction

Innovation, conceptualized as a process where existing knowledge is recombined in novel ways, plays a critical role in a country's economic growth (Schumpeter & Nichol, 1934) Innovation enables companies from emerging markets to catch up with those of developed market competitors (Chan, Chen, & Liu, 2021). Despite playing such a critical role, innovative activities often result in adverse environmental outcomes and, thereby, require stakeholders to take proactive approaches to minimize such adverse outcomes (Longoni, Luzzini, & Guerci, 2018). One such approach involves encouraging companies to develop and adopt environment-friendly innovative activities, i.e. green innovation (Lin, Ho, Sambasivan, Yip, & Mohamed, 2021).

Green innovation has been promoted as a global strategy for sustainable development that firms can use to combat increasing environmental issues and sustain competitive advantage (Rennings & Rammer, 2011; Yao, Zeng, Sheng, & Gong, 2021). Green innovation

JEL Classification — G12, G30, O30

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has been used by the stakeholders as an ethical and strategic tool to evaluate firms. From an ethical perspective, when firms engage in green innovation, stakeholders would judge these firms as socially responsible, thereby enlarging the investor base. Flammer (2013) documents that greener firms can decrease pollution by providing eco-friendly products and processes that ultimately reduce the environmental footprint. From a strategic perspective, firms are likely to pursue green innovation to create uniqueness at the product and organizational levels to increase their competitiveness. Prior studies document that firms engaging in green innovation benefit from increased competitiveness, enhanced efficiency, higher brand equity and greater profitability (Child, Lu, & Tsai, 2007; Dangelico & Pujari, 2010). Research has also found that firms with more green innovation suffer less from financial constraints (Zhang, Xing, & Wang, 2020). Despite the positive consequences of green innovation documented in previous studies, green innovation also is associated with high risk (Cronin, Smith, Gleim, Ramirez, & Martinez, 2011) and poor firm performance (Palmer, Oates, & Portney, 1995), among others. This paper aims to explore the association between green innovation and the cost of equity. We choose cost of equity as the outcome variable, since this is one of the key considerations for investment decisions as it systematically captures the investors' perception of risk. Therefore, understanding whether shareholders perceive investments in green innovation as a risk-minimizing strategy and hence, require lower returns, is likely to provide important insights regarding the importance of green innovation for companies.

This study relies upon two perspectives to explain the association between green innovation and the cost of equity capital. First, the *investors base perspective* suggests that a diversified investor base enables firms to attract public financing because a pool of heterogeneous investor base with different risk preferences and trading motives is a precursor for optimum funding sources. Companies may attract ethical investors by establishing a good image of themselves as environmental-friendly firms through engaging in green innovation activities (El Ghoul, Guedhami, Kwok, & Mishra, 2011; Elmawazini, Chkir, Mrad, & Rjiba, 2022). Such investors are likely to expect less returns on their investments in green-innovative firms, thus reducing the cost of equity of green firms. Second, from *shareholders' perceived risk perspective*, green innovation facilitates companies to decrease environmental risk exposure, resulting in lower equity risk premiums. Green innovation aims to reduce a company's environmental externalities by inventing goods that generates less waste and emits less carbon dioxide. Furthermore, green innovation, being eco-friendly activity, likely reduces the business risk by decreasing the threat of litigation that can impose significant costs on the company. Thus, shareholders of green firms are likely to expect less returns and hence, we should expect a negative association between green innovation and the cost of equity.

Firms' decisions to invest in green innovation are influenced by a variety of factors such as financial constraints and regulatory uncertainties (Shen, Zhang, Liu, & Hou, 2020; Zhang *et al.*, 2020). We thus examine the settings where the relation between green innovation and cost of equity may be more or less pronounced. First, we argue that the negative relationship postulated above is likely to be more pronounced for less financially constrained firms since firms with financial flexibility are better equipped to invest in green innovation. Furthermore, financial flexibility decreases a firm's cost of equity capital (Dai, Shackelford, Zhang, & Chen, 2013; Dhaliwal, Heitzman, & Zhen Li, 2006). We also explore whether the green innovation and cost of equity relationship is conditional on the economic policy uncertainty (hereafter EPU). EPU decreases financial stability, accentuates financial constraints, increases cost of equity and also decreases innovation (Bhattacharya, Hsu, Tian, & Xu, 2017; Bloom, Floetotto, Jaimovich, Saporta-Eksten, & Terry, 2018; Phan, Iyke, Sharma, & Affandi, 2021; Tran, 2021; Xu & Yang, 2021). Based on this evidence, we predict the negative relationship between green innovation and cost of equity would be stronger during periods of low EPU. Additionally, we explore whether the relationship between green innovation and cost of equity is moderated by the quality of the internal control environment. Prior research shows that a poor-quality internal control environment increases cost of equity (Dhaliwal, Hogan, Trezevant, & Wilkins, 2011; Ogneva, Subramanyam, & Raghunandan, 2007) and decreases investments (Li, Shu, Tang, & Zheng, 2019). Therefore, we expect the negative association between green innovation and cost of equity will be more pronounced for firms with a strong internal control environment.

We choose China to investigate the research question for the following reasons. First, China is the largest emitter of CO_2 (29.18%), followed by the USA (14.02%) [1]. Chinese policymakers, as well as the polluted industries, have been under considerable pressure to shift to cleaner energy sources and engage in green innovation strategies (Zhao & Wu, 2007). Accordingly, it is worth investigating whether investments in green innovation result in reduced cost of equity in our setting. Second, China's capital markets suffer from acute information asymmetry and agency problems (Poncet, Steingress, & Vandenbussche, 2010), thereby making it difficult for firms to access finance at a cheaper cost. Although the Chinese securities regulators have promulgated a series of regulations for capital market development, effective and credible enforcement of such regulations remain a concern (Piotroski & Wong, 2012). As is well known, lack of capital impedes productive investments, including investments in green innovation, and hence, it will affect the cost of capital. Third, the Chinese government has initiated several regulatory reforms related to environmental protection, including green security, insurance, and the policy of green credit (He, Zhang, Zhong, Wang, & Wang, 2019). Although these initiatives are important, they also create uncertainties, i.e. policy uncertainties for firms given the costs associated with compliance with such regulatory reforms. The existence of policy uncertainties, therefore, provides an interesting setting to explore the moderating effects of EPU on the relation between green innovation and cost of equity.

Using a sample of Chinese listed firms spanning the period 2008–2018, we document a negative relationship between green innovation and the cost of equity. In terms of economic significance, a 10% increase in green patents (green processes) decreases the cost of equity by 0.005% (0.004%). Our results remain robust to possible endogeneity concerns stemming from omitted variable concern, reverse causation problem and design choices. We further document that this negative association is pronounced for less financially constrained firms, during periods of heightened economic policy uncertainty, and for firms with strong internal control environment. Finally, we document that the passage of the 2012 Environmental Protection Law of China had an attenuating effect on the negative association between green innovation and the cost of equity.

Our study contributes to the literature in several important ways. First, we contribute to green innovation literature by documenting that the investments in green innovation are perceived favorably by shareholders. This finding demonstrates the importance of firms' ongoing initiatives toward developing a sustainable production process through green innovation that will likely provide competitive advantages to firms. Our finding therefore suggests that informing stakeholders about a company's investments in green innovation, as indicated by the number of patented green innovations, may be more important than simply disclosing the company's environmental efforts. The finding is also important because many businesses are hesitant to participate in environment-friendly initiatives, due to the high cost and risk of such projects. Our study therefore has practical implication. Second, we contribute to the voluminous literature on the determinants of cost of equity by documenting that green innovation has additional predictive ability, even after controlling for firms' environmental disclosures. Third, by documenting the moderating role of financial constraints, EPU and the internal control environment on the association between green innovation and the cost of equity capital, we enrich the theoretical arguments on how green innovation relates to cost of equity capital: a finding yet to be documented in the literature (e.g. Elmawazini *et al.*, 2022).

The remainder of the paper is structured as follows: Section 2 reviews the related literature and develops the hypothesis. Section 3 describes the sample selection procedure and research design choices. Section 4 presents the main test results. Finally, Section 5 concludes the paper.

2. Literature review and hypothesis development

2.1 Green innovation

Green innovation can be defined as technological innovation activities that lead to resource-saving, clean production processes and products, thereby enabling firms to fulfill economic and environmental targets (Wong, 2013). Given the significance of green innovation activities for a nation's sustainable development, it is not surprising to see researchers' increasing interest in examining the determinants and consequences of green innovation. For example, research has found that firm characteristics, including firm size (Embong, Mohd-Saleh, & Hassan, 2012), firm growth (Amore & Bennedsen, 2016), stakeholders' characteristics (Liu, Li, Peng, & Lee, 2020; Peng & Lin, 2008), CEO and top management team characteristics (He & Jiang, 2019; Quan, Ke, Qian, & Zhang, 2023), and the quality of the internal control environment (Chan *et al.*, 2021; Li, Han, & He, 2019) are related to the development of green innovation. Furthermore, financial constraints and EPU have also been found to be significantly related to green innovation (Canepa & Stoneman, 2008; García-Quevedo, Segarra-Blasco, & Teruel, 2018; Shen *et al.*, 2020; Xu & Yang, 2021).

In terms of green innovation's consequences, existing evidence has shown green innovation is associated with a positive firm reputation (Amores-Salvadó, Martín-de Castro, & Navas-López, 2014), strong competitive advantage (Chang, 2011), more brand equity (Yao *et al.*, 2021), and better firm performance (Xie, Huo, & Zou, 2019), but is negatively related to idiosyncratic risk and the cost of equity for a sample of 132 automotive firms (Lin, Mohamed, Sambasivan, & Yip, 2020). Green innovation can diversify the company's investor base by attracting ethical investors to the company (El Ghoul *et al.*, 2011). Zhang *et al.* (2020) show that green innovation mitigates financial constraints for a sample of Chinese firms.

2.2 Cost of equity

One of the most important considerations in investment decisions is cost of equity since it typically reflects how investors perceive risk. Prospective investors will demand a larger return to compensate for the increased risk if they perceive firm-level fundamental activities signaling high risk. Easley and O'hara (2004) state that the quantity and quality of information affect the cost of equity. Hence, the extant literature discusses the role of information from two related perspectives: information asymmetry and information risk (e.g. Diamond & Verrecchia, 1991; Lambert, Leuz, & Verrecchia, 2007). A plethora of research has examined various determinants of cost of equity, including financial reporting quality (Francis, LaFond, Olsson, & Schipper, 2004; Habib, 2006), and the quality of corporate governance (Mazzotta & Veltri, 2014; Srivastava, Das, & Pattanayak, 2019). Relevant to our research, the literature examining the relationship between corporate social responsibility (CSR) and the cost of equity has found that firms with better CSR performance have lower cost of equity (Dahiya & Singh, 2021; Gupta, Raman, & Shang, 2018; Xu, Liu, & Huang, 2015). Fonseka, Rajapakse, and Tian (2019) investigate the relationship between environmental information disclosure and the cost of equity capital for a sample of Chinese energy sector firms and document a negative relationship.

2.3 Green innovation and the cost of equity capital

We predict a negative association between green innovation and the cost of equity capital from two theoretical perspectives. First, from the *shareholder risk perspective*, we argue that green innovation enables firms reduce environmental risk exposure and hence, lowers equity risk premiums. Investors would require a risk premium as a compensation for increased risk emanating from the market's perception about a firm's risk level. Green innovation creates a positive perception in the market for a firm (Miles & Covin, 2000) and is one of the key determinants that influence financial growth and environmental sustainability (Dangelico &

Pujari, 2010). As discussed in 2.1. above, firms with more green innovation enjoy high brand equity and better firm performance, among other benefits, and lower risk. Firms with high green innovation technology are likely to have easier access to capital markets at cheaper costs because such firms cater to the demands of wider stakeholders and therefore, are perceived as trustworthy. Increased trust reduces litigation, reputation, and competition risks. Thus, green firms are more likely to gain a favorable public image, and are less likely to violate environmental regulations, which in turn reduces firm risks, and therefore, the cost of equity. However, if shareholders require less return because of reduced environmental risk, then this effect should manifest more for the green process measure, than for the green patents measure, as the latter have not been implemented yet.

Second, according to the investor base perspective, non-green firms have a high cost of capital because of a small investor base which stems from an increasing proportion of ethical investors avoid investing in non-green firms (Breuer, Fichter, Lüdeke-Freund, & Tiemann, 2018). Small investor base reduces the opportunities for risk-sharing, increases risk and hence, results in lower share prices (Heinkel, Kraus, & Zechner, 2001). Empirical evidence reveals that when stocks are removed from the sustainability index, firms experience negative abnormal returns (Becchetti, Ciciretti, Hasan, & Kobeissi, 2012). Firms can attract more investors by pursuing initiatives that are more eco-friendly (Wang, Feng, & Huang, 2013), i.e. firms can expand their investor base by investing in green patents and processes. A heterogeneous investor base enables firms to diversify its risk and the literature suggests that efficient risk-sharing among a larger pool of capital providers leads to a lower cost of capital (Dhaliwal *et al.*, 2011; Wang *et al.*, 2013). Companies may attract ethical investors by establishing a good image of themselves as environment-friendly firms through engaging in green innovation activities (El Ghoul *et al.*, 2011; Elmawazini *et al.*, 2022). When investors observe these firms and decide to invest in them, due to the effective risk sharing such investors are likely to expect less returns on their investments in green-innovative firms, thus reducing the cost of equity of green firms. Przychodzen and Przychodzen (2015) document that green firms exhibit better return on equity, return on assets, and higher profit margins compared to their non-green peers. In sum, green innovation increases the firm's brand image, reduces the firm's litigation risk, and lowers the firm's risk because green innovation is an eco-friendly activity. Based on these arguments, we develop the following hypothesis:

H1. Green innovation is negatively associated with the cost of equity for Chinese firms.

2.3.1 The moderating effect of financial constraint. The financial development level of a country plays a pivotal role in innovation investments because financial institutions facilitate the financing of such investments (King & Levine, 1993). As is well known, developing green products and processes requires considerable time and resources (Hall & Lerner, 2010) both in the present and in the future so that the ongoing green development initiatives face minimal disruption (Hyytinen & Toivanen, 2005). As is well documented, financial constraints deter firm investment and growth (Poncet *et al.*, 2010; Stein, 2003). Gorodnichenko and Schnitzer (2013) find that financial constraints are negatively related to firm innovation, suggesting that financial frictions play a key role in the innovation decision of the firm. Prior studies have documented that the success of green innovation hinges critically on the availability of capital (García-Quevedo *et al.*, 2018), because of the high costs for developing green products and processes (Brown, Martinsson, & Petersen, 2012; Quan *et al.*, 2023). Thus, less financially constrained firms are more likely to engage in green innovation due to the availability of sufficient resources. Furthermore, green innovation initiatives involve higher risk, thus, financially constrained firms might be unable to tolerate such a risk and hence are less likely to invest in green innovations (Quan *et al.*, 2023). As financially constrained firms seek to look for external financing including equity financing, such firms need to use green innovation, among others, as a signaling mechanism to attract ethical investors. However, heightened financial constraints will impede green innovation and increase the cost of raising external finance. This is unlikely to be a problem for less financially constrained firms. Therefore, we expect H1 to be more pronounced for less financially constrained firms. Thus, we hypothesize as follows:

H2. Financial constraint moderates the relationship between green innovation and the cost of equity of Chinese firms.

2.3.2 The moderating effect of EPU. EPU refers to the uncertainty in regulations and fiscal policies and may force firms to delay and/or postpone their investment decisions (Azzimonti, 2018; Baker, Bloom, & Davis, 2016; Bonaime, Gulen, & Ion, 2018). The moderating effect of EPU on the relationship between green innovation and the cost of equity is *ex ante* unclear as prior studies on the relationship between a firm's innovation and EPU have found mixed results. Heightened EPU increases systematic risk and lenders demand higher returns for bearing additional risks. Consequently, an increase in EPU increases the cost of external financing, thereby accentuating the financial constraint of firms and slowing down firm innovation (Xu, 2020). Also, heightened EPU makes it difficult for managers to predict innovation outcomes accurately which further discourages managerial propensities to engage in innovation including green innovation. Bloom (2009) proposes a model in which excessive uncertainty affects economic development by driving firms to postpone investment and hiring optimally. Bhattacharya *et al.* (2017) find that EPU inhibits corporate innovation. Using data from listed firms in China, Wang, Wei, and Song (2017) find EPU has negative impacts on corporate R&D investment.

Those suggesting a positive association between heightened EPU, and innovation argue that from the growth option perspective, firms may decide to invest under uncertainty to gain the future benefits that may occur from earlier investments (Shen *et al.*, 2020). Abel and Eberly (1996) argue that more uncertainty should not necessarily decrease investments; rather, increased investments under uncertainty could lead to long-term benefits because of the irreversible nature of investments. Companies tend to be prepared to accept higher capital costs to invest despite increasing EPUs since growth potential is one of the main factors driving future investments (Gennaioli, Ma, & Shleifer, 2016). Using data from China, Shen *et al.* (2020) document a positive relationship between EPU and firm innovation: a finding attributable to the possibility of reaping benefits in the future from investments during uncertain periods. Therefore, an increase in EPU will not necessarily reduce the innovation level of firms. This is especially true for companies dealing with green projects, which are still in the early phases of development (Liu, He, Liang, Yang, & Xia, 2020). Therefore, firms may wish to engage more in green innovation during periods of heightened economic uncertainty, which might be viewed favorably by investors. Although prior research generally finds that cost of equity increases during periods of high policy uncertainty (Liu & Wang, 2022; Pástor & Veronesi, 2013; Pham, 2019), increased investments in green innovation may attenuate this effect. So, we develop the following hypothesis:

H3. EPU moderates the relationship between green innovation and the cost of equity of Chinese firms.

2.3.3 The moderating effect of internal control environment. A weak internal control environment reduces the quality of financial reporting (Donelson, Ege, & McInnis, 2017), increases information asymmetry and, consequently, information risk. The internal control literature documents that high quality internal control system is associated with less information asymmetry, thereby, a lower information risk which in turn decreases the firm's cost of equity (Gordon & Wilford, 2012; Ogneva *et al.*, 2007). Since high information risk increases cost of equity (Easley & O'hara, 2004; Lambert *et al.*, 2007), it is important to explore whether the association between green innovation and cost of equity is conditional on the quality of the control environment.

There are competing arguments regarding the moderating effects of internal control environment on the association between green innovation and the cost of equity. Some argue that high quality internal control environment discourages managers from engaging in risky innovative initiatives since extensive controls are required over these initiatives and hence, managers' efforts to adopt green innovative projects may be compromised (Bargeron, Lehn, & Zutter, 2010). In contrast, others argue that high quality internal control environment is likely to ease financial constraints and give firms better access to financial resources, thereby, encouraging managers to invest in green innovation (Hall & Lerner, 2010). Studies on the relationship between innovation and internal control quality provides mixed evidence. First, findings documenting a positive association between internal control quality and innovation are theorized on the premise that strong control environment reduces financial constraints and the agency problems thereby, encouraging managers to invest in projects that can create value (Chan *et al.*, 2021). Studies that find a negative association (e.g. Bargeron *et al.*, 2010; Li, Han, & He, 2019) attribute such results to a strong control environment discouraging managers to engage in risky projects. Drawing on the arguments above, we hypothesize the following:

H4. The internal control environment moderates the association between green innovation and the cost of equity of Chinese firms.

3. Research design

3.1 Data and sample selection

We begin with an initial sample of 19,616 firm-year observations spanning the period 2008–2018 that excluded non-financial firms. Our sample period starts from 2008 as one of the key control variables, CSRR, only became available since 2008. The 2008–2018 sample period allows us to investigate the effects of the adoption of The Construction of Ecological Civilization (CEC) [2] by the Chinese government who passed a major environment-related regulation namely, the "Environmental Protection Law of China" in 2012. The CEC has been documented as a key driver for green technology development in China (Wei, Hulin, & Xuebing, 2011). Our sample is reduced by 6,168 observations due to missing values of CSR rating data. Our final sample consists of 10,641 firm-year observations after dropping missing values of some other control variables. Panel A of Table 1 shows the sample selection procedure.

We collect data on green innovation from the National Intellectual Property Administration (NIPA) of China, while we collect the required data for calculating the COE from the WIND database. The EPU data is retrieved from the China's EPU index. The financial and corporate governance data are collected from the China Stock Market and Accounting Research (CSMAR) database. The data pertaining to firms' internal control environment is retrieved from the DIB Internal Control and Risk Management Database: a database developed by DIB Enterprise Risk Management Technology Co. Ltd. To avoid the effect of outliers, we winsorize the continuous variables at the top and bottom 1% of their respective distributions. Panel B of Table 1 reports that the Manufacturing industry represents the majority of our sample (61.35%), followed by the Wholesale and Retail Business industry (5.67%), and the Electricity, Thermal, Gas and Water Production and Supply industry (4.95%).

3.2 Measurement of variables

3.2.1 Dependent variable:. Following Fonseka *et al.* (2019) we use the Easton (2004) PEG ratio (denoted as PEG) and modified PEG ratio (denoted as MPEG) based on the analysts' earnings forecasts. These two measures are estimated as follows:

Panel A: Sample selection procedure	Observations
All observations available for the period 2008 to 2018 excluding financial firms	19,616
(−) Firms with missing data related to CSR variable	(6,168)
(−) Firms with missing values for control variables	(2,807)
Final sample	10,641

Panel B: Industry distribution Industry	Freq.	Percent (%)
A: Agriculture, forestry, animal husbandry and fishery	180	1.66
B: Mining industry	345	3.17
C: Manufacturing industry	6,505	61.35
D: Electricity, Thermal, Gas and Water Production and Supply Industry	536	4.95
E: Construction business	317	2.93
F: Wholesale and retail business	620	5.67
G: Transportation, Warehousing and Postal Service	478	4.39
H: Accommodation and catering	27	0.25
I: Information transmission, software and information technology services	485	4.49
K: Real Estate	529	4.86
L: Leasing and Business Services	140	1.31
M: Scientific Research and Technology Services	26	0.24
N: Water Conservancy, Environment and Public Facilities Industry	106	0.97
P: Education	38	0.3
Q: Health and social work	106	0.9
R: Culture, Sports and Entertainment	107	0.98
S:Comprehensive	113	1.04
	10,641	100.00

Note(s): This table is prepared by the authors

Table 1. This table reports sample selection procedure (Panel A) and the distribution of the sample across the industry groups (Panel B)

$$PEG = \sqrt{(AFEPS_2 - AFEPS_1)/P_0} \tag{1}$$

$$MPEG = A + \sqrt{A^2 + (AFEPS_2 - AFEPS_1)\Big/P_0} \tag{2}$$

$$A = DPS_1/(2P_0)$$

Where $AFEPS_1$ and $AFEPS_2$ are the one and two-year-ahead analyst earnings forecasts per share, respectively; P_0 refers to the stock price at the end of the year; and DPS_1 refers to one-year-ahead analysts' forecasted dividend per share. Definitions and sources of all variables are provided in Table 2.

3.2.2 Independent variable:. Green patents are related to low carbon, environmentally friendly, sustainability, emission reduction, recycling, clean, ecology, economic and environmental protection. Following previous studies, we use two proxies to identify the firms' green innovation practices, namely, green patents (GP) (Berrone, Fsfuri, Gelabert, & Gomez-Mejia, 2013; Li, Zhao, Zhang, Chen, & Cao, 2018; Quan *et al.*, 2023) and green processes (GPR) (Luan, Tien, & Chen, 2016). GP is measured as the natural logarithm of one plus the number of green patents and GPR is measured as the natural logarithm of one plus green processes (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; Li *et al.*, 2018; Zhang *et al.*, 2020). These measures capture firms' initiatives to implement green production methods resulting in reductions of pollution, and efficient utilization of resources.

Variable	Definition	Source
Control variables		
SIZE	Firm size defined as the log of a firm's market value of equity	CSMAR
TOBIN_Q	Tobin Q measured as market value of equity divided by book value of equity at the end of the year	CSMAR
DEBT	Firm leverage defined as the total liabilities to total assets	CSMAR
ROA	Return on assets defined as the net profit scaled by total assets	CSMAR
AGE	Firm age defined as the number of years since a firm has been listed	CSMAR
REST	A binary variable refers to financial restatements coded 1 if a firm restated the financial reports in a year (t), and zero otherwise	CSMAR
DAC	Discretionary accruals calculated using adjusted-Jones models as follows $TA_{i,t}/A_{i,t-1} = \alpha_0(1/A_{i,t-1}) + \alpha_1(\Delta REV_{i,t}/A_{i,t-1}) + \alpha_2(PPE_{i,t}/A_{i,t-1})$ (A. 1) $NDA_{i,t}/A_{i,t-1} = \alpha_0(1/A_{i,t-1}) + \alpha_1[(\Delta REV_{i,t} - \Delta REC_{i,t})/A_{i,t-1}] + \alpha_2(PPE_{it}/A_{i,t-1}) + \varepsilon_{i,t}$ (A. 2) $DAC_{i,t} = TA_{i,t}/A_{i,t-1} - NDA_{i,t}/A_{i,t-1}$ (A. 3) Where $TA_{i,t}$ is total accruals of a firm i in fiscal year t, $A_{i,t-1}$ is one year lagged total assets, $\Delta REV_{i,t}$ is the total revenue in fiscal year t minus the total revenue in fiscal year $t-1$ scaled by total assets in fiscal year $t-1$. $\Delta REC_{i,t}$ is net receivables in fiscal year t minus net receivables in fiscal year $t-1$ scaled by total assets in fiscal year $t-1$. $PPE_{i,t}$ is total property plant and equipment in fiscal year t scaled by total assets in fiscal year $t-1$. $NDA_{i,t}$ is the non-discretionary accruals for firm i in fiscal year t, and DAC is the discretionary accruals	CSMAR
CSRR	CSR rating defined as the scores of a firm CSR performance	
SOE	State-owned enterprises defined as dummy variable equals one if the firm affiliated by the government	CSMAR
TOP10	The percentage of ownership of top 10 largest shareholders	CSMAR
IOWN	Institutional ownership defined as the percentage of institutional ownership	CSMAR
BSIZE	The board size defined as number of directors on the board of the firm	CSMAR
BIND	Board independence measured as the ratio of independent directors in the board	CSMAR
DUAL	A binary variable coded 1 if the CEO is the chairman of the board	CSMAR
Moderating variables		
FC	Financial constraints proxy measured using SA index calculated as follows FC= (−0.737*SIZE) + (0.043* SIZE^2) - (0.040*AGE). Where SIZE refers to the firm size measured as the total assets and AGE refers to the number of years a firm has been listed	CSMAR
FC_D	A dummy variable coded 1 if FC is more than the median FC, zero otherwise	CSMAR
EPU	Baker *et al.* (2016) EPU index, defined as the number of articles that mention the uncertainty in future economic policy of the government in major newspapers	Baker *et al.* (2016)
EPU_D	A dummy variable coded 1 if the EPU is more than the median EPU, zero otherwise	Baker *et al.* (2016)
IC	Internal control environment defined as the composite score of IC strength derived from five dimensions of IC: financial reporting quality, operational efficiency, asset safety, IC strategies, and legal compliance. IC ranges from 1 to 1000, where a low value represents a weak IC environment	DIB Internal Control and Risk Management Database
IC_D	A dummy variable coded 1 if the IC is more than the median of IC, zero otherwise	As above

Note(s): This table is prepared by the authors

Table 2. Measurement of variables

3.2.3 Control variables:. Consistent with prior research (e.g. Lin *et al.*, 2021; Zhang *et al.*, 2020) we include several firm-level financial determinants of COE. SIZE is the firm size defined as the natural log of the market value of equity, DEBT refers to firm leverage defined as total debts scaled by total assets, TOBIN_Q refers to the firm's growth opportunities, ROA is the return on assets, and AGE is the firm age defined as the number of years since being listed on the stock exchange. Prior research shows a strong relation between financial reporting quality (FRQ) and cost of equity (Francis *et al.*, 2004). We include two proxies of FRQ namely, financial restatements (REST), coded 1 if the firm restated its financial reports in year (t), and zero otherwise, and discretionary accruals (DAC) following the modified Jones (Dechow, Sloan, & Sweeney, 1995) model. We include the CSR rating variable to rule out the possibility that green innovation captures CSR activities. CSRR is the CSR rating defined as the CSR scores of a firm. We also include several corporate governance variables likely to affect firm-level COE. SOE refers to the state-owned enterprises coded 1 for state-owned firms, and zero otherwise, TOP10 refers to the percentage of ownership by the top 10 largest shareholders, IOWN refers to the institutional ownership defined as the percentage of institutional shareholdings, BSIZE refers to board size defined as the number of directors on the board, BIND is board independence measured as the proportion of independent directors on the board, and DUAL refers to the CEO duality: coded 1 if the CEO is also the chairman of the board, and zero otherwise.

3.2.4 Moderating variables:. Financial constraint (FC): We use the SA_index developed by Hadlock and Pierce (2010) as our proxy for FC. FC is derived using the formula (-0.737*SIZE$+0.043$*SIZE$^2-0.040$*AGE); where SIZE is the natural log of book assets (in millions) and AGE refers to the number of years a firm has been listed.

EPU: To explore the uncertainty related to governmental economic policies, we utilize the time varying EPU index created by Baker *et al.* (2016). Baker *et al.* (2016) develop EPU indices based on newspaper coverage for major economies. The authors construct the EPU index for China based on a scaled count of articles about policy-related economic uncertainty in South China Morning Post, Hong Kong's leading English-language newspaper. The index is at the monthly frequency and, we take the annual average of the monthly EPU index.

Internal control (IC) environment: To examine the moderating effect of IC environment, we follow Alkebsee and Habib (2021) and adopt the DIB Internal Control and Risk Management index, which is constructed by DIB Enterprise Risk Management Technology Co., Ltd. This database is constructed based on five dimensions of IC: financial reporting quality, operational efficiency, asset safety, IC strategies and legal compliance. The index ranges from 1 to 1000, where a low value represents a weak IC environment.

3.3 Empirical model

We employ the unbalanced panel data procedures because the sample contained data across firms and over time. The use of panel data leads to more variability, informative data, more efficiency, more degrees of freedom and less collinearity among variables (Baltagi, 2005). We deploy the fixed-effect (FE) model from within the panel data techniques for its ability to account for the individual effects of each firm. We use the following FE regression to test our main hypothesis:

$$\begin{aligned} COE_{i,t} = {} & \beta_0 + \beta_1 GI_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 DEBT_{i,t} + \beta_4 TOBIN\_Q_{i,t} + \beta_5 ROA_{i,t} + \beta_6 AGE_{i,t} \\ & + \beta_7 FRQ_{i,t} + \beta_8 CSRR_{i,t} + \beta_9 SOE_{i,t} + \beta_{10} TOP10_{i,t} + \beta_{11} IOWN_{i,t} + \beta_{12} BSIZE_{i,t} \\ & + \beta_{13} BIND_{i,t} + \beta_{14} DUAL_{i,t} + Fixed\ Effects + \varepsilon_{i,t}, \end{aligned} \tag{3}$$

Variable definitions are provided in Table 2 as before. In order to test H2 to H4, we use the following regression specification:

$$COE_{i,t} = \beta_0 + \beta_1 GI_{i,t} + \beta_2 MV_{i,t} + \beta_3 GI*MV_{i,t} + \beta_4 SIZE_{i,t} + \beta_5 DEBT_{i,t} + \beta_6 TOBIN\_Q_{i,t} + \beta_7 ROA_{i,t} + \beta_8 AGE_{i,t} + \beta_9 FRQ_{i,t} + \beta_{10} CSRR_{i,t} + \beta_{11} SOE_{i,t} + \beta_{12} TOP10_{i,t} + \beta_{13} IOWN_{i,t} + \beta_{14} BSIZE_{i,t} + \beta_{15} BIND_{i,t} + \beta_{16} DUAL_{i,t} + Fixed\ effects + \varepsilon_{i,t}, \quad (4)$$

MV are the three moderating variables namely, FC for testing H2; EPU for testing H3; and IC for testing H4. We are interested in the sign and significance of the interactive variables GI*MV which test the moderating effects of FC, EPU and IC on the association between green innovation and the cost of equity capital in China. All other variables are as defined in Table 2.

4. Empirical results

4.1 Descriptive statistics

Table 3 shows the summary statistics of the regression variables. The average PEG and MPEG are 0.095 and 0.109 with a median of 0.058 and 0.077, respectively. Fonseka *et al.* (2019) reported an average MPEG of 0.119. The mean GP and GPR is 0.212 and 0.16, respectively. Quan *et al.* (2023), for example, reported an average GP of 0.20. The average firm size is 22.086 with a TOBIN_Q of 2.074 and a debt ratio of 0.427. Average ROA is 4%. The average age of our sample firms is 19.31 year. 21.9% of our sample firms restated their financial reports. The mean discretionary accruals (DAC) is 1.9 % of lagged total assets. The average CSRR is 26.64. Top ten shareholders own, on average, 36% of the shares, whereas 39.1% are SOEs and institutional owners (IOWN) account for 38% of the shares. Around 26.2% of our sample firms have a CEO who is also the chairman of the board. The average board size is 7.86, with 37.3% of the board members being independent directors.

		N	Mean	SD	0.25	Median	0.75
Dependent variables	PEG	10,641	0.095	0.058	0.058	0.085	0.117
	MPEG	10,641	0.109	0.077	0.061	0.091	0.135
Independent variables	GP	10,641	0.212	0.600	0.000	0.000	0.000
	GPR	10,641	0.160	0.502	0.000	0.000	0.000
Control variables	SIZE	10,641	22.086	1.308	21.126	21.894	22.811
Moderating variables	TOBIN_Q	10,641	2.074	1.363	1.278	1.667	2.362
	DEBT	10,641	0.427	0.208	0.261	0.421	0.589
	ROA	10,641	0.04	0.218	0.013	0.036	0.067
	AGE	10,641	19.31	5.79	15.86	20.97	25.73
	REST	10,641	0.219	0.414	0.000	0.000	0.000
	DAC	10,641	0.019	0.178	−0.03	0.019	0.070
	CSRR	10,641	26.643	15.781	17.75	22.78	28.63
	SOE	10,641	0.391	0.488	0.000	0.000	1.00
	TOP10	10,641	0.36	0.15	0.24	0.344	0.463
	IOWN	10,641	0.381	0.243	0.165	0.385	0.573
	BSIZE	10,641	7.86	1.706	7.00	9.00	9.50
	BIND	10,641	0.373	0.053	0.333	0.333	0.429
	DUAL	10,641	0.262	0.440	0.000	0.000	1.000
	FC	10,641	−3.696	0.258	−3.867	−3.709	−3.536
	EPU	10,641	260.482	134.251	134.874	197.767	396.953
	IC	10,641	656.676	135.277	633.28	679.61	712.76

Note(s): This table reports the descriptive statistics of all variables used. All variables are defined in Table 2. This table is prepared by the authors

Table 3. Descriptive statistics

4.2 Correlation analysis

Table 4 presents the Pearson correlation analysis. The correlation coefficient between PEG and GP are negative and significant (correlation −0.025, $p < 0.01$), so is the correlation between PEG and GPR (correlation −0.026, $p < 0.01$). MPEG is also negatively and significantly correlated with the two variants of green innovation proxies (correlation −0.041 and −0.037, $p < 0.01$). The correlations between the cost of equity variables and the control variables are generally consistent with expectations. Multicollinearity is not a concern, as none of the correlation coefficient between independent variables exceeds 0.6. In addition, the variance inflation factor (VIF) test suggests that the highest VIF is 1.42, which is much lower than the commonly-used threshold of 10.00.

4.3 Panel unit root test and Hausman test

To determine the applicability of using panel data analysis we have to check the stationarity of our data. According to Im, Pesaran, and Shin (2003) and Levin, Lin, and Chu (2002), the Fisher-type unit root test facilitates checking our data's stationarity, especially for unbalanced panel data. Panel A of Table 5 reports the results of the Fisher-type Augmented Dickey-Fuller (ADF) units root test. The results reveal that the variables were verified to be stationary at the first difference, implying that the series was integrated at order one. These findings indicate that the data are stationary and could be used for panel data analysis (Mahmood, Ahmad, Rizwan, & Rashid, 2021). Furthermore, one may doubt the suitability of using the FE specification as there is greater within-firm variation in green innovation over time. Thus, we perform the Hausman (1978) test to determine the suitability of using the FE specification. The findings displayed in panel B Table 5 support using the FE model. For example, the χ^2 values are highly significant for PEG and MPEG model when GP is the proxy for green innovation (234.73 and 235.79, both significant at $p < 0.001$). We find qualitatively similar result for GPR.

4.4 Regression results

We report the regression results for H1 in Table 6. Columns (1) and (2) report the result for PEG model for the GP and GPR proxies of green innovations, whereas columns (3) and (4) report the result for MPEG model. The coefficients of GP (coefficient −0.051, $p < 0.01$) is negative and significant for the PEG specifications and GPR (coefficient −0.045, $p < 0.01$) is also negative and significant for the MPEG. The corresponding coefficients are −0.051 ($p < 0.01$), −0.046 ($p < 0.01$) for MPEG specification. We, therefore, find support for H1. Our findings are consistent with the findings of Elmawazini *et al.* (2022) who also document a negative relationship between green technologies and the cost of capital. Our results could be consistent with both the shareholders' risk perspective as well as shareholder base perspective. Although we could not perform any direct test to confirm this proposition, the findings suggest that investors prefer to invest in innovative firms even if the expected returns are low. In addition, such findings enhance the notion that engaging in green innovation projects expands the shareholders' base. In terms of economic significance, the coefficient on GP and GPR indicates that a 10% increase in GP (GPR), for example, decreases PEG by 0.052% (0.041%) [3]. With respect to control variables, the regression results reveal that the cost of equity decreases for larger firms, for firms with good performance, for state-owned firms, for firms with high ratio of institutional shareholders. The cost of equity, however, increases for older firms.

4.5 Endogeneity tests

One may argue that our baseline results suffer from the reverse causality issue. That is, firms with lower cost of equity are better equipped to make optimal investment on green

Table 4.
Correlation matrix

Variables	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
PEG (1)		1.000																	
MPEG (2)		*0.757*	1.000																
GP (3)	1.12	*−0.025*	*−0.041*	1.000															
GPR (4)	1.10	*−0.026*	*−0.037*	*0.924*	1.000														
SIZE (5)	2.13	*0.158*	*0.162*	*0.208*	*0.194*	1.000													
TOBIN_Q (6)	1.50	*−0.200*	*−0.203*	*−0.068*	*−0.070*	*−0.370*	1.000												
DEBT (7)	1.52	*0.242*	*0.187*	*0.080*	*0.082*	*0.544*	*−0.264*	1.000											
ROA (8)	1.27	*−0.100*	*−0.131*	−0.007	−0.007	*−0.087*	*0.145*	*−0.378*	1.000										
AGE (9)	1.31	*0.178*	*0.169*	−0.006	−0.014	*0.434*	*0.045*	*0.431*	*−0.214*	1.000									
REST (10)	1.23	0.051	0.080	−0.003	−0.003	−0.015	*0.029*	0.002	*−0.024*	0.021	1.000								
DAC (11)	1.14	0.070	0.090	−0.020	−0.016	0.019	−0.020	−0.023	*0.146*	−0.013	0.023	1.000							
CSRR (12)	1.18	*−0.031*	*−0.065*	*0.039*	*0.033*	*0.283*	*−0.073*	*0.042*	*0.128*	*0.058*	*−0.075*	*0.047*	1.000						
SOE (13)	1.61	*0.073*	*0.050*	0.011	0.011	*0.350*	*−0.142*	*0.322*	*−0.145*	*0.411*	*−0.069*	−0.020	*0.158*	1.000					
TOP10 (14)	1.37	0.050	−0.011	0.013	0.016	*0.198*	*−0.128*	*0.076*	*0.087*	*−0.077*	*−0.057*	0.001	*0.136*	*0.237*	1.000				
IOWN (15)	1.55	0.010	−0.019	*0.067*	*0.058*	*0.451*	*0.090*	*0.256*	*0.044*	*0.438*	*−0.029*	0.008	*0.215*	*0.346*	*0.261*	1.000			
BSIZE (16)	1.34	*0.037*	*0.029*	*0.041*	*0.031*	*0.237*	*−0.132*	*0.168*	−0.021	*0.129*	*−0.031*	−0.011	*0.130*	*0.269*	0.008	*0.163*	1.000		
BIND (17)	1.21	0.008	0.010	0.011	0.012	*0.043*	*0.041*	−0.004	−0.013	*−0.028*	0.013	0.013	0.005	*−0.048*	*0.061*	−0.016	*−0.496*	1.000	
DUAL (28)	1.14	*−0.053*	*−0.041*	0.006	0.012	*−0.175*	*0.053*	*−0.175*	0.074	*−0.244*	*0.031*	0.013	*−0.076*	*−0.300*	*−0.041*	*−0.178*	*−0.178*	*0.101*	1.000

Note(s): Italic faced correlations are significant at $p < 0.01$. All variables are defined in Table 2. This table is prepared by the authors

Panel A: The results of the Fisher-type Augmented-Dickey Fuller (ADF) units root test			
Variables	(1) Statistics	(2) P-V	(3) Process
MPEG	135.2515	0.0006	ST
PEG	141.6551	0.0003	ST
GP	90.3856	0.0103	ST
GPR	143.4061	0.0000	ST
SIZE	99.9471	0.0027	ST
TOBIN_Q	92.5882	0.0005	ST
DEBT	135.2328	0.0000	ST
ROA	1.02e+04	0.0000	ST
AGE	132.2128	0.0000	ST
REST	142.5685	0.0000	ST
DAC	111.9871	0.0000	ST
CSRR	141.2037	0.0000	ST
SOE	110.0787	0.0003	ST
TOP10	111.9302	0.0002	ST
IOWN	125.9600	0.0000	ST
BSIZE	135.4062	0.0000	ST
BIND	162.2240	0.0000	ST
DUAL	65.6195	0.0320	ST

Panel B: Hausman (1978) test								
	PEG				MPEG			
Variables	(1) Fe	(2) Re	(3) Diff	(4) S.E.	(5) Fe	(6) Re	(7) Diff	(8) S.E.
GP*	−0.0049	−0.0010	−0.0039	0.0012	−0.0054	−0.0011	−0.0043	0.0012
SIZE	−0.0145	−0.0005	−0.0140	0.0014	−0.0147	−0.0006	−0.0140	0.0014
TOBIN_Q	−0.0043	−0.0032	−0.0011	0.0004	−0.0044	−0.0029	−0.0015	0.0004
DEBT	0.0512	0.0435	0.0077	0.0049	0.0519	0.0429	0.0090	0.0049
ROA	−0.1010	−0.0928	−0.0081	0.0075	−0.1033	−0.0979	−0.0054	0.0075
AGE	0.0153	0.0089	0.0064	0.0027	0.0153	0.0091	0.0062	0.0027
REST	−0.0009	0.0002	−0.0011	0.0007	−0.0009	0.0001	−0.0010	0.0007
DAC	0.0019	0.0016	0.0003	0.0015	0.0018	0.0017	0.0001	0.0015
CSRR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SOE	−0.0137	−0.0060	−0.0076	0.0042	−0.0127	−0.0057	−0.0071	0.0043
TOP10	−0.0158	0.0081	−0.0240	0.0081	−0.0150	0.0086	−0.0236	0.0082
IOWN	−0.0184	−0.0154	−0.0030	0.0027	−0.0184	−0.0156	−0.0028	0.0027
BSIZE	−0.0042	0.0011	−0.0053	0.0050	−0.0036	0.0015	−0.0051	0.0050
BIND	0.0260	0.0174	0.0085	0.0134	0.0235	0.0171	0.0064	0.0135
DUAL	−0.0006	−0.0007	0.0001	0.0016	−0.0003	−0.0006	0.0003	0.0016
$\chi^2(15) = 234.729$ ($p < 0.001$)					$\chi^2(15) = 235.786$ ($p < 0.001$)			

Note(s): *The corresponding χ^2 values are 232.401 ($p < 0.001$) for PEG model and 233.071 ($p < 0.001$) for MPEG model when GPR variant is considered as the proxy for green innovation (result untabulated)
This table presents the stationarity test (Panel A) and Hausman (1978) test (Panel B). All variables are defined in Table 2. This table is prepared by the authors

Table 5. Results of Fisher-type ADF and the Hausman tests

innovation: a proposition that may cause reverse causation concern. Furthermore, omitted variables affecting both the dependent and the independent variable may also give rise to endogeneity concerns. To address such endogeneity concerns, we perform a two-stage least square (2SLS) regression within fixed-effect specification. We use the industry average green innovation as our instruments (INAVGP and INAVGPR). This is consistent with Zhang *et al.* (2020), who use the industry average green innovation as the instrumental variable arguing

Variables	(1) PEG	(2) PEG	(3) MPEG	(4) MPEG
GP	−0.051***	–	−0.051***	–
	[−3.11]		[−3.43]	
GPR	–	−0.045***	–	−0.046***
		[−2.68]		[−2.98]
SIZE	−0.014***	−0.014***	−0.015***	−0.015***
	[−9.18]	[−6.41]	[−9.25]	[−6.43]
TOBIN_Q	−0.004***	−0.004***	−0.004***	−0.004***
	[−6.50]	[−6.80]	[−6.32]	[−6.57]
DEBT	0.051***	0.051***	0.052***	0.052***
	[8.23]	[6.49]	[8.30]	[6.52]
ROA	−0.101***	−0.101***	−0.103***	−0.103***
	[−7.53]	[−3.84]	[−7.69]	[−3.86]
AGE	0.015***	0.015***	0.015***	0.015***
	[5.40]	[5.08]	[5.36]	[5.05]
REST	−0.001	−0.001	−0.001	−0.001
	[−0.62]	[−0.60]	[−0.61]	[−0.59]
DAC	0.002	0.002	0.002	0.002
	[0.58]	[0.64]	[0.56]	[0.62]
CSRR	0.000	0.000	−0.000	−0.000
	[0.03]	[0.07]	[−0.13]	[−0.07]
SOE	−0.014***	−0.014**	−0.013***	−0.013*
	[−3.00]	[−2.02]	[−2.77]	[−1.85]
TOP10	−0.016*	−0.016	−0.015	−0.015
	[−1.69]	[−1.29]	[−1.59]	[−1.21]
IOWN	−0.018***	−0.018***	−0.018***	−0.018***
	[−4.56]	[−4.30]	[−4.54]	[−4.26]
BSIZE	−0.004	−0.004	−0.004	−0.004
	[−0.66]	[−0.55]	[−0.56]	[−0.48]
BIND	0.026	0.026	0.023	0.023
	[1.39]	[1.21]	[1.25]	[1.08]
DUAL	−0.001	−0.001	−0.000	−0.000
	[−0.27]	[−0.24]	[−0.12]	[−0.10]
Constant	0.416***	0.417***	0.390***	0.391***
	[11.59]	[8.35]	[10.80]	[7.75]
Industry	No	No	No	No
Year	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Observations	10,641	10,641	10,641	10,641
Adjusted R^2	0.13	0.13	0.13	0.13

Note(s): This table reports the results of the relationship between green innovation and the cost of equity. Robust *t*-statistics (clustered at the firm level) are reported in brackets. *, **, *** denote a two-tailed *p* value of less than 0.10, 0.05, and 0.01, respectively. All variables are defined in Table 2. This table is prepared by the authors

Table 6. Green innovation and the cost of equity: Baseline regression

that this variable affects firm-level green innovation but does not affect firm-level cost of equity. Fonseka *et al.* (2019), too, utilize the average value of environment information disclosure for the energy product-year as instrumental variable (also see Xu *et al.*, 2015).

Panel A of Table 7 reports the results of the 2SLS approach. In the first stage model we regress GP and GPR on INAVGP and INAVGPR and find the coefficients positive and highly significant (coefficients 0.039 ($p < 0.01$) and 0.085 ($p < 0.01$) for INAVGP and INAVGPR, respectively), suggesting that our instrument is significantly related to our independent variable; thereby, it is a valid instrument. Moreover, we perform the Sargan (1958) test to

Panel A: 2SLS results

Variables	(1) 1st stage GP	(2) 2nd stage PEG	(3) 2nd stage PEG	(4) 1st stage GPR	(5) 2nd stage MPEG	(6) 2nd stage MPEG
INAVGP	0.039***	–	–	–	–	–
	[9.34]					
GP	–	0.054*	–	–	0.057*	–
		[1.81]			[1.93]	
INAVGPR	–	–	–	0.085***	–	–
				[16.84]		
GPR	–	–	0.034*	–	–	0.038*
			[1.80]			[1.88]
SIZE	0.088***	−0.016***	−0.015***	0.067***	−0.016***	−0.015***
	[14.41]	[−6.29]	[−6.49]	[13.30]	[−6.29]	[−6.50]
TOBIN_Q	0.012***	−0.004***	−0.004***	0.008**	−0.004***	−0.004***
	[2.84]	[−6.30]	[−6.74]	[2.43]	[−6.02]	[−6.48]
DEBT	0.066**	0.049***	0.050***	0.071***	0.049***	0.051***
	[2.29]	[5.70]	[6.16]	[2.96]	[5.65]	[6.13]
ROA	−0.098	−0.100***	−0.102***	−0.053	−0.102***	−0.104***
	[−1.32]	[−3.66]	[−3.82]	[−0.87]	[−3.68]	[−3.83]
AGE	−0.153***	0.012***	0.014***	−0.106***	0.012***	0.014***
	[−13.47]	[3.30]	[4.36]	[−11.21]	[3.10]	[4.19]
REST	−0.001	−0.001	−0.001	−0.006	−0.001	−0.001
	[−0.09]	[−0.61]	[−0.60]	[−0.58]	[−0.59]	[−0.58]
DAC	−0.040	0.003	0.003	−0.019	0.003	0.003
	[−1.50]	[0.97]	[0.85]	[−0.83]	[0.98]	[0.85]
CSRR	0.000	0.000	0.000	0.000	0.000	0.000
	[0.50]	[1.36]	[0.87]	[1.05]	[1.36]	[0.85]
SOE	0.019	−0.011	−0.013*	0.007	−0.010	−0.012*
	[1.64]	[−1.52]	[−1.86]	[0.75]	[−1.30]	[−1.66]
TOP10	−0.124***	−0.008	−0.011	−0.071**	−0.007	−0.010
	[−3.33]	[−0.60]	[−0.85]	[−2.28]	[−0.47]	[−0.74]
IOWN	0.005	−0.013**	−0.016***	0.009	−0.013**	−0.016***
	[0.19]	[−2.47]	[−3.40]	[0.39]	[−2.43]	[−3.33]
BSIZE	0.096***	−0.006	−0.005	0.076***	−0.006	−0.005
	[3.34]	[−0.65]	[−0.69]	[3.18]	[−0.67]	[−0.66]
BIND	0.215**	0.019	0.023	0.207**	0.016	0.021
	[2.08]	[0.82]	[1.07]	[2.40]	[0.66]	[0.93]
DUAL	−0.013	0.001	−0.000	−0.012	0.001	0.000
	[−1.04]	[0.29]	[−0.03]	[−1.13]	[0.37]	[0.10]
Constant	−1.851***	0.443***	0.431***	−1.486***	0.419***	0.406***
	[−12.62]	[8.07]	[8.41]	[−12.17]	[7.50]	[7.81]
Industry	No	No	No	No	No	No
Year	Yes	Yes	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,641	10,641	10,641	10,641	10,641	10,641
Adjusted R^2	0.14	0.12	0.11	0.14	0.13	0.12

Note(s): This table reports the results of the 2SLS model, the variables INAVGP and INAVGPR use as instruments. Robust *t*-statistics (clustered at the firm level) are reported in brackets. *, **, *** denote a two-tailed *p* value of less than 0.10, 0.05, and 0.01, respectively. All variables are defined in Table 2. This table is prepared by the authors

(*continued*)

Table 7.
Endogeneity tests

Panel B: Results of the PSM analysis: Entropy balanced method
Covariate matching table

	Treatment variable: TREATGP								
	Treat			Control (before matching)			Control (after matching)		
Variables	Mean	Variance	Skewness	Mean	Variance	Skewness	Mean	Variance	Skewness
SIZE	22.650	2.031	0.557	22.130	1.593	0.734	22.640	2.208	0.610
TOBIN_Q	1.940	1.426	4.493	2.141	2.107	3.643	1.940	1.646	3.774
DEBT	0.469	0.035	−0.146	0.443	0.043	0.090	0.469	0.046	0.023
ROA	0.048	0.003	0.411	0.048	0.003	1.877	0.048	0.003	4.630
AGE	20.51	0.576	−0.618	21.65	0.598	−0.786	20.51	0.700	−0.603
REST	0.221	0.172	1.345	0.219	0.171	1.358	0.221	0.172	1.346
DAC	0.010	0.018	−6.893	0.020	0.034	0.886	0.010	0.043	−5.938
CSRR	27.690	309.100	1.484	26.990	260.300	1.482	27.690	264.400	1.496
SOE	0.402	0.241	0.399	0.432	0.245	0.275	0.402	0.240	0.399
TOP10	0.357	0.024	0.451	0.356	0.022	0.441	0.357	0.023	0.448
IOWN	0.429	0.057	−0.079	0.407	0.055	0.036	0.429	0.058	−0.020
BSIZE	2.158	0.043	−0.126	2.153	0.038	−0.274	2.158	0.040	−0.158
BIND	0.374	0.003	1.510	0.372	0.003	1.492	0.374	0.003	1.495
DUAL	0.246	0.186	1.179	0.239	0.182	1.222	0.246	0.186	1.180

PSM regression results

Variables	(1) PEG	(2) MPEG
TREATGP	−0.023*	−0.022**
	[−1.90]	[−2.05]
SIZE	0.003***	0.003***
	[3.22]	[3.30]
TOBIN_Q	−0.005***	−0.004***
	[−6.74]	[−5.93]
DEBT	0.037***	0.036***
	[6.86]	[6.73]
ROA	−0.085***	−0.089***
	[−4.13]	[−4.27]
AGE	0.008***	0.008***
	[6.77]	[6.74]
REST	0.001	0.001
	[0.66]	[0.69]
DAC	0.005*	0.005*
	[1.80]	[1.71]
CSRR	−0.000*	−0.000**
	[−1.79]	[−1.97]
SOE	−0.003*	−0.003*
	[−1.75]	[−1.66]
TOP10	0.015***	0.016***
	[2.74]	[2.88]
IOWN	−0.012***	−0.013***
	[−3.37]	[−3.50]
BSIZE	−0.002	−0.001
	[−0.38]	[−0.22]
BIND	−0.012	−0.011
	[−0.68]	[−0.65]
DUAL	0.002	0.001
	[0.96]	[0.87]
Constant	0.043*	0.009

Table 7. (*continued*)

PSM regression results

Variables	(1) PEG	(2) MPEG
	[1.89]	[0.41]
Industry	Yes	Yes
Year	Yes	Yes
Observations	10,641	10,641
Adjusted R^2	0.16	0.16

Note(s): This table reports the results of the Entropy balanced model. Robust t-statistics (clustered at the firm level) are reported in brackets. *, **, *** denote a two-tailed p value of less than 0.10, 0.05, and 0.01, respectively. All variables are defined in Table 2. This table is prepared by the authors

Panel C: ITCV analysis

Variables	PEG (GP) Impact	Variables	PEG (GPR) Impact	Variables	MPEG (GP) Impact	Variables	MPEG (GPR) Impact
ROA	0.001	ROA	0.000	ROA	0.001	ROA	0.001
CSRR	0.000	CSRR	0.000	CSRR	0.000	CSRR	0.000
SOE	0.000	REST	0.000	SOE	0.000	SOE	0.000
REST	0.000	SOE	0.000	REST	0.000	REST	0.000
BSIZE	0.000	DUAL	0.000	BSIZE	0.000	DACC	−0.000
DUAL	0.000	DACC	−0.000	DUAL	0.000	BSIZE	−0.000
DACC	−0.000	BSIZE	−0.000	DACC	−0.000	BIND	−0.000
BIND	−0.000	BIND	−0.000	BIND	−0.000	DUAL	−0.000
INST	−0.000	INST	−0.000	INST	−0.000	INST	−0.000
TOP10	−0.001	TOP10	−0.001	TOP10	−0.001	TOP10	−0.001
SIZE	−0.002	DEBT	−0.001	DEBT	−0.003	DEBT	−0.001
DEBT	−0.003	SIZE	−0.002	SIZE	−0.003	SIZE	−0.003
TOBIN_Q	−0.005	TOBIN_Q	−0.004	TOBIN_Q	−0.004	TOBIN_Q	−0.004
AGE	−0.009	AGE	−0.009	AGE	−0.010	AGE	−0.010
ITCV	−0.017	ITCV	−0.012	ITCV	−0.022	ITCV	−0.017

Panel D: The GMM test

Variables	(1) PEG	(2) MPEG	(3) PEG	(4) MPEG
L.PEG	0.335***	–	0.335***	–
	[22.16]		[22.15]	
GP	−0.030**	−0.030***	–	–
	[−2.51]	[−2.71]		
L.MPEG	–	0.329***	–	0.328***
		[21.66]		[21.43]
GPR	–	–	−0.020**	−0.030**
			[−2.12]	[−2.26]
Control variables	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Constant	0.000	−0.022	−0.001	−0.022
	[0.03]	[−1.58]	[−0.05]	[−1.60]
Observations	5,916	5,818	5,916	5,818
AR(1)	$z = -7.04, p \geq 0.00$	$z = -6.91, p \geq 0.00$	$z = -9.07, p \geq 0.000$	$z = -6.93, p \geq 0.00$
AR(2)	$z = 1.06, p \geq 0.289$	$z = 1.13, p \geq 0.259$	$z = 1.06, p \geq 0.299$	$z = 1.12, p \geq 0.263$
Sargan test	$\chi^2 = 6{,}714.8, p \geq 0.00$	$\chi^2 = 6{,}634.9, p \geq 0.00$	$\chi^2 = 6{,}714.5, p \geq 0.00$	$\chi^2 = 6{,}634.4, p \geq 0.00$
Hansen test	$\chi^2 = 815.9, p \geq 0.132$	$\chi^2 = 794.7, p \geq 0.150$	$\chi^2 = 825.7, p \geq 0.164$	$\chi^2 = 805.5, p \geq 0.172$

Note(s): This table reports the results of the GMM test. Robust t-statistics (clustered at the firm level) are reported in brackets. *, **, *** denote a two-tailed p value of less than 0.10, 0.05, and 0.01, respectively. All variables are defined in Table 2. This table is prepared by the authors

Table 7.

check the null hypothesis of whether our instrumental variables are exogenous. The results of the Sargan and Basmann test do not reject the null hypothesis (*Sargan* $\chi^2 = 4.26$, $p = 0.031$, *Basmann* $\chi^2 = 3.86$, $p = 0.038$), thereby further confirming the validity of the chosen instruments. The coefficients on GP and GPR remain negative and significant in the second stage regression specification, thereby suggesting that our results are not biased by endogeneity concerns.

4.5.1 The propensity score matching (PSM) approach. To control for endogeneity caused by observable rather than unobservable variables, we use the propensity score matching (PSM) approach (Rosenbaum & Rubin, 1985). We use the entropy balancing method to reduce discrepancies in observable variables between treatment and control samples. This approach, however, varies in how it maintains covariate balance. Entropy balancing is used by specifying a set of covariates (the determinants of cost of equity) to be matched, balance conditions, and a tolerance threshold. The balance conditions are the mean, variance and skewness of covariate distributions that should be distributed evenly across treatment and control samples. According to McMullin and Schonberger (2020), the tolerance level sets the minimal degree of covariate balance required before the entropy balancing system stops altering control sample weights, similar to a caliper width for propensity-score matching. A tolerance threshold of 0, on the other hand, will result in equal distribution of moments.

Panel B of Table 7 shows the distributions of the covariates. The statistics for all variables in the GP treatment and control samples are insignificant, demonstrating that the covariates are evenly distributed across the treatment and control samples. Regression results show that the coefficients of TREATGP, in all columns, are negative and significant (PEG = -0.022, $p < 0.10$, and MPEG = -0.023, $p < 0.05$, respectively). These findings, therefore, suggest that our main results are robust to potential endogeneity concerns arising from observable, rather than unobservable, factors.

4.5.2 Impact threshold of a confounding variable (ITCV) test. Following the suggestion of Frank (2000) and Larcker and Rusticus (2010), we perform a ITCV test to address the omitted variable concern and report the results in Panel C. ITCV measures how correlated an omitted variable must be with the green innovation (GP and GPR) and the cost of equity (PEG and MPEG) to reverse the significant results reported in Table 6. According to Frank (2000), we find the impact of an omitted variable must be -0.017 for GP and -0.012 for GPR which is much higher than the most impactful control variable AGE with an impact value of -0.009 for both GP and GPR. Therefore, an omitted variable would need to be at least 1.9 (-0.017/-0.009) and 1.33 (-0.012/-0.009) times larger than the most impactful control variable included in the regression model, to reverse the main results reported in Table 6 for the PEG model. The corresponding numbers are 2.2 and 1.7 times for the MPEG model. This test shows that an omitted variable would need to be rather large in magnitude to overturn the baseline results.

4.5.3 The generalized method of moments (GMM) test. The GMM approach (Arellano & Bond, 1991; Arellano & Bover, 1995) addresses endogeneity problems stemming from reverse causation concern, i.e. instead of green innovation affecting cost of equity it could be that firms with a lower cost of equity may cause firms to engage more in green innovation activities. GMM is also applicable when the dependent variable is dynamic, and the independent variable is not exogenous (Roodman, 2009). The cost of equity is not exogenous, so the causality may have run in the opposite direction. To detect the dynamic specifications of GP and GPR and PEG and MPEG, the GMM contains Arellano and Bond's (1991) autocorrelation tests: AR1 and AR2. GMM provides two standard tests: the Sargan test, which is used for over-identification, and the Hansen test, which is used for the homogeneity of instruments.

Panel D of Table 7 shows the regression results of the GMM test. In columns 1 and 2, the coefficients on GP and GPR are negative and significant (coefficients -0.030, significant at

$p < 0.05$ and $p < 0.01$, respectively), which confirms our baseline results. In addition, the coefficients on AR1 are significant (−7.04 and −6.91, $p < 0.01$), which suggests that the null hypothesis of no autocorrelation in the first difference can be rejected, while the coefficients on AR2 are insignificant (1.06 and 1.12), indicating that the error terms in the level regressions are not correlated. In columns 3 and 4 the coefficients on GPR are negative and significant (coefficient = −0.020 and −0.030, both significant at $p < 0.05$), which again confirms our baseline results. In addition, the coefficients on AR1 are significant (−9.07 and −6.93, $p < 0.01$), while those on AR2 are insignificant (1.06 and 1.13). Furthermore, the p values of the Sargan tests are all statistically significant, whereas the Hansen test values are insignificant in all columns. Overall, our baseline findings are robust to reverse causality concerns.

4.6 Cross sectional tests

4.6.1 The moderating effect of financial constraint (FC). To investigate the moderating effect of financial constraint (test of H2) we divide our sample firms into high vs low FC firms using the median values of FC. Firm-year observations with FC greater than median are considered financially constrained (FC_D = 1) while those with FC values below median are coded financially unconstrained firms (FC_D = 0). Panel A of Table 8 reports the results. The coefficients on the interactive variable GP*FC are positive and significant for both PEG and MPEG models (coefficients = 0.030, both significant at $p < 0.05$) (columns 1 and 2). We find similar evidence for GPR*FC variable. These findings suggest that financially constrained firms lack resources to invest in green innovation, which increases risk and consequently, the cost of equity capital. In other words, unconstrained firms are better able to invest more in green innovation, which improves firm image, reduces risk and thereby, reduces the cost of equity (Gorodnichenko & Schnitzer, 2013; Howell, 2016; Mohnen, Palm, Van Der Loeff, & Tiwari, 2008; Zhang *et al.*, 2020).

4.6.2 The moderating effect of EPU. We also investigate whether EPU moderates the relationship between green innovation and the cost of equity (test of H3). We split our sample firms into two sub-samples using the median of EPU measure, with high EPU firm-year observations being coded 1 (EPU_D = 1) when the observation has EPU value above the median EPU, and zero otherwise (EPU_D = 0). Panel B of Table 8 reports the results. The coefficients on the interactive variable GP*EPU are negative and significant for both PEG (coefficient −0.022, $p < 0.10$) (column 1) and MPEG (coefficient −0.020, $p < 0.10$) (column 2) models. We find similar evidence for GPR*EPU variable in columns 3 and 4. Our finding is in line with the notion that firms may decide to invest in green innovation activities under uncertainty to gain future benefits that may accrue from earlier investments. This suggests that although cost of equity increases during periods of high EPU (Liu & Wang, 2022; Pástor & Veronesi, 2013; Pham, 2019), increased investments in green innovation may attenuate this effect.

4.6.3 The moderating effect of IC environment. To investigate the moderating effect of IC environment on the association between green innovation and cost of equity (test of H4), we group our sample firms into firms with strong IC environment (IC_D = 1) when the firm-level IC score is above the median score, and zero otherwise (IC_D = 0). Panel C of Table 8 reports the results. The coefficients on the interactive variable GP*IC are negative and significant for both PEG (coefficient −0.021, $p < 0.10$) (column 1) and MPEG (coefficient −0.020, $p < 0.10$) (column 2) models. We find similar evidence for GPR*IC variable in columns 3 and 4. These findings imply that firms with a strong internal control environment are likely to invest more in green innovation courtesy of reduced information asymmetry which helps reduces the cost of equity for green firms.

4.7 The effect of 2012 regulation on the cost of equity capital

As mentioned before the Chinese government adopted the CEC in 2012 to encourage more investments in green innovation by firms. This passage of the regulation allows to examine

Variables	(1) PEG	(2) MPEG	(3) PEG	(4) MPEG
Panel A: Green innovation and the cost of equity: Moderating effect of financial constraints				
GP	−0.022*	−0.024*	–	–
	[−1.73]	[−1.75]		
FC	0.012***	0.012***	0.012***	0.012***
	[4.14]	[4.30]	[4.10]	[4.26]
GP*FC	0.030**	0.030**	–	–
	[2.04]	[2.03]		
GPR	–	–	−0.014**	−0.015**
			[−2.02]	[−2.05]
GPR*FC	–	–	0.041***	0.051***
			[2.60]	[2.61]
Other control variables	Yes	Yes	Yes	Yes
Constant	0.106***	0.076***	0.106***	0.076***
	[6.76]	[4.85]	[6.76]	[4.84]
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	10,641	10,526	10,641	10,526
Adjusted R^2	0.15	0.14	0.15	0.14
Panel B: Green innovation and the cost of equity: Moderating effects of EPU				
GP	−0.030*	−0.040**	–	–
	[−1.68]	[−2.07]		
EPU	0.005	0.004	0.006	0.007
	[0.87]	[0.85]	[0.23]	[0.91]
GP*EPU	−0.022*	−0.020*	–	–
	[−1.76]	[−1.73]		
GPR	–	–	−0.012*	−0.013*
			[−1.85]	[−1.87]
GPR*EPU	–	–	−0.040*	−0.041*
			[−1.76]	[−1.71]
Other control variables	Yes	Yes	Yes	Yes
Constant	0.417***	0.376***	0.417***	0.377***
	[11.61]	[9.33]	[11.62]	[9.35]
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	10,641	10,641	10,641	10,641
Adjusted R^2	0.13	0.13	0.13	0.13
Panel C: Green innovation and the cost of equity: Moderating effect of IC				
GP	−0.040*	−0.040**	–	–
	[−1.96]	[−2.28]		
IC	−0.003**	−0.003**	−0.003**	−0.003**
	[−2.03]	[−204]	[−2.29]	[−2.24]
GP*IC	−0.021*	−0.020*	–	–
	[−1.79]	[−1.78]		
GPR	–	–	−0.038*	−0.034**
			[−1.79]	[−2.07]
GPR*IC	–	–	−0.012*	−0.012*
			[−1.84]	[−1.72]
Other control variables	Yes	Yes	Yes	Yes
Constant	0.405***	0.375***	0.406***	0.376***
	[10.09]	[9.30]	[10.11]	[9.32]
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	10,641	10,641	10,641	10,641
Adjusted R^2	0.13	0.13	0.13	0.13

Note(s): This table reports the results of the moderating effect of financial constraint (Panel A), EPU (Panel B), and internal control environment (Panel C) on the relationship between green innovation and the cost of equity. Robust *t*-statistics (clustered at the firm level) are reported in brackets. *, **, *** denote a two-tailed *p* value of less than 0.10, 0.05, and 0.01, respectively. All variables are defined in Table 2. This table is prepared by the authors

Table 8.
Moderation tests

the effects of the regulation on the cost of equity capital. We compare the coefficients on the green innovation variables between the pre and-post regulation periods using the Chow test and report the results in Table 9. As is evident from the table, the coefficients on GP and GPR are negative and significant in the *post*-regulation period but insignificant in the *pre*-regulation period. For example, the coefficient on GP is −0.007 ($p < 0.10$) and −0.01 ($p < 0.01$) for PEG and MPEG measures of COE for post-regulation period, respectively. The corresponding coefficients for the pre-regulation period are insignificant. The Chow test at the bottom of the table shows the difference in coefficients between the pre- and post-regulation period is significant at $p < 0.10$. We find similar results for GPR. The findings, therefore, suggest that the regulation was successful in promoting firm's investment in green innovation which further lowered the cost of equity capital for such firms.

Variables	(1) PEG POST = 1	(2) PEG POST = 0	(3) PEG POST = 1	(4) PEG POST = 0	(5) MPEG POST = 1	(6) MPEG POST = 0	(7) MPEG POST = 1	(8) MPEG POST = 0
GP	−0.007*	0.001	–	–	−0.010***	0.011	–	–
	[−1.75]	[0.57]			[−2.64]	[0.20]		
GPR	–	–	−0.005*	0.003	–	–	−0.011**	0.001
			[−1.98]	[1.25]			[−2.56]	[0.64]
SIZE	0.002**	−0.003***	0.002**	−0.003***	0.002***	−0.001	0.002***	−0.001
	[2.16]	[−2.69]	[2.19]	[−2.80]	[6.20]	[−1.07]	[6.17]	[−1.14]
TOBIN_Q	−0.006***	−0.007***	−0.006***	−0.007***	0.001***	0.001	0.001***	0.001
	[−11.64]	[−6.47]	[−11.64]	[−6.49]	[4.34]	[1.52]	[4.33]	[1.51]
DEBT	0.041***	0.037***	0.041***	0.037***	0.009***	0.012***	0.009***	0.012***
	[9.85]	[5.92]	[9.86]	[5.94]	[5.20]	[4.97]	[5.21]	[4.98]
ROA	−0.024*	−0.093***	−0.024*	−0.092***	0.073***	0.032***	0.073***	0.032***
	[−1.82]	[−4.46]	[−1.82]	[−4.45]	[13.55]	[3.67]	[13.55]	[3.69]
AGE	0.007***	0.011***	0.007***	0.011***	0.001*	−0.000	0.001*	−0.000
	[6.76]	[7.02]	[6.73]	[7.08]	[1.79]	[−0.48]	[1.80]	[−0.44]
REST	−0.000	−0.005*	−0.000	−0.005*	−0.001	−0.000	−0.001	−0.000
	[−0.17]	[−1.72]	[−0.18]	[−1.73]	[−1.23]	[−0.07]	[−1.22]	[−0.08]
DAC	0.001	0.002	0.001	0.002	0.000	0.007***	0.000	0.007***
	[0.31]	[0.36]	[0.31]	[0.38]	[0.07]	[2.87]	[0.09]	[2.88]
CSRR	−0.000***	0.000**	−0.000***	0.000**	−0.000	0.000	−0.000	0.000
	[−3.86]	[2.14]	[−3.86]	[2.14]	[−1.58]	[0.02]	[−1.58]	[0.02]
SOE	−0.007***	−0.005**	−0.007***	−0.005**	−0.000	0.002**	−0.000	0.002*
	[−4.32]	[−2.46]	[−4.32]	[−2.47]	[−0.02]	[1.97]	[−0.01]	[1.96]
TOP10	0.011**	0.003	0.011**	0.004	−0.003	0.002	−0.003	0.002
	[2.22]	[0.53]	[2.22]	[0.56]	[−1.30]	[0.82]	[−1.26]	[0.84]
IOWN	−0.011***	−0.027***	−0.011***	−0.027***	0.002	0.004**	0.002	0.004**
	[−2.98]	[−5.77]	[−2.98]	[−5.79]	[1.52]	[2.41]	[1.51]	[2.40]
BSIZE	−0.000	0.005	−0.000	0.005	−0.005***	−0.001	−0.005***	−0.001
	[−0.08]	[0.84]	[−0.09]	[0.87]	[−3.04]	[−0.55]	[−3.07]	[−0.53]
BIND	0.002	0.026	0.002	0.026	−0.011*	−0.004	−0.011*	−0.004
	[0.14]	[1.33]	[0.13]	[1.35]	[−1.75]	[−0.48]	[−1.78]	[−0.46]
DUAL	0.002	−0.005*	0.002	−0.005*	0.001	−0.001	0.001	−0.001
	[1.01]	[−1.81]	[1.02]	[−1.82]	[0.91]	[−1.20]	[0.93]	[−1.21]
Constant	0.044**	0.138***	0.044**	0.140***	−0.041***	0.007	−0.040***	0.007
	[2.29]	[5.44]	[2.28]	[5.52]	[−5.11]	[0.65]	[−5.07]	[0.70]
Year & Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,024	3,617	7,024	3,617	7,024	3,617	7,024	3,617
Adj. R^2	0.09	0.10	0.09	0.10	0.05	0.02	0.05	0.02
The Chow test	$\chi^2 = 2.66, p > 0.073$		$\chi^2 = 2.21.80, p > 0.090$		$\chi^2 = 3.29, p > 0.069$		$\chi^2 = 2.45, p > 0.082$	

Note(s): This table reports the results of the passage of the 2012 environmental regulation on the cost of equity capital. Robust *t*-statistics (clustered at the firm level) are reported in brackets. *, **, *** denote a two-tailed *p* value of less than 0.10, 0.05, and 0.01, respectively. All variables are defined in Table 2. This table is prepared by the authors

Table 9. Green innovation and the cost of equity capital: The effect of 2012 regulation

5. Conclusion

This study examines the relationship between green innovation and the cost of equity. Based on a sample of Chinese public firms spanning the period from 2008–2018, we document a significant and negative relationship between green innovation (green patents and processes) and the cost of equity capital. We further explore the moderating effects of financial constraints, economic policy uncertainty, and the internal control environment on the association between green innovation and the cost of equity. The results document that financial constraint impedes green innovation and thus, increases the cost of equity. Our findings further reveal that economic policy uncertainty, and a strong internal control environment moderates the negative association between green innovation and the cost of equity capital. Our results remain robust to controlling for endogeneity concerns using the 2SLS, entropy balancing method, and the GMM approach.

Our study has important policy implications. As the Chinese government is becoming increasingly conscious about sustainable development, our evidence provides important insights that listed firms can benefit from green innovation and, thereby, help government achieve its objectives of "green development". This implication is particularly important because many firms are reluctant to invest in eco-friendly environmental projects due to the high cost and risks associated with such projects. Our study also contributes to the voluminous literature on the determinants of cost of equity by documenting that green innovation has additional predictive ability, even after controlling for firms' environmental disclosures.

Notes

1. For more details, please visit https://worldpopulationreview.com/country-rankings/carbon-footprint-by-country
2. The CEC consists of a collection of principles and development concepts based on natural respect and conservation, with the goal of benefiting human society. In the 1970s, the notion of ecological civilization, anchored in environmental campaigns, permeated across Western culture (Xiang-chao, 2018).
3. As our independent variable is measured in log, we proceed as follows in calculating the economic significance. The coefficient on GP is -0.051. The economic significance for a 10% increase in GP, therefore, is 0.051*log(1.10) or 0.005%. The corresponding value for GPR is 0.045*log(1.10) or 0.004%.

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