

## RESEARCH ARTICLE

# Partial privatisation and green innovation in China: The role of industrial context and regional development

Muhammad Usman<sup>1</sup> | Maria Ishaque<sup>2</sup>  | Ammar Ali Gull<sup>3,4</sup>  | Vincent Tawiah<sup>5</sup> 

<sup>1</sup>School of Accounting, Xijing University, Xian, China

<sup>2</sup>Department of Accounting, Essex Business School, University of Essex, Essex, UK

<sup>3</sup>Léonard de Vinci Pôle Universitaire, Research Center, Paris La Défense, France

<sup>4</sup>International School, Vietnam National University, Hanoi, Vietnam

<sup>5</sup>DCU Business School, Dublin City University, Dublin, Ireland

## Correspondence

Maria Ishaque, Department of Accounting, Essex Business School, University of Essex, Essex, UK.

Email: [maria.ishaque@essex.ac.uk](mailto:maria.ishaque@essex.ac.uk)

## Abstract

This study examines the relationship between partial privatisation (i.e., state ownership reduction) and green innovation in China. Employing a large dataset of 36,072 firm-year observations between 2005 and 2022, we document a positively significant association between partial privatisation and green innovation, suggesting that privatisation promotes green innovation in Chinese firms. Further analyses shows that the relationship is stronger for firms in environmentally sensitive industries and those located in more developed regions. Our main finding is robust to the alternative measurement of variables and endogeneity concerns using the propensity score matching (PSM), firm-fixed effects and the system generalised method of moments (GMM) approach. Finally, we document that green innovation in privatised firms yields superior performance. Our findings highlight the significant contribution of privatisation in the quest for low-carbon emissions in China by promoting green innovation.

## KEYWORDS

China, climate change, firm performance, green innovation, partial privatisation

## 1 | INTRODUCTION

From the Rio Declaration to the Paris Agreement and sustainable development goals (hereafter, SDGs), environmental protection is of paramount significance to achieve sustainable economic growth. At least nine of the 17 SDGs (i.e., SDG6—clean water and sanitation; SDG7—affordable and clean energy; SDG9—industry, innovation and infrastructure; SDG11—sustainable cities and communities; SDG12—responsible consumption and production; SDG13—climate action; SDG14—life below water; SDG15—life on land; and SDG17—partnerships for the goals) are centred on the environment and climate conservation. This has paved the way for an increasing number of firms, across developed and developing countries, to resort to green innovation (hereafter, GI) initiatives. These green initiatives relate mainly to environmental protection, low-carbon, eco-energy

saving, emission reduction, sustainability, recycling, pollution, water resources and biodiversity. There is a consensus in the extant literature that the adoption of GI has implications for environmental protection as well as organisational performance (Javed et al., 2023; Nadeem et al., 2020; Tawiah et al., 2024; Xie et al., 2016). One of the reasons is that investment in GI paves the way for achieving a competitive advantage (Chang, 2011). Moreover, with customers becoming increasingly aware of environmental issues, the surge in demand for green products is another factor that tends to improve performance (Javed et al., 2023; Kam-Sing Wong, 2012). Although it is costly to invest in technologies, the resultant decrease in the cost of environmental performance leads to an improvement in the long-term performance and profitability of organisations. Therefore, the adoption of green technologies is beneficial to not only the environment but also the stakeholders (Ahmed et al., 2024; Khan, Kaur, et al., 2021).

**Abbreviations:** CEO, chief executive officer; CNRDS, Chinese Research Data Services Platform; CSMAR, Chinese Stock Market & Accounting Research; CSR, corporate social responsibility; FE, firm-fixed effects; GI, green innovation; GMM, generalised method of moments; NIPA, National Intellectual Property Administration; PSM, propensity score matching; SDGs, sustainable development goals; SOEs, state-owned enterprises.

Khan, Kaur, et al. (2021) and Khan, Dhir, et al. (2021) conducted a structured literature review of studies on green processes and product innovations and found that most of the studies have considered China as a context. Given that ownership structure is an important determinant of GI, researchers have shown interest in understanding the firms' adoption of GI initiatives in relation to the ownership structure (i.e., state-owned vs. privately owned firms). Notably, the state-owned enterprises (hereafter, SOEs) in China are increasingly acknowledging GI as an important driver for their sustainable development through green transformation (Yuan et al., 2021). In this regard, the mixed-ownership reform aimed at reducing (increasing) state (private) ownership has been embraced as a tool to promote the green transformation of SOEs. This has continued to invite the attention of scholarly researchers to examine the association between partial privatisation<sup>1</sup> and environmental innovation initiatives, in the Chinese context. For instance, Khan et al. (2019) examined the association between state ownership reduction and corporate social responsibility (hereafter, CSR) performance. Similarly, Boubakri et al. (2019) assessed the link between CSR and privatised firms. Pan et al. (2019) studied the relationship between various levels of state ownership and GI. Further, Yuan et al. (2021) examined the impact of a mixed-ownership structure of SOEs on GI. However, the results remain inconsistent.

We mainly focus on Chinese firms because China is among the countries facing grave environmental pollution issues and corporate sector is among the largest contributor to global pollution and ecological changes (Tawiah et al., 2024). As per the United Nations Environment Program, China accounts for more than one fourth of emissions worldwide, which is highest across the globe. Moreover, China is ranked 160 out of 180 countries based on the environmental performance as per the 2022 Yale University Environmental Performance Index. Since the China's pattern of growth has led to persevering environmental pollution and ecological damage (Javed et al., 2023), the Chinese government has been taking various regulatory measures and reforms to strengthen its commitment to tackling environmental issues. For instance, it has introduced a carbon emission cap policy (Zhao et al., 2014) and created the Ministry of Ecology and Environment to oversee its implementation (Dai & Zhang, 2017). Furthermore, given its important position as a member of the United Nations, China has also shown tremendous progress with GI as a bridge to achieve the SDGs agenda. The initiative of GI to achieve SDGs has also been reinforced by scholarly research (e.g., Javed et al., 2023; Tawiah et al., 2024; Walz et al., 2017) asserting that since China intends to keep its competitive position in the global market, there is a surge in its GI initiatives. Existing literature (Pan et al., 2019; Yuan et al., 2021) documents that ownership structure may help firms achieve environmental sustainability by promoting GI. However, it is not known whether the recent state ownership reduction or partial privatisation reform introduced by the Chinese government has any impact on green initiatives of Chinese firms. Therefore, it is of paramount importance to examine whether such reforms can help firms

tackle the issue of climate change and environmental pollution through the promotion of sustainability initiatives such as GI.

Drawing on a combination of resource-based and stakeholder theory, we adopt a multi-theory perspective to better understand the relationship of partial privatisation and GI. Moreover, the contingency theory (Donaldson, 2001) suggests that partial privatisation-GI relationship may be subject to various contingencies. Following this line of arguments, prior studies (Javed et al., 2023; Nadeem et al., 2020; Tawiah et al., 2024) have shown that firms' tendency to engage in GI activities varies across regions (i.e., more vs. less developed regions) and industries (i.e., environmentally sensitive industries vs. environmentally non-sensitive industries). The firms' likelihood of adopting innovation varies based on their location; since developed regions have both institutional and technological infrastructure, it creates an enabling environment for firms to engage in green initiatives (Javed et al., 2023; Tawiah et al., 2024). Furthermore, firms operating in environmentally sensitive industries are more likely to adopt GI because of the stakeholders' pressure and higher scrutiny by the regulators (Javed et al., 2023; Nadeem et al., 2020). We therefore dig deep and examine whether the relationship between partial privatisation and GI is driven by some firm-level contingencies such as the level of regional development and industrial context.

We employ a large sample of Chinese non-financial firms for the period between 2005 and 2022 to test the proposed hypotheses. The results validate a positive relationship between partial privatisation and GI, implying that privatised firms are more likely to go green. Accordingly, privatisation is likely to facilitate the adoption of long-term projects aimed at promoting GI and gaining a competitive advantage to maximise the shareholders' wealth. The results also show that partial privatisation affects GI activities of firms located in more developed regions and operating in environmentally sensitive industries, but not in less developed regions and environmentally non-sensitive industries firms. Taken together, these findings uphold the relevance of contingency perspective in partial privatisation-GI nexus. Our main finding holds to a series of robustness tests including the use of alternate proxies and identification strategies, the propensity score matching (PSM), firm-fixed effects (FEs) and the system generalised method of moments (GMM). Finally, we document that higher engagement of firms in GI activities following privatisation is associated with better financial performance.

Our study makes several contributions to existing literature. First, it provides new evidence of the effect of ownership structure on GI in China. Prior studies have mainly focused on the level of state ownership (Pan et al., 2019; Yuan et al., 2021). We expand these studies by focusing on the reduction in state ownership as a result of partial privatisation of state-owned firms in China. The results validate a positive relationship between partial privatisation and GI. Second, this study contributes to the growing sustainability governance literature by presenting partial privatisation as another important determinant of firms' environmental innovation. Third, our study contributes to the literature by examining how partial privatisation drives GI. In this regard, our study documents that the association of partial privatisation and GI is subject to the level of regional development and the

<sup>1</sup>The term partial privatisation refers to the state ownership reduction.

industrial context of the firms. Therefore, we add to the literature on contingency theory (Donaldson, 2001) by documenting that partial privatisation is more likely to promote GI in firms operating in more developed regions and environmentally sensitive industries. Finally, we contribute to the scant but growing sustainability accounting literature by showing that firms' engagement in GI because of partial privatisation yields superior financial performance. Taken together, this study elucidates the instrumental role of the Chinese government's strategy of privatisation in protecting the climate by promoting GI among firms.

The next section will review the literature on GI initiatives and develop hypotheses for empirical testing, followed by methodology in Section 3. Section 4 provides empirical results. Finally, Section 5 concludes with some implications and directions for future research.

## 2 | LITERATURE REVIEW AND HYPOTHESES

The extant literature on GI is split into two main streams. One highlights the antecedents, consequences, challenges and organisational capabilities surrounding GI, and the other focuses on examining GI initiatives in relation to the ownership structure (i.e., state-owned or privately owned firms). However, the interplay of ownership structure and GI initiatives remains an under-researched area.

Scholarly research on the antecedents and consequences of GI includes the environmental orientation of the firms (Feng et al., 2018), ethical values (Chang, 2011), technological implementation (Kong et al., 2016), political connections (Nanda & Rhodes-Kropf, 2013), organisational learning (Manuj et al., 2014), institutional pressure (Qi et al., 2021; Wang et al., 2020), environmental awareness and commitment (Burki et al., 2018), financial performance (Xie et al., 2016), firm value (Yao et al., 2019), competitive advantage (Chang, 2011), brand equity (Kammerer, 2009), green product success (Kam-Sing Wong, 2012), job satisfaction (Iranmanesh et al., 2019), energy efficiency (Yan et al., 2021) and CO<sub>2</sub> emission reduction (Du et al., 2019). Furthermore, some challenges and organisational capabilities affecting green motives include a lack of qualified staff (Consoli et al., 2016), technological gaps (Stucki & Woerter, 2017), commercial uncertainty (Stucki & Woerter, 2019), capital investments (Abdullah et al., 2016; Khan, Kaur, et al., 2021), environmental ethics and commitment (Guo et al., 2020), environmental management systems (Papagiannakis et al., 2019), research and development strength (Hu et al., 2021), the technological readiness of the firms (Chang, 2019; Zhang et al., 2020), organisational learning (Awan et al., 2021), management approach (Liao & Long, 2018; Ogbeibu et al., 2020; Peng & Liu, 2016; Shu et al., 2016) and board gender diversity (He & Jiang, 2019; Nadeem et al., 2020). Additionally, green product innovation has also been examined for its association with firm performance (Ch'ng et al., 2021), firm value and systematic risk (Yao et al., 2019) and competitive advantage (Khan, Dhir, et al., 2021; Long & Liao, 2021).

More recently, scholarly research has shown a great deal of interest in examining sustainability initiatives concerning the ownership

structure of the firms. The extant studies on GI in SOEs provide inconsistent results. For instance, Khan et al. (2019) found a negative association between state ownership reduction and CSR performance. However, Boubakri et al. (2019) found a positive association between privatisation and CSR performance. Pan et al. (2019) found that compared to low or high levels, GI is low when state ownership is at an intermediate level, suggesting a U-shaped relationship. However, Yuan et al. (2021) found that mixed ownership promotes GI in SOEs. In a nutshell, most of the scholarly work has focused on the antecedents, consequences and challenges surrounding GI, and the ownership structure of the firms as a facilitator of GI remains under-researched.

Our review of GI literature highlights various gaps that need to be addressed. First, the inconsistent results around state ownership and GI suggest that there is a need to further understand the relationship between ownership structure and GI initiatives. Specifically, there is a need to empirically investigate whether partial privatisation is associated with the tendency of firms to go green. Furthermore, it is also important to understand how or when partial privatisation impacts GI. To address this question, we argue that firms' location and industry nature are likely to moderate the association between partial privatisation and GI. Finally, the literature has shown that state ownership reduction has a direct impact on financial performance, but it is unclear whether the interplay of partial privatisation and GI impacts financial performance. Therefore, it is important to address these gaps for a better understanding of the GI initiatives of partially privatised firms.

Scholars (e.g., Bag & Gupta, 2017; Munodawafa & Juhl, 2019) support a multi-theory perspective, combining resource-based and stakeholder theories, for an in-depth understanding of the interplay between partial privatisation and eco-innovation initiatives. From the perspective of resource-based theory, firms need to have significant resources at their discretion to pursue sustainability initiative such as GI that may provide benefit in the long run and SOEs face significant barriers to resource availability because of their reliance on the state (Xie et al., 2018; Zhou et al., 2017). In emerging economies such as China, the state is the ultimate controller of finance and other resources required for SOEs' innovation and green transformation (Cuervo-Cazurra et al., 2014). For SOEs to develop a new product, several stages of state approval are involved, which acts as a hindrance to innovation efficiency (Xie et al., 2018). Likewise, Zhou et al. (2017) highlight the traditional economic logic that state ownership is not compatible with innovation efficiency. Others (Goldeng et al., 2008; Inoue et al., 2013; Kroll & Kou, 2019; Pan et al., 2019) also suggest a negative association between state ownership and innovation. A dominant stream of research on SOEs' adoption of GI highlights the state's reluctance to commit to GI initiatives that are not likely to bring in a competitive advantage and economic benefits in the short run. Furthermore, this does not sit well with the promotion requirements of SOEs' executives.

Arguably, drawing on the stakeholder theory, a mixed ownership structure tends to reduce the controlling power of the state as a decision-maker with non-state owners having an opportunity to commit to the expansion of GI initiatives (Yuan et al., 2021). Furthermore, non-state-owned firms are more likely to consider a wider set of

stakeholders while making organisational policies to seek their support. In recent years, stakeholders have shown serious concerns regarding the environmental sustainability of firms (Javed et al., 2023). Given that we argue that privatisation is more likely to promote GI in China because of the significant pressure of stakeholders on such firms, that is not the case for SOEs. Similarly, Pan et al. (2019) assert that SOEs have to chase multiple targets, in addition to profitability and innovation, due to which firms' resource utilisation and GI efficiency are hampered. These assertions coincide with the resource-based and stakeholder view that private owners, who primarily are concerned with a competitive advantage, influence decisions around the effective utilisation of resources, which help organisations address environmental concerns of stakeholders by actively pursuing GI initiatives (Munodawafa & Johl, 2019). We therefore posit that partial privatisation facilitates GI.

**Hypothesis 1.** Partial privatisation is positively associated with GI.

It is also important to understand how or when partial privatisation impacts GI. In this regard, contingency theory (Donaldson, 2001) suggests that nexus of partial privatisation and GI is subject to some organisational contingencies. The extant research (Javed et al., 2023; Tawiah et al., 2024) also hints that GI initiatives are affected by some contingency factors such as location (more vs. less developed regions). Morales and Sariago-Kluge (2021) examined the motivations for GI from a regional perspective. They found that GI in less developed regions is driven by personal connections, environmental fragility, political will and natural resources endowment. Javed et al. (2023) also found a strong impact of female CEOs on GI in more developed regions of China. The resource-based view implies that due to the uneven capabilities of regional governments to perform innovatively and address the challenges of governance and sustainability, GI is likely to be less prevalent in underdeveloped regions. In this regard, Foray (2015) suggested the lack of entrepreneurial capacities and weak administration as barriers to innovation in less developed regions. In contrast, the availability of human capital and government support required to implement GI initiatives in well-developed regions create an enabling environment for firms to pursue GI initiatives. Therefore, we hypothesise that the association between partial privatisation and GI is likely to be affected by the firms' regional location.

**Hypothesis 2.** The effect of partial privatisation on GI is more pronounced for firms located in more developed regions than those located in less developed regions.

Taking a stakeholder theory perspective, a related stream of research also highlights various institutional pressures that drive firms' adoption of GI initiatives. Some examples include coercive regulatory measures, such as administrative punishments and strict inspection (Shen et al., 2020; Wang et al., 2020), normative pressure from media (Chen et al., 2018), customers (Huang et al., 2016) and non-governmental agencies (Berrone et al., 2013) and peer pressure from

firms in the same industry (Carter & Rogers, 2008). Such pressures tend to induce firms to adopt environment-friendly or green initiatives and create competitive challenges and barriers for non-green firms (Qi et al., 2021). More importantly, the stakeholders' expectations of firms adopting GI initiatives vary significantly based on the industrial context (Javed et al., 2023; Nadeem et al., 2020). Industry type is an important factor motivating a firm to go green (Gull, Hussain, Khan, Nadeem, & Zalata, 2023; Shu et al., 2016). Arguably, environmentally sensitive industries are more prone to stakeholders' pressure, which increases the likelihood of their adoption of green initiatives. This is mainly because of the ever-increasing calls for culminating environmental pollution and the more damaging effect of environmentally sensitive firms on the climate. According to Du et al. (2019), emission levels have reached an all-time high, which has triggered calls, worldwide, for firms to go green as a step towards curbing environmental deterioration (see Khan, Kaur, et al., 2021). All these pressure groups (e.g., customers, media and regulators) are important stakeholders who have a critical role to play in the firms' go-green decisions. Since the environmental orientation, characterised by recognition of the environmental problems surrounding the firm, is shaped by the pressure from various stakeholders (Feng et al., 2018; Nadeem et al., 2020), the association between partial privatisation and GI is likely to be affected by whether a firm belongs to a less or more environmentally sensitive industry.

**Hypothesis 3.** The effect of partial privatisation on GI is more pronounced for firms belonging to more environmentally sensitive industries than the rest of the firms.

## 3 | METHODOLOGY

### 3.1 | Data and sample

We gather state ownership and control variables data from the Chinese Research Data Services Platform (CNRDS) and Chinese Stock Market & Accounting Research (CSMAR). Data on GI were obtained from China's National Intellectual Property Administration (NIPA) database. The sample period starts from 2005 because it was the year when information regarding the state's ultimate ownership was made available on CSMAR (e.g., Usman et al., 2020) and ends in 2022. Our initial sample consists of all listed non-financial companies with no missing data on GI and state ownership. The final sample yields 36,072 firm-year observations after dropping observations with missing data on control variables.

### 3.2 | Main variables

#### 3.2.1 | Partial privatisation

According to Chen et al. (2018), partially privatised firms are those who experience a reduction in state ownership. We use several

approaches to measure partial privatisation. First, consistent with prior literature (Chen et al., 2018), we use a dummy variable (*Privatisation\_Dum*) coded 1 for firms where the state ownership has decreased through the secondary sale of shares and 0 otherwise. Second, we measure privatisation as a percentage of reduced share ownership by the state (*Privatisation\_Pro*). We also adopt the threshold approach and determine the level of privatisation based on a 10% or 20% cap on state ownership.<sup>2</sup> *Privatisation\_10%* is a dummy variable that equals 1 if a firm has sold 10% or more shares from its portion of state ownership and 0 otherwise. *Privatisation\_20%* is a dummy variable that equals 1 if a firm has sold 20% or more shares from its portion of state ownership and 0 otherwise.

### 3.2.2 | Green innovation

Following prior studies (Berrone et al., 2013; Chen et al., 2018; Javed et al., 2023; Usman et al., 2020), we first collect information regarding the number of environment-related patents to capture GI. Specifically, the number of environment-related patents by a firm is determined through a search using keywords such as 'green', 'low-carbon', 'environmental', 'energy-saving', 'emissions reduction', 'clean', 'cycling', 'saving', 'sustainable', 'ecology', 'environmental pollution' and 'environmental protection'. We then use the log of the number of patents (i.e., the log of the number of patents plus 1) as a measure of GI. This approach is consistent with existing GI studies and mainly justified because the log-transformed measure of GI helps reduce the effect of heteroscedasticity and the magnitude of differences in green patents across (Javed et al., 2023; Tawiah et al., 2024). We also use the log of the number of green patents applied (*Green\_Applied*) as an alternative measure of GI.<sup>3</sup>

### 3.3 | Econometric modelling

To examine the effect of partial privatisation on GI (H1), we estimate Equation (1). To examine H2, we estimate Equation (1) for the subsample of firms located in more and less developed regions of China. To test H3, we estimate Equation (1) for the subsample of firms belonging to environmentally sensitive and non-sensitive industries. We estimate Equation (1) using ordinary least square (OLS) regressions with year and industry-fixed effects to condense the effect of differences over time and across industries. We also cluster the standard errors at the firm-level while controlling for heteroscedasticity.

$$Green\_Innovation_{i,t} = \beta_0 + \beta_1 Privatization_{i,t} + \beta_n Controls_{i,t} + \varepsilon_{i,y} \quad (1)$$

where *Green\_Innovation* represents different proxies of GI while *Privatisation* refers to proxies of partial privatisation. Based on the findings of prior GI studies (Berrone et al., 2013; Chen et al., 2018; Javed

et al., 2023; Usman et al., 2020), *Controls* is a vector of control variables. These variables are related to the board structure, ownership structure, regional development and firms' economic status. Board structure controls include *Board\_Size* (measured as the number of directors on board) and *Board\_Independence* (measured as a proportion of independent directors on the board) because larger boards and independent boards are more inclined to protect the company reputation by investing in green technologies (Nadeem et al., 2020). The ownership structure variables include *Institutional\_Equity* (measured as a proportion of shares held by institutions) and *SOE* (a dummy variable that equals 1 if the ultimate owner is local or central government and 0 otherwise) because stakeholder theory suggests that institutional investors and governments are the vital stakeholders and might play significant role in firm's engagement in GI (Javed et al., 2023; Zhao et al., 2023). We also control for the level of *Region\_Development* (a dummy variable that equals 1 if the company headquarters is in a developed region of the country and 0 otherwise) because developed regions have higher level of carbon emissions due to the higher economic activity in these regions (Javed et al., 2023), which is detrimental for the environment and firms in such regions face more regulatory pressure regarding investing in green technologies. Finally, we include several economic variables because these economic factors also play an important role in firm's decision to invest in green technologies. These controls include *Firm\_Performance* (measured as the market value divided by the book value of the total assets), *Firm\_Size* (measured as the natural logarithm of sales), *Firm\_Age* (measured as the natural logarithm of the number of years a firm has been listed on the stock exchange), *Financial\_Leverage* (measured as the ratio of total debt to total assets), *Capital\_Intensity* (measured as the total assets to total sale ratio) and *Analyst\_Following* (measured as the natural logarithm of the number of analysts following the firm). We also control for industry and time effects as well as cluster standard errors at firm-level. The definition of all variables is given in Table 1.

## 4 | RESULTS

### 4.1 | Descriptive statistics

The descriptive statistics including the mean, standard deviation, minimum and maximum are presented in Table 2 (Columns 1 to 4). The mean of *Privatisation\_Dum* and *Privatisation\_Pro* is 0.291 and 4.409, respectively. These statistics imply that on average, state ownership has reduced in 29.1% of the sample firms with an average reduction of 4.409%. The mean of *Green\_Innovation* measured by the number of green patents suggests that on average, the sample firms have filed more than two green-innovation-related patents during the sample period. However, the minimum value of 0 and maximum of 55 with a high standard deviation of 8.184 suggest significant variation in green innovativeness of the sample firms.<sup>4</sup> The average *Board\_Size* is 8.698

<sup>2</sup>We are grateful to an anonymous reviewer for this suggestion.

<sup>3</sup>We are grateful to an anonymous reviewer for this suggestion.

<sup>4</sup>To improve the understandability, we provide descriptive statistics using the number of green patents value instead of log-transformed measure of GI.



**TABLE 1** Description of variables.

Variables	Description
<i>Green_Innovation</i>	Green innovation is defined as the log of the number of environment-related patents (such as patents related to environmental protection, low-carbon, eco-energy saving, emission reduction, sustainability, recycling, pollution, water resources and biodiversity).
<i>Green_Applied</i>	The log of the number of green patents applied.
<i>Privatization_Dum</i>	A dummy variable that equals 1 if a firm has sold its portion of state ownership and 0 otherwise.
<i>Privatization_Pro</i>	Percentage reduced share ownership by government.
<i>Privatisation_10%</i>	A dummy variable that equals 1 if a firm has sold 10% or more shares from its portion of state ownership and 0 otherwise.
<i>Privatisation_20%</i>	A dummy variable that equals 1 if a firm has sold 20% or more shares from its portion of state ownership and 0 otherwise.
<i>Board_Size</i>	Number of the board of directors.
<i>Board_Independence</i>	Proportion of independent directors on the board.
<i>Institutional_Equity</i>	Proportion of shares held by institutions.
<i>SOE</i>	A dummy variable that equals 1 if the ultimate owner is local or central government and 0 otherwise.
<i>Region_Development</i>	A dummy variable which equals 1 if the company headquarters is located in developed region of the country and 0 otherwise.
<i>Firm_Performance</i>	Firm's market value divided by the book value of the firm's total assets.
<i>Firm_Size</i>	The log of sales.
<i>Firm_Age</i>	The log of the number of years firm has been listed on the stock exchange.
<i>Financial_Leverage</i>	Total debt to total assets ratio.
<i>Capital_Intensity</i>	Total assets to total sale ratio.
<i>Analyst_Following</i>	The log of the number of analysts following the firm.

Note: All the continuous variables are winsorized at the 1% and 99% levels.

with 37.3% of the board members being independent directors (*Board\_Independence* = 0.373). The state is the ultimate owner in 45.5% of the sample firms (*SOE* = 0.455), and on average, institutional investors own 47.4% shares (*Institutional\_Equity* = 0.474). The mean of *Region\_Development* is 0.641, which suggests that 64.1% of our sample firms are in developed regions of China. The average *Firm\_Performance*, *Firm\_Size* and *Firm\_Age* is 2.009, 21.531 and 2.303, respectively. Sample firms' average *Financial\_Leverage* stands at 0.469 with a *Capital\_Intensity* ratio of 2.793. Finally, the mean of *Analyst\_Following* is 1.266, which suggests that each firm is covered by at least one analyst.

Column 5 to 8 of Table 2 documents the results of univariate analysis for firms with and without state ownership reduction. The

results of the univariate analysis imply that firms with (*Privatisation\_Dum* = 1) and without partial privatisation (*Privatisation\_Dum* = 0) differ significantly based on firm-specific characteristics. Notably, partially privatised firms are more likely to pursue GI than the rest of the firms (i.e., *Green\_Innovation* 3.630 vs. 2.586 at  $p < .01$ ).

## 4.2 | Correlation analysis

As part of the pre-regression analysis, we perform the Pearson pairwise correlation analysis among all variables. The results presented in Table 3 show that both measures of partial privatisation are positively and significantly correlated with GI. Hence, providing precursory evidence that privatisation is positively related to GI. Except for the correlation between proxies of privatisation,<sup>5</sup> none of the variables has a high correlation above the standard threshold of 0.7 (Gull, Hussain, Khan, Mushtaq, & Orij, 2023), implying that multicollinearity is not an issue.

## 4.3 | Regression results

### 4.3.1 | Baseline results

The regression estimations for assessing the link between partial privatisation and GI are presented in Table 4. We use two measures of partial privatisation throughout the analysis to enhance the reliability of our results. In Columns 1 and 2, partial privatisation is measured using the dummy variable (*Privatisation\_Dum*) and proportion of state ownership reduction (*Privatisation\_Pro*), respectively. The coefficient on both proxies of privatisation (*Privatisation\_Dum*  $\beta = 0.038$  at  $p < .01$  & *Privatisation\_Pro*  $\beta = 0.001$  at  $p < .05$ ) is positive and statistically significant, suggesting that partial privatisation promotes GI. These results are economically significant too. Consistent with prior studies (Adhikari & Agrawal, 2016; Usman et al., 2022), we calculate economic significance by multiplying the coefficient on privatisation with its standard deviation. For instance, the estimated coefficient of 0.001 on *Privatisation\_Pro* suggests that one standard deviation decrease in the proportion of state ownership leads to an increase of about 0.013 ( $= 0.001 * 12.886$ ) in GI, which is approximately 0.101% of its standard deviation.

Taken together, our results validate H1 by showing that partial privatisation enhances the tendency of firms to go green. These results are also in line with the resource-based view, which suggests that SOEs have multiple targets to achieve simultaneously, other than profitability and innovation which hinders them from allocating resources for long-term projects aimed at promoting GI (Pan et al., 2019). In contrast, private owners are mainly concerned with gaining and maintaining the competitive advantage to create value through the effective utilisation of resources and stakeholder

<sup>5</sup>A high correlation between the two alternative measures of privatisation is expected as both variables capture the same concept.

TABLE 2 Descriptive statistics and univariate analysis.

Variables	Descriptive statistics for whole sample (N = 36,072)				Univariate analysis of firms with and without partial privatisation			
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
	Mean	Standard deviation	Minimum	Maximum	Privatization_Dum = 1 (N = 10,489)	Privatization_Dum = 0 (N = 25,583)	Mean differences	t-Test for mean differences
Green_Innovation	2.889	8.184	0.000	55.000	3.630	2.586	-1.045	-11.027***
Privatization_Dum	0.291	0.454	0.000	1.000	-	-	-	-
Privatization_Pro	4.409	12.886	0.000	99.602	-	-	-	-
Board_Size	8.698	1.787	4.000	19.000	9.101	8.532	-0.569	-14.354***
Board_Independence	0.373	0.055	0.250	0.800	0.369	0.375	0.005	-27.775***
Institutional_Equity	0.474	0.235	0.006	0.933	0.549	0.443	-0.105	-39.736***
SOE	0.455	0.498	0.000	1.000	0.665	0.369	-0.296	-53.268***
Region_Development	0.641	0.480	0.000	1.000	0.588	0.663	0.074	13.457***
Firm_Performance	2.009	1.285	0.609	9.998	1.907	2.051	0.144	9.746***
Firm_Size	21.531	1.493	17.294	25.432	21.856	21.398	-0.458	-26.755***
Firm_Age	2.303	0.621	1.099	3.296	2.403	2.263	-0.139	-19.510***
Financial_Leverage	0.469	0.204	0.056	0.999	0.496	0.458	-0.038	-16.140***
Capital_Intensity	2.793	3.082	0.384	22.611	2.674	2.841	0.167	4.674***
Analyst_Following	1.266	1.182	0.000	4.331	1.431	1.198	-0.232	-17.069***

\*Significance at  $p < .10$ , \*\*Significance at  $p < .05$ , and \*\*\*Significance at  $p < .01$ .

TABLE 3 Correlation matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Green_Innovation	1.000													
(2) Privatization_Dum	0.058*	1.000												
(3) Privatization_Pro	0.002*	0.534*	1.000											
(4) Board_Size	0.051*	0.145*	0.012*	1.000										
(5) Board_Independence	0.060*	-0.045*	-0.018*	-0.454*	1.000									
(6) Institutional_Equity	0.107*	0.205*	0.014*	0.251*	-0.077*	1.000								
(7) SOE	0.063*	0.270*	-0.089*	0.286*	-0.077*	0.416*	1.000							
(8) Region_Development	0.067*	-0.071*	-0.021*	-0.089*	0.024*	-0.085*	-0.154*	1.000						
(9) Firm_Performance	-0.107*	-0.051*	0.011*	-0.143*	0.053*	-0.077*	-0.187*	0.024*	1.000					
(10) Firm_Size	0.362*	0.139*	0.005	0.206*	0.017*	0.357*	0.230*	0.044*	-0.349*	1.000				
(11) Firm_Age	0.069*	0.102*	0.006	0.085*	-0.013*	0.184*	0.332*	-0.123*	-0.121*	0.213*	1.000			
(12) Financial_Leverage	0.127*	0.085*	0.014*	0.131*	-0.015*	0.173*	0.212*	-0.088*	-0.289*	0.340*	0.226*	1.000		
(13) Capital_Intensity	-0.055*	-0.025*	0.001	-0.035*	0.019*	-0.014*	-0.026*	-0.030*	-0.009	-0.413*	0.136*	-0.002	1.000	
(14) Analyst_Following	0.194*	0.090*	0.049*	0.130*	0.011*	0.282*	-0.009	0.056*	0.088*	0.461*	-0.126*	-0.042*	-0.156*	1.000

\*Significance at  $p < .05$ .

TABLE 4 Partial privatisation and green innovation (H1).

Variables	Whole sample Green_Innovation	
	Column 1	Column 2
Privatisation_Dum	0.038*** (3.17)	-
Privatisation_Pro	-	0.001** (1.97)
Board_Size	0.012 (1.62)	0.012* (1.67)
Board_Independence	0.483** (2.40)	0.485** (2.41)
Institutional_Equity	-0.033 (-0.66)	-0.029 (-0.60)
SOE	0.058** (2.41)	0.068*** (2.85)
Region_Development	0.094*** (4.17)	0.094*** (4.15)
Firm_Performance	-0.015** (-2.39)	-0.015** (-2.35)
Firm_Size	0.179*** (16.80)	0.180*** (16.87)
Firm_Age	0.039** (2.24)	0.038** (2.23)
Financial_Leverage	0.225*** (4.59)	0.224*** (4.57)
Capital_Intensity	0.000 (1.60)	0.000* (1.70)
Analyst_Following	0.072*** (7.65)	0.072*** (7.68)
Constant	-4.394*** (-17.94)	-4.412*** (-18.02)
Year fixed	Yes	Yes
Industry fixed	Yes	Yes
Cluster at firm-level	Yes	Yes
Adjusted R <sup>2</sup>	.33	.33
N	36,072	36,072

Note: *t*-Statistics in parentheses.\* $p < .10$ , \*\* $p < .05$ , and \*\*\* $p < .01$ .

engagement. Consequently, partial privatisation is likely to facilitate the adoption of long-term projects aimed at promoting GI and gaining a competitive advantage to maximise shareholders' wealth (Munodawafa & Johl, 2019).

Regarding the control variables, we observe that *Board\_Size*, *Board\_Independence*, *SOE*, *Region\_Development*, *Firm\_Age*, *Firm\_Size*, *Capital\_Intensity* and *Analyst\_Following* are positively and significantly associated with *Green\_Innovation*. While on contrary to our expectations, *Firm\_Performance* shows a negatively significant relationship



with *Green\_Innovation* (Tawiah et al., 2024). The rest of the variables show no significant relationship with *Green\_Innovation*.

#### 4.3.2 | The role of regional development

The existing body of research on environmental innovation underscores the nuanced relationship between partial privatisation and GI, particularly in the context of firms' regional location, such as developing versus developed regions. Building upon the contingency theory and resource-based view, which emphasises the importance of organisational capabilities and resources in driving innovation, it can be inferred that the uneven capabilities of regional governments play a significant role in determining the prevalence of GI in underdeveloped regions. This hypothesis underscores the importance of considering regional context when examining the relationship between privatisation strategies and environmental innovation, as the dynamics at play may differ significantly across different geographical locations.

The regression results for examining the link between partial privatisation and GI contingent on the level of regional development are presented in Table 5. In Columns 1–2 and 3–4, we report the results using a sample of firms located in more and less developed regions, respectively. The coefficient on proxies of partial privatisation is positive in both samples (Columns 1–4). However, the coefficient on proxies of partial privatisation (*Privatisation\_Dum*  $\beta = 0.051$  at  $p < .01$  & *Privatisation\_Pro*  $\beta = 0.001$  at  $p < .05$ ) is statistically significant only for the sample of firms located in more developed regions (Column 1–2), suggesting that partial privatisation is more likely to promote GI in firms located in well-developed regions.

These findings support H2 and are in line with prior studies (Foray, 2015; Javed et al., 2023) documenting that firms' likelihood of adopting innovation varies based on their location. Therefore, our finding that partial privatisation facilitates corporate GI more in developed regions is not surprising, because stakeholders in developed regions are well aware of climate change and are more likely to hold firms accountable for their impact on the climate, which persuades firms to pursue GI more actively (Javed et al., 2023). More importantly, developed regions have both institutional and technological infrastructure (Foray, 2015), thus creating an enabling environment for firms to engage in green initiatives.

By elucidating the differential impact of partial privatisation on GI across regions of varying development levels, our findings contribute to a deeper understanding of the relationship between privatisation strategies and environmental innovation. In line with the contingency perspective, our results underscore the importance of considering regional context when formulating policies and interventions aimed at promoting sustainable business practices and fostering GI.

#### 4.3.3 | The role of industrial context

Given that stakeholders exert significant influence over firms' environmental orientation and decisions regarding GI adoption (Feng

et al., 2018; Nadeem et al., 2020), it follows that the association between partial privatisation and GI is likely to be influenced by whether a firm operates in a less or more environmentally sensitive industry. Prior studies assert that firms' engagement in initiatives aimed at environmental protection depends on their industrial context (Gull, Hussain, Khan, Mushtaq, & Orij, 2023; Javed et al., 2023; Nadeem et al., 2020). Arguably, firms operating in environmentally sensitive industries tend to care more about environmental protection and climate change, because of the stakeholders' pressure and regulatory requirements (Gull, Hussain, Khan, Mushtaq, & Orij, 2023; Javed et al., 2023; Nadeem et al., 2020). Therefore, it is important to examine whether the association between partial privatisation and GI varies based on the firms' industrial context. To empirically test these arguments, we divide the sample into environmentally sensitive and non-sensitive industries. Consistent with prior studies (Gull, Hussain, Khan, Mushtaq, & Orij, 2023; Javed et al., 2023; Lu & Herremans, 2019; Nadeem et al., 2020), we consider agriculture, forestry, chimerical, fishing, mining and construction industries as the environmentally sensitive industries while the remaining industries are termed as environmentally non-sensitive industries.

The regression results for examining the link between partial privatisation and GI based on the industrial context are presented in Table 6. In Columns 1–2 and 3–4, we report the results using a sample of environmentally sensitive and non-sensitive industries, respectively. The coefficient on proxies of partial privatisation (*Privatisation\_Dum* & *Privatisation\_Pro*) is positive in both samples (Columns 1–4). However, the coefficient on proxies of partial privatisation (*Privatisation\_Dum*  $\beta = 0.041$  at  $p < .01$  & *Privatisation\_Pro*  $\beta = 0.001$  at  $p < .05$ ) is statistically significant only for the sample of environmentally sensitive industries (Columns 1–2), suggesting that industrial context drives the association between privatisation and GI. These results provide empirical support to H3 that the effect of partial privatisation on GI is more pronounced for firms belonging to environmentally sensitive industries. The results are also in line with the arguments of stakeholder theory, which suggests that firms operating in environmentally sensitive industries are more likely to adopt GI because of the stakeholders' pressure and higher scrutiny by the regulators. The results also provide empirical support to contingency perspective by showing that firms in environmentally sensitive industries are more likely to embrace green initiatives in response to partial privatisation. These insights contribute to a deeper understanding of the complex dynamics influencing firms' sustainability practices and underscore the importance of tailored strategies for promoting environmental innovation across different industrial sectors.

#### 4.4 | Robustness analysis using alternate proxies

In this section, we test the robustness of our results to alternate proxies of the dependent and independent variables. We begin the robustness estimations with an alternative measurement of the explanatory variable—partial privatisation. We adopt the threshold approach to determine the level of privatisation based on 10% or 20% cap on state

Variables	More developed regions <i>Green_Innovation</i>		Less developed regions <i>Green_Innovation</i>	
	Column 1	Column 2	Column 3	Column 4
<i>Privatisation_Dum</i>	0.051*** (3.15)	-	0.020 (1.19)	-
<i>Privatisation_Pro</i>	-	0.001** (2.25)	-	0.000 (0.05)
<i>Board_Size</i>	0.024** (2.54)	0.025** (2.57)	-0.003 (-0.27)	-0.003 (-0.24)
<i>Board_Independence</i>	0.721*** (2.70)	0.721*** (2.70)	0.273 (0.93)	0.276 (0.93)
<i>Institutional_Equity</i>	-0.011 (-0.19)	-0.007 (-0.12)	-0.102 (-1.32)	-0.100 (-1.29)
SOE	0.103*** (3.14)	0.116*** (3.57)	0.021 (0.63)	0.025 (0.75)
<i>Firm_Performance</i>	-0.008 (-0.99)	-0.008 (-0.95)	-0.028*** (-3.11)	-0.028*** (-3.10)
<i>Firm_Size</i>	0.186*** (13.18)	0.187*** (13.24)	0.161*** (10.44)	0.161*** (10.47)
<i>Firm_Age</i>	0.053** (2.42)	0.053** (2.43)	-0.002 (-0.06)	-0.002 (-0.06)
<i>Financial_Leverage</i>	0.241*** (3.68)	0.240*** (3.66)	0.185*** (2.65)	0.185*** (2.64)
<i>Capital_Intensity</i>	0.000 (1.00)	0.000 (1.14)	0.000* (1.79)	0.000* (1.80)
<i>Analyst_Following</i>	0.068*** (5.85)	0.068*** (5.88)	0.086*** (5.56)	0.086*** (5.57)
Constant	-4.835*** (-14.85)	-4.861*** (-14.92)	-3.520*** (-10.26)	-3.528*** (-10.30)
Year fixed	Yes	Yes	Yes	Yes
Industry fixed	Yes	Yes	Yes	Yes
Cluster at firm-level	Yes	Yes	Yes	Yes
Adjusted R <sup>2</sup>	.35	.35	.31	.31
N	23,122	23,122	12,950	12,950

Note: *t*-Statistics in parentheses.

\**p* < .10, \*\**p* < .05, and \*\*\**p* < .01.

ownership reduction. *Privatisation\_10%* is a dummy variable that equals 1 if the firm has sold 10% or more shares from its portion of state ownership and 0 otherwise. *Privatisation\_20%* is a dummy variable that equals 1 if a firm has sold 20% or more shares from its portion of state ownership and 0 otherwise. The results using these proxies are presented in Columns 1 and 2 of Table 7. Next, we consider the alternate measure of GI. Specifically, we use the log of the number of patents applied (*Green\_Applied*). The results using *Green\_Applied* are presented in Columns 3 and 4 of Table 7. The results of all specifications reported in Table 7 show a positively significant association between partial privatisation and GI. Hence, confirming that our main findings are not subject to measurement issues.

**TABLE 5** Partial privatisation, regional development and green innovation (H2).

#### 4.5 | Controlling for endogeneity

In this section, we examine whether our results for the relationship between partial privatisation and GI are driven because of the endogeneity caused by the self-selection bias, omitted variables bias or dynamic panel endogeneity. Following prior studies (Gull, Hussain, Khan, Nadeem, & Zalata, 2023; Javed et al., 2023; Nadeem et al., 2020; Nekhili et al., 2020; Shahab et al., 2022), we employ PSM, FE and the system GMM to address these potential endogeneity issues.

First, there is a possibility that our main findings are driven by some observable differences in firms with and without partial

**TABLE 6** Partial privatisation, industry nature and green innovation (H3).

Variables	Environmental sensitive industries <i>Green_Innovation</i>		Environmental non-sensitive industries <i>Green_Innovation</i>	
	Column 1	Column 2	Column 3	Column 4
<i>Privatisation_Dum</i>	0.041*** (3.04)		0.022 (1.55)	
<i>Privatisation_Pro</i>		0.001** (2.41)		0.000 (0.55)
<i>Board_Size</i>	0.009 (1.09)	0.009 (1.13)	0.019 (1.27)	0.020 (1.29)
<i>Board_Independence</i>	0.355* (1.66)	0.357* (1.67)	0.958** (2.21)	0.961** (2.22)
<i>Institutional_Equity</i>	-0.078 (-1.42)	-0.075 (-1.36)	0.148 (1.50)	0.151 (1.53)
SOE	0.031 (1.15)	0.042 (1.59)	0.119** (2.33)	0.121** (2.40)
<i>Region_Development</i>	0.089*** (3.58)	0.088*** (3.57)	0.105** (2.25)	0.104** (2.23)
<i>Firm_Performance</i>	-0.013* (-1.93)	-0.013* (-1.90)	0.008 (0.54)	0.008 (0.55)
<i>Firm_Size</i>	0.154*** (13.38)	0.155*** (13.43)	0.293*** (11.49)	0.294*** (11.53)
<i>Firm_Age</i>	0.066*** (3.52)	0.066*** (3.50)	-0.050 (-1.37)	-0.050 (-1.36)
<i>Financial_Leverage</i>	0.246*** (4.49)	0.245*** (4.47)	0.082 (0.82)	0.084 (0.84)
<i>Capital_Intensity</i>	0.000 (1.33)	0.000 (1.45)	0.013*** (3.86)	0.013*** (3.89)
<i>Analyst_Following</i>	0.072*** (6.80)	0.073*** (6.82)	0.074*** (4.00)	0.074*** (4.03)
Constant	-3.964*** (-14.97)	-3.981*** (-15.05)	-6.982*** (-12.44)	-6.993*** (-12.49)
Year fixed	Yes	Yes	Yes	Yes
Industry fixed	Yes	Yes	Yes	Yes
Cluster at firm-level	Yes	Yes	Yes	Yes
Adjusted R <sup>2</sup>	.41	.41	.32	.32
N	7508	7508	28,564	28,564

Note: t-Statistics in parentheses.

\* $p < .10$ , \*\* $p < .05$ , and \*\*\* $p < .01$ .

privatisation (as shown in Columns 5–8 of Table 2) rather than the impact of partial privatisation on GI. To address this concern, we follow existing studies and perform the PSM-based analysis. This method allows us to create a control group similar to the treatment group based on several firm-level attributes except GI. To do so, we first match the firms where state ownership has reduced (i.e., treatment) with those who do not experience such a reduction (i.e., control) using the nearest neighbour approach. Then, we estimate our main equation using the matched sample. The results presented in Columns 1–5 of Table 8 show that matching has been performed

accurately. First, the results of univariate analysis (Columns 1–3) using post-match sample show no significant difference in treatment and control groups based on the observable firm characteristics (i.e., control variables). The results of the probit regressions (Columns 4–5) reinforce the quality of matching because several control variables are significantly associated with *Privatisation\_Dum* in pre-match probit regression (Column 4), while none of the control variables show significant association with *Privatisation\_Dum* in post-match probit regression. Hence, confirming that matching is well performed. We then estimate Equation (1) using the matched sample to examine the

**TABLE 7** Partial privatisation and green innovation using alternate proxies.

Variables	Green_Innovation		Green_Applied	
	Column 1	Column 2	Column 3	Column 4
Privatisation_10%	0.036** (2.19)	-	-	-
Privatisation_20%	-	0.043** (2.26)	-	-
Privatisation_Dum	-	-	0.059*** (4.21)	-
Privatisation_Pro	-	-	-	0.001** (2.34)
Board_Size	0.012* (1.67)	0.012* (1.67)	0.015 (1.62)	0.015* (1.68)
Board_Independence	0.486** (2.41)	0.485** (2.41)	0.648*** (2.65)	0.650*** (2.66)
Institutional_Equity	-0.029 (-0.58)	-0.029 (-0.58)	-0.045 (-0.77)	-0.039 (-0.68)
SOE	0.068*** (2.85)	0.069*** (2.89)	0.083*** (2.82)	0.097*** (3.35)
Region_Development	0.094*** (4.16)	0.094*** (4.15)	0.118*** (4.38)	0.118*** (4.35)
Firm_Performance	-0.015** (-2.36)	-0.015** (-2.35)	-0.011 (-1.46)	-0.011 (-1.42)
Firm_Size	0.180*** (16.86)	0.180*** (16.86)	0.230*** (17.42)	0.231*** (17.49)
Firm_Age	0.038** (2.23)	0.038** (2.22)	0.051** (2.48)	0.051** (2.48)
Financial_Leverage	0.224*** (4.57)	0.224*** (4.58)	0.207*** (3.57)	0.206*** (3.55)
Capital_Intensity	0.000* (1.70)	0.000* (1.70)	0.000** (2.30)	0.000** (2.45)
Analyst_Following	0.072*** (7.66)	0.072*** (7.68)	0.109*** (9.73)	0.110*** (9.77)
Constant	-4.413*** (-18.02)	-4.412*** (-18.03)	-5.557*** (-17.95)	-5.584*** (-18.03)
Year fixed	Yes	Yes	Yes	Yes
Industry fixed	Yes	Yes	Yes	Yes
Cluster at firm-level	Yes	Yes	Yes	Yes
Adjusted R <sup>2</sup>	.33	.33	.34	.34
N	36,072	36,072	36,072	36,072

Note: *t*-Statistics in parentheses.

\**p* < .10, \*\**p* < .05, and \*\*\**p* < .01.

association between partial privatisation and GI. The results reported in Columns 6 and 7 are qualitatively similar to those documented in Table 4.

Second, our results may be spurious because of omitted variable bias. In simple words, the relationship between partial privatisation and GI may be driven by unobservable firm-level characteristics that can be correlated with both firm GI and the probability of reduction in state ownership. To address this concern, we employ the FE

estimations as suggested by prior GI studies (Javed et al., 2023; Tawiah et al., 2024). The results presented in Columns 1 and 2 of Table 9 also show a positive association between partial privatisation and GI.

Finally, we use the system GMM estimations to investigate the effect of partial privatisation on GI while controlling for dynamic panel endogeneity (Gull, Hussain, Khan, Mushtaq, & Orij, 2023; Nadeem et al., 2020; Shahab et al., 2022). The results of the system GMM

TABLE 8 Partial privatisation and green innovation using propensity score matching (PSM).

Variables	Univariate analysis		1st stage results		2nd stage results	
	Treatment group	Control group	Results using whole sample	Results using matched sample	Results using matched sample	Results using matched sample
	Privatisation_Dum = 1 Column 1	Privatisation_Dum = 0 Column 2	Privatisation_Dum Column 4	Privatisation_Dum Column 5	Green_Innovation Column 6	Green_Innovation Column 7
Privatisation_Dum	-	-	-	-	0.033** (2.45)	-
Privatisation_Pro	-	-	-	-	-	0.001** (1.99)
Board_Size	9.101	9.043	0.029*** (5.97)	0.011 (1.04)	0.006 (0.66)	0.006 (0.68)
Board_Independence	0.369	0.370	-0.053 (-0.36)	0.092 (0.53)	0.606** (2.26)	0.606** (2.26)
Institutional_Equity	0.549	0.552	0.399*** (10.00)	-0.109 (-1.16)	0.019 (0.27)	0.020 (0.30)
SOE	0.665	0.665	0.524*** (29.32)	0.036 (1.64)	0.090*** (3.11)	0.100*** (3.45)
Region_Development	0.588	0.583	-0.077*** (-4.88)	0.010 (0.53)	0.149*** (5.01)	0.149*** (5.02)
Firm_Performance	1.907	1.866	0.050*** (6.93)	0.008 (0.94)	-0.030*** (-3.11)	-0.030*** (-3.07)
Firm_Size	21.856	21.875	0.117*** (8.14)	-0.072 (-1.05)	0.203*** (14.23)	0.203*** (14.26)
Firm_Age	2.403	2.449	-0.022 (-0.52)	-0.043 (-0.81)	-0.033 (-1.33)	-0.035 (-1.39)
Financial_Leverage	0.496	0.498	0.000* (1.85)	0.000 (0.77)	0.314*** (4.63)	0.312*** (4.61)
Capital_Intensity	2.674	2.644	0.077*** (9.62)	0.011 (1.15)	0.000 (0.77)	0.000 (0.84)
Analyst_Following	1.431	1.433	-2.553*** (-16.27)	-0.155 (-0.84)	0.061*** (5.01)	0.061*** (4.99)
Constant	-	-	0.029*** (5.97)	0.011 (1.04)	-4.913*** (-15.22)	-4.920*** (-15.26)
Year fixed	-	-	Yes	Yes	Yes	Yes
Industry fixed	-	-	Yes	Yes	Yes	Yes

(Continues)





TABLE 8 (Continued)

Variables	Univariate analysis		1st stage results		2nd stage results	
	Treatment group	Control group	Results using whole sample	Results using matched sample	Results using matched sample	Results using matched sample
	Privatisation_Dum = 1 Column 1	Privatisation_Dum = 0 Column 2	Privatisation_Dum Column 4	Privatisation_Dum Column 5	Green_Innovation Column 6	Green_Innovation Column 7
Cluster at firm-level	-	-	No	No	Yes	Yes
Adjusted/pseudo R <sup>2</sup>	-	-	.102	.001	.34	.34
N	10,489	10,489	36,072	20,978	20,978	20,978
			Mean differences Column 3			
			-	-	-	-

Note: t-Statistics in parentheses.

\* $p < .10$ , \*\* $p < .05$ , and \*\*\* $p < .01$ .

estimates are reported in Columns 3 and 4 of Table 9. The coefficient on both proxies of partial privatisation remains positive and highly significant. Taken together, these results suggest that our main finding is robust to potential endogeneity concerns.

#### 4.6 | Partial privatisation, green innovation and firm performance

There is a consensus in the extant literature that new technology, including GI, affects financial performance (e.g., Chien & Peng, 2012; Xie et al., 2016). Thus, the adoption of GI has implications for financial performance too. One of the reasons is that investment in GI paves the way for achieving a competitive advantage in comparison to the rivals (Chang, 2011). Moreover, with customers becoming increasingly aware of environmental issues, the surge in demand for green products is another factor that tends to improve performance (Kam-Sing Wong, 2012). Although it is costly to invest in technologies, the resultant decrease in the cost of environmental performance leads to an improvement in the long-run performance and profitability of organisations. The adoption of green technologies, therefore, is beneficial to not only the environment but also the stakeholders (Khan, Kaur, et al., 2021). These assertions coincide with stakeholder theory, which provides a demand-side perspective while highlighting the role of stakeholder groups in influencing the performance outcomes of GI (He et al., 2018). The stakeholder groups are broadly classified into capital market stakeholders, product market stakeholders and organisational stakeholders. All these groups have a critical role to play in an organisation's performance (Munodawafa & Johl, 2019). This implies that a reduction in state ownership paves the way for other stakeholder groups to influence strategic decision-making concerning the innovation initiatives of an organisation, which ultimately affects long-term financial performance. Against the backdrop of stakeholder view, our point of departure from existing studies is the examination of the relationship between partial privatisation and GI on financial performance. While partial privatisation has traditionally been studied for its direct impact on financial performance, we examine the indirect effect of partial privatisation on financial performance through the lens of GI.

We validate our arguments about the nexus of partial privatisation, GI and firm performance using Equation (2).

$$\begin{aligned} \text{Firm\_Performance}_{i,t} = & \beta_0 + \beta_1 \text{Privatization}_{i,t} + \beta_2 \text{Green\_Innovation}_{i,t} \\ & + \beta_3 \text{Privatization}_{i,t} * \text{Green\_Innovation}_{i,t} \\ & + \beta_n \text{Controls}_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where  $\text{Firm\_Performance}_{i,t}$  represents firms financial performance and  $\text{Privatization}_{i,t} * \text{Green\_Innovation}_{i,t}$  is our main variable of interest measured as the interaction term between proxies of partial privatisation and GI ( $\text{Green\_Innovation} * \text{Privatisation\_Dum}$  &  $\text{Green\_Innovation} * \text{Privatisation\_Pro}$ ). All other variables are as defined in Section 3.3.

**TABLE 9** Partial privatisation and green innovation using firm-fixed effects and system generalised method of moments (GMM).

Variables	Firm-fixed effect <i>Green_Innovation</i>		System GMM <i>Green_Innovation</i>	
	Column 1	Column 2	Column 1	Column 2
<i>Privatisation_Dum</i>	0.019** (2.49)	-	0.017*** (2.75)	
<i>Privatisation_Pro</i>	-	0.001*** (2.67)		0.001** (2.36)
<i>Lag_Green_Innovation</i>	-	-	0.858*** (151.39)	0.858*** (152.42)
<i>Board_Size</i>	-0.002 (-0.54)	-0.002 (-0.55)	0.001 (0.51)	0.002 (0.73)
<i>Board_Independence</i>	0.091 (1.00)	0.092 (1.00)	0.100 (1.61)	0.095 (1.52)
<i>Institutional_Equity</i>	-0.003 (-0.11)	-0.004 (-0.14)	-0.031* (-1.81)	-0.031* (-1.86)
SOE	0.053*** (2.93)	0.056*** (3.12)	0.023*** (3.03)	0.027*** (3.61)
<i>Region_Development</i>	0.109*** (2.75)	0.110*** (2.78)	0.016** (2.43)	0.015** (2.26)
<i>Firm_Performance</i>	-0.011*** (-2.82)	-0.011*** (-2.81)	-0.006** (-2.15)	-0.006* (-1.89)
<i>Firm_Size</i>	0.153*** (26.26)	0.153*** (26.32)	0.042*** (12.15)	0.042*** (12.15)
<i>Firm_Age</i>	0.032* (1.68)	0.031 (1.58)	-0.010 (-1.50)	-0.010 (-1.56)
<i>Financial_Leverage</i>	0.096*** (3.49)	0.097*** (3.52)	0.045*** (2.69)	0.045*** (2.72)
<i>Capital_Intensity</i>	0.000 (0.39)	0.000 (0.40)	0.000*** (2.68)	0.000*** (2.88)
<i>Analyst_Following</i>	0.018*** (3.80)	0.019*** (3.85)	0.025*** (7.55)	0.026*** (7.76)
Constant	-3.273*** (-25.25)	-3.276*** (-25.29)	-1.627*** (-10.84)	-1.616*** (-10.79)
Year fixed	Yes	Yes	Yes	Yes
Firm fixed	Yes	Yes	No	No
Industry fixed	No	No	Yes	Yes
Adjusted R <sup>2</sup> /Wald Chi <sup>2</sup>	.23	.23	59,402.22***	60,388.69***
Arellano-Bond test AR(1) (z-value)	-	-	-30.15***	-30.15***
Arellano-Bond test AR(2) (z-value)	-	-	1.45	1.45
Sargan test (Chi-square)	-	-	25,422.80***	25,424.10***
N	36,072	36,072	31,397	31,397

Note: t-Statistics in parentheses.

\* $p < .10$ , \*\* $p < .05$ , and \*\*\* $p < .01$ .

The results reported in Columns 1 and 2 of Table 10 show no significant association among proxies of privatisation (*Privatisation\_Dum* and *Privatisation\_Pro*) and financial performance. We also observe a

negatively significant relationship between GI (*Green\_Innovation*) and financial performance. However, the coefficient on the interaction term between proxies of partial privatisation and GI

**TABLE 10** Partial privatisation, green innovation and firm performance.

Variables	Firm_Performance	
	Column 1	Column 2
<i>Privatisation_Dum</i>	0.003 (0.15)	-
<i>Privatisation_Pro</i>	-	-0.000 (-0.76)
<i>Green_Innovation * Privatisation_Dum</i>	0.046*** (3.72)	-
<i>Green_Innovation * Privatisation_Pro</i>	-	0.001** (2.16)
<i>Green_Innovation</i>	-0.045*** (-4.17)	-0.034*** (-3.22)
<i>Board_Size</i>	-0.021*** (-3.26)	-0.020*** (-3.18)
<i>Board_Independence</i>	0.493** (2.56)	0.505*** (2.62)
<i>Institutional_Equity</i>	0.714*** (12.82)	0.721*** (12.93)
SOE	-0.098*** (-3.38)	-0.092*** (-3.17)
<i>Region_Development</i>	0.061** (2.44)	0.061** (2.42)
<i>Firm_Size</i>	-0.446*** (-31.29)	-0.445*** (-31.23)
<i>Firm_Age</i>	0.072*** (3.38)	0.074*** (3.43)
<i>Financial_Leverage</i>	-0.290*** (-4.09)	-0.292*** (-4.12)
<i>Capital_Intensity</i>	-0.000*** (-5.57)	-0.000*** (-5.58)
<i>Analyst_Following</i>	0.282*** (23.64)	0.282*** (23.65)
Constant	9.817*** (35.48)	9.784*** (35.41)
Year fixed	Yes	Yes
Industry fixed	Yes	Yes
Cluster at firm-level	Yes	Yes
Adjusted R <sup>2</sup>	.36	.36
N	36,072	36,072

Note: t-Statistics in parentheses.

\* $p < .10$ , \*\* $p < .05$ , and \*\*\* $p < .01$ .

(*Green\_Innovation \* Privatisation\_Dum*  $\beta = 0.046$  at  $p < .01$  & *Green\_Innovation \* Privatisation\_Pro*  $\beta = 0.001$  at  $p < .05$ ) is positively significant, implying that engagement of partially privatised firms in green initiatives yields superior financial performance. Hence, validating our claim that firms' engagement in GI because of the reduction in

state ownership improves financial performance. Consistent with the stakeholder theory, our results imply that a reduction in state ownership paves the way for other stakeholder groups to influence strategic decision-making concerning the firms' engagement in activities aimed at promoting GI to protect the environment, which ultimately affects long-term financial performance.

## 5 | CONCLUSION

In the wake of globalisation and the quest to reduce its carbon footprint, China has taken numerous steps in recent years to achieve its low-emission target. As the major contributors to carbon emissions, firms have taken a keen interest in developing innovations aimed at zero emissions. However, the capacity of management to develop more GI largely depends on the ownership structure of the firm since management is just an agent who acts according to the interests and decisions of the owners (principals). Therefore, this paper is an attempt to better understand the relationship between ownership structure and GI initiatives of a firm. Given the unique ownership structures in China (i.e., the dominance of state ownership and gradual growth of privatisation), we test whether the reduction in state ownership or partial privatisation affects the level of GI. We also examine when or how partial privatisation is likely to impact the firms' tendency to pursue GI. To do so, we mainly rely on the contingency perspective and investigate the impact of the level of regional development and firms' industry nature on the relationship between partial privatisation and GI. Finally, we examine whether higher engagement of firms in GI because of partial privatisation improves their financial performance.

We employ robust econometric analysis on a large sample of non-financial firms between 2005 and 2022 yielding 36,072 firm-year observations. Consistent with the resource-based and stakeholder theories, we find a positive and highly significant association between partial privatisation and GI under various assumptions. The relationship is stronger for firms in environmentally sensitive industries and those located in more developed regions, as expected based on the contingency theory. Our results imply that privatisation increases the chances for more stakeholders to engage in increasing pressure on firms to be more sustainable. Furthermore, privatisation offers flexibility to firms to solicit resources from external sources to enhance their innovativeness. We also demonstrate that the interaction of partial privatisation with GI exerts a positive influence on firm performance. In simple words, the increase in GI via privatisation is also beneficial for firms' financial performance.

This study extends the extant literature by enhancing our understanding of the relationship between partial privatisation and GI, and the impact that firms' location and industrial context have on this relationship. The results also demonstrate that the interplay of partial privatisation and GI has implications for firms' financial performance too. In terms of policy implications, the findings also suggest that partial privatisation reform of the Chinese government aimed at reducing the level of state ownership helps promote environmental sustainability.

Concurrently, there are also some limitations to note. Even though we have provided empirical support for the relationship between partial privatisation and GI, future studies may adopt a qualitative approach to better understand the underlying motives of Chinese firms for GI. Our findings may be considered in conjunction with relevant future studies adopting interpretive approaches to research partial privatisation and GI. The study employs several econometric techniques to rule out potential endogeneity concerns, but we acknowledge that it is not possible to completely rule out such concerns. Finally, we acknowledge that our findings may not be generalizable because of the unique institutional features of the Chinese market.

### CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

### DATA AVAILABILITY STATEMENT

The authors do not have the right to share the data.

### ORCID

Maria Ishaque  <https://orcid.org/0000-0002-0408-2686>

Ammar Ali Gull  <https://orcid.org/0000-0003-0231-3935>

Vincent Tawiah  <https://orcid.org/0000-0003-1679-387X>

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