

Article

The Impact of Green Investment on Digital Value: Evidence from Chinese Listed Companies

Chaokai Xue * and Yulong Chen

Business School, Shandong University of Technology, Zibo 255049, China; 23518031386@stumail.sdut.edu.cn

* Correspondence: xuechaokai@sdut.edu.cn

Abstract

The escalating global climate crisis has increased scholarly and practical attention to green investment as a key driver of corporate sustainability. From a systems perspective, enterprises can be viewed as complex socio-technical systems in which green resource allocation, technological innovation, and digital transformation interact dynamically. Against this background, this study examines how green investment (GI) affects corporate digital value (DV) and whether green technological innovation (GTI) serves as a transmission mechanism in this relationship. Using panel data from 15,244 firm-year observations of Chinese A-share listed companies from 2012 to 2024, this study applies panel data estimation methods to test the proposed relationships. The results show that GI significantly enhances DV, indicating that green resource allocation can strengthen firms' digital value creation. GTI plays a partial mediating role in the relationship between GI and DV, suggesting that green investment contributes to digital value not only directly but also by stimulating technological innovation within the corporate system. Further heterogeneity analysis reveals that the positive effect of GI on DV is more pronounced among state-owned enterprises and firms located in eastern regions. These findings enrich the literature on green–digital transformation by highlighting the systemic linkage between green investment, green technological innovation, and digital value creation. They also provide practical implications for policymakers and corporate managers seeking to promote coordinated low-carbon and digital development through more effective green investment and innovation strategies.

Keywords: green investment; digital value; green technological innovation; China

1. Introduction

As the global climate crisis intensifies, the need for ecological and low-carbon investment has become increasingly urgent. Green investment (GI), as a market-oriented mechanism for allocating capital to environmentally sustainable activities, has emerged as an important driver of global sustainable development. Existing research has documented a close association between greenhouse gas emissions and investment in green energy [1]. According to the International Energy Agency (IEA), global investment in clean energy technologies and infrastructure is expected to reach nearly USD 2.2 trillion by 2025, accounting for more than 67% of total global energy investment. China accounts for approximately one-third of this investment, indicating the growing role of global capital markets in supporting green technologies and renewable energy. Overall, green investment has become a central force in global economic transformation and an important catalyst for innovation-driven, high-quality economic development [2]. At the firm level, green investment is not only an environmental governance tool but also a strategic mechanism



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for reshaping corporate value creation. From a systems perspective, enterprises can be understood as complex socio-technical systems in which capital allocation, technological innovation, environmental governance, and digital transformation interact with one another. GI may affect corporate digital value (DV) by changing firms' resource allocation patterns, stimulating low-carbon technological upgrading, and improving their capacity to integrate green and digital capabilities. Prior studies have shown that GI can guide capital toward emission-reduction technologies, strengthen environmental responsibility [3], stimulate corporate green innovation [4], and enhance firms' digital value [5]. Green finance also provides enterprises with additional financial resources to promote digital transformation and sustainable growth [6]. In China, policy initiatives such as the Carbon Neutrality Action Plan and green finance policies provide institutional support for green investment, particularly among heavily polluting enterprises, and have improved firms' green innovation performance [7]. These developments suggest that green investment may play a systemic role in linking environmental transition with digital value creation.

Green investment (GI) and corporate digital value (DV) are not connected through a simple linear relationship; rather, their linkage depends on whether environmental resource allocation can be converted into firm-specific capabilities and innovation outcomes. The Natural Resource-Based View (NRBV) proposed by Hart [8] provides an appropriate theoretical foundation for understanding this process. From the NRBV perspective, green investments are not merely compliance-oriented expenditures but strategic resource commitments that can help firms develop valuable, rare, and difficult-to-imitate capabilities related to pollution prevention, resource efficiency, and sustainable development. These capabilities can improve internal processes, reduce environmental costs, and strengthen firms' long-term competitive advantages. In this sense, GI may enhance DV by enabling firms to integrate green resources with digital technologies, thereby improving operational efficiency, information processing, and value creation within the corporate system. The Porter Hypothesis further explains that well-designed environmental investment and regulation can induce innovation by encouraging firms to improve resource efficiency, redesign production processes, and develop cleaner technologies [9]. Under this logic, GI provides both financial support and strategic incentives for firms to pursue GTI, such as green patents, low-carbon technologies, cleaner production processes, hydrogen energy, and sustainable aviation fuel [10,11]. These innovation activities can reduce waste, lower environmental compliance costs, and improve firms' ability to respond to environmental regulations and market demand [12]. More importantly, GTI can serve as a transmission mechanism through which GI is transformed into digital value. By promoting green technological upgrading, GI enhances firms' capability to combine environmental innovation with digital transformation, thereby supporting sustainable development and improving corporate digital value [13,14]. However, existing studies have mainly discussed the GI–GTI–DV relationship at a conceptual level, while empirical evidence on the mediating role of GTI remains limited. Therefore, this study develops an empirical framework to examine whether and how GTI mediates the effect of GI on DV.

A comprehensive understanding of this relationship also requires attention to firm heterogeneity. The effect of green investment on digital value may vary across firms because enterprises operate within different ownership systems and regional environments. First, ownership structure may shape the effectiveness of GI. State-owned enterprises (SOEs), which are fully or partially owned by the government, are generally more responsive to policy signals than non-SOEs [15]. The 2024 Chinese Government Work Report emphasized the development of green and low-carbon industries, which may encourage SOEs to prioritize the long-term strategic value of green investment. By contrast, non-SOEs, especially private firms, usually face stronger market competition and greater financing constraints.

Their green investment decisions may be more closely related to short-term reputation gains, competitive positioning, and immediate digital returns, which may limit the scale and continuity of their green investment. Second, regional development conditions may influence the extent to which GI can be converted into DV. Firms located in different regions face distinct levels of economic development, policy support, digital infrastructure, marketization, and innovation resources. In China, enterprises in the eastern, central, and western regions differ substantially in their ability to allocate resources, conduct innovation, and respond to market demand [16]. The eastern region has a higher level of economic development, more advanced digital infrastructure, stronger market mechanisms, and greater technological innovation capacity. These conditions enable firms to transform green investment into digital outcomes more effectively [17]. The central region is undergoing industrial transformation and upgrading; although green investment can support firms' digital development, its contribution to digital value may be constrained by relatively weaker technological accumulation and resource allocation efficiency. The western region has a weaker foundation in both green economic development and digital transformation, and firms often face greater constraints in capital, technology, and talent. As a result, the effect of green investment on digital value may be less pronounced in this region [18]. These differences indicate that the regional environment is an important contextual factor in the system through which green investment empowers enterprises to create digital value.

In summary, the relationship among green investment, green technological innovation, and corporate digital value remains an emerging research topic. Although prior studies have examined the environmental and innovation effects of green investment, less attention has been paid to how green investment contributes to digital value creation through green technological innovation. Moreover, limited empirical evidence has explained how ownership structure and regional conditions shape this process. To address these gaps, this study investigates the following research questions:

1. Does green investment significantly enhance corporate digital value?
2. Does green technological innovation mediate the relationship between green investment and corporate digital value?
3. Does the effect of green investment on corporate digital value differ across ownership types and regions?

This study makes several academic contributions. First, it develops a theoretical framework linking green investment (GI), green technological innovation (GTI), and corporate digital value (DV), and empirically examines the internal mechanism through which GI affects DV using ordinary least squares (OLS) estimation. From a systems perspective, the study conceptualizes firms as socio-technical systems in which environmental resource allocation, technological innovation, and digital value creation interact dynamically. This framework helps explain how green investment can be transformed into digital value through capability development and innovation transmission, thereby providing new evidence for addressing the potential “win-win” relationship between corporate green transformation and business efficiency. Second, this study identifies GTI as a key mediating mechanism in the relationship between GI and DV. By focusing on the transmission effect of GTI, the study extends research on the economic consequences of green investment and clarifies the systemic pathway of “green input–innovation-driven transformation–digital value creation”. This perspective shows that green investment does not automatically generate digital value; rather, its value-enhancing effect depends on whether firms can convert green resource commitments into technological innovation and digital transformation capabilities. The findings therefore provide empirical evidence for firms seeking to optimize green investment decisions and strengthen value-generation mechanisms. Third, this study examines the heterogeneous effects of GI from the perspectives of ownership structure and

regional distribution. The results reveal that the effect of green investment on digital value differs across governance systems and regional development environments. This not only broadens the research framework on green governance and digital transformation but also provides practical implications for designing differentiated green incentive policies.

The remainder of this study is organized as follows. Section 2 develops the research hypotheses and reviews the relevant literature on green investment, digital value, and green technological innovation. Section 3 describes the variables, data, and empirical model. Section 4 reports the empirical results. Section 5 discusses the findings, theoretical contributions, practical implications, and conclusions.

2. Literature Review and Research Hypothesis

2.1. Green Investment (GI)

China is undergoing a pivotal transition in its economic paradigm. The nation must transition from resource-intensive growth patterns characterized by high energy consumption and pollution toward an eco-friendly economic model prioritizing green. Green investment serves as a critical catalyst in this transformation by funding ecological infrastructure. While academic consensus on green investment's definition remains evolving, this study conceptualizes it as corporate capital allocation to environmentally restorative initiatives. Specifically building upon Ren [19], we operationalize GI as enterprises' strategic deployment of financial resources into clean technologies and sustainable projects, designed to stimulate technological innovation, elevate operational performance, and ultimately propel green economic transition alongside long-term sustainable development goals. Companies must pay attention to the factors that affect green investment in the process of achieving performance goals. The more companies pay attention to economic and social sustainability, the more they will increase their green investment [2]. With the establishment and refinement of the green financial system, enterprises have broadened their green financing channels. Corporate green investment has been significantly impacted by financial initiatives like digital finance [20], green bonds [21], and green credit [22]. These initiatives optimize corporate operating costs and improve corporate environmental compliance and sustainability.

2.2. Digital Value (DV)

Corporate digital value (DV) is not merely the aggregation of digital-related assets or investments; rather, it represents a multidimensional outcome generated through enterprise digital transformation, digital intangible assets, digital investment, and data-driven value creation. By integrating digital technologies, data resources, analytical tools, and organizational capabilities, firms can reshape value creation processes across product design, research and development, production, operations, and management. In this process, enterprises do not create digital value in isolation. Instead, they co-create value with technology suppliers, service providers, customers, and other stakeholders within a broader digital value ecosystem [23]. Such ecosystem-based interaction enables firms to leverage existing core capabilities, develop new digital capabilities, and respond more effectively to the requirements of digital strategies, thereby building sustainable competitive advantages and reshaping the underlying logic of value creation [24]. Based on this understanding, this study defines corporate digital value as the measurable benefits generated by firms through the application of digital technologies, data resources, and data analytics in production, operations, management, and market activities. It reflects the process through which data assets, information insights, and knowledge applications are transformed into economic value, strategic advantages, and innovation capabilities. Specifically, DV may be manifested in revenue growth, cost optimization, operational efficiency improvement, customer

experience enhancement, and business model innovation. From a systems perspective, corporate digital value does not only depend on technology investment. It emerges from the systematic integration of digital capabilities into organizational decision-making, business processes, and ecosystem collaboration.

2.3. Green Technology Innovation (GTI)

Green technological innovation (GTI) is a key driver of economic growth and sustainable development. By introducing new technologies, processes, and production methods, GTI can improve production efficiency, enhance productivity, support the emergence of new industries and business models, and promote high-quality sustainable development. Schumpeter's theory of economic development defines innovation as the introduction of "new combinations" of production factors into the economic system. Building on this classic understanding and prior studies on technological innovation [25,26], this study defines GTI as innovation activities that rely on scientific and technological knowledge to develop new technologies, processes, products, or practices that reduce environmental impacts and improve resource efficiency. Under the dual pressures of global climate risks and resource scarcity, GTI provides an important pathway for advancing the green economy and sustainable development. From a systems perspective, GTI can be understood as a technological upgrading mechanism embedded in the interaction among production systems, environmental governance systems, and corporate value creation systems. It reduces excessive dependence on fossil fuels, accelerates the application of clean and environmentally friendly technologies, lowers carbon emissions [27], and improves the dynamic balance between economic activity and ecological protection. Therefore, GTI has become a strategic instrument for countries and enterprises seeking to achieve low-carbon transition, resource efficiency, and long-term sustainable competitiveness.

2.4. The Impact of Green Investment on Corporate Digital Value

The primary objective of corporate green investment (GI) is to reconcile economic returns with environmental responsibility and to support firms' transition toward sustainable development [14]. Existing studies show that corporate green investment can significantly promote green innovation [4]. However, GI is often directed toward clean energy, energy-saving technologies, green supply chains, and other environmentally oriented activities, which usually require substantial upfront capital expenditure. Compared with conventional technologies, these investments may also involve higher operating costs, longer payback periods, and greater uncertainty in the early stages of implementation. As a result, firms may face short-term financial pressure and investment risks when engaging in green investment. Despite these potential constraints, green investment may enhance corporate digital value (DV) through several systemic mechanisms. Ambec and Lanoie [28] provide an influential theoretical foundation for understanding how improved environmental performance can strengthen firm competitiveness. They suggest that environmental initiatives may generate business value through both cost-reduction and revenue-enhancing channels. Following this logic, GI can improve resource efficiency, reduce environmental compliance costs, optimize production processes, and strengthen firms' reputation and market recognition. These effects create favorable conditions for firms to integrate digital technologies into environmental management, production coordination, and strategic decision-making.

More specifically, GI can enhance firms' digital capabilities and digital value creation by encouraging the adoption of digital technologies, intelligent management systems, and data-driven environmental governance tools. These technologies improve the efficiency of resource utilization, production processes, and energy management [29]. In addition, the growing emphasis on sustainable development attracts investors' attention to firms'

green and digital practices, which can improve capital market recognition and support the implementation of digital strategies [30]. From a systems perspective, green investment helps connect environmental resource allocation, process digitization, data integration, and intelligent decision-making within the corporate value creation system. Firms that actively engage in GI are therefore more likely to develop stronger digital operational capabilities and greater long-term value creation potential than firms without such investments.

In summary, green investment is not only a driver of corporate sustainable development but also an important mechanism for enhancing corporate digital value. By improving environmental performance, strengthening operational efficiency, and facilitating the integration of green and digital capabilities, GI can contribute to the creation of measurable digital value. Therefore, this study proposes the following hypothesis:

H1. *Green investment has a positive effect on corporate digital value.*

2.5. The Mediating Role of Green Technological Innovation

Firms are the primary actors in implementing green technological innovation (GTI). However, with the development of Industry 4.0, firms' technological innovation activities are increasingly constrained by cost pressures, technical barriers, and uncertainty in the transformation process. These constraints may weaken firms' ability to convert environmental strategies into technological and digital outcomes. This study argues that green investment (GI) can help address these constraints by providing financial resources, technological support, and organizational conditions for green technological transformation [31]. In this sense, GI can drive the integrated development of digital, green, and intelligent technologies. First, GI provides firms with the financial support required for technological upgrading. By allocating capital to cleaner technologies, production process improvement, and resource-efficient equipment, GI can reduce cost-related risks, improve productivity, and strengthen the financing environment for technological innovation [32]. This ensures that firms have sufficient resources to support green technology development and digital transformation. Second, GI enables firms to access external technological resources [33]. Through cooperation with research institutions, environmental organizations, technology suppliers, and other external actors, firms can build innovation networks and accelerate the transformation and application of green technologies. Third, GI can improve the internal innovation environment. These conditions stimulate firms' internal green innovation vitality and improve their market competitiveness and sustainable development capabilities.

GTI is a crucial pathway through which firms transform GI into corporate digital value (DV). Through GTI, firms can promote intelligent production processes, digital resource allocation, and refined operational management. These changes improve resource utilization efficiency, reduce operating costs, enhance data-driven decision-making, and ultimately contribute to digital value creation [13]. At the same time, GI provides the necessary financial support and resource guarantees for GTI, enabling firms to develop green technologies, optimize green production models, and improve the application of digital technologies [34,35]. Recent studies further support this mechanism. Flammer [36] shows that sustainability-related investments can create firm value through both innovation and financial channels, suggesting that green investment may enhance value creation when it is converted into innovation capabilities and improved financing conditions. Xie et al. [37] directly examine the relationship between green innovation and corporate financial performance, providing evidence that green innovation can strengthen firms' competitive advantages and value creation capacity. In addition, Liu et al. [38] emphasize the importance of business, innovation, and platform ecosystems, which helps explain how innovation contributes to organizational value creation through systemic interactions among firms, technologies, platforms, and external stakeholders. These studies indicate that the effect of

GI on DV should not be understood as a simple input–output relationship. Rather, from a systems perspective, GI enhances DV through a dynamic transmission process in which green resources are converted into innovation capabilities, digital operational capabilities, and ecosystem-based value creation.

Therefore, GTI serves as a key mediating mechanism linking GI and DV. By promoting green technological upgrading, GI helps firms improve digital production, digital management, and data-driven decision-making, thereby enhancing corporate digital value while supporting sustainable development goals. Accordingly, this study proposes the following hypothesis:

H2. *Green technological innovation mediates the relationship between green investment and corporate digital value.*

2.6. Moderating Factors: Ownership Natures, Region

Green investment and green technological innovation are embedded in an innovation ecosystem composed of governments, financial institutions, technology suppliers, research institutions, and market actors. As Liu et al. [37] suggest, firms occupy different positions and possess different capabilities within systemic interactions, which may lead to heterogeneous effects along the “GI→GTI→DV” pathway. Accordingly, this study further examines whether the effect of green investment on digital value varies across firm ownership types and regional locations.

2.6.1. Ownership Natures

Ownership structure shapes how firms respond to green investment (GI) because it affects institutional pressures, resource access, strategic priorities, and organizational willingness to undertake sustainability-oriented innovation [39]. From the perspective of institutional theory, state-owned enterprises (SOEs) are more closely aligned with national policy objectives and environmental regulation, and therefore face stronger pressure to implement green development strategies [40]. As key actors in China’s green transition and “dual carbon” agenda, SOEs are more likely to treat GI as a long-term strategic task rather than a short-term financial decision. Recent evidence also suggests that psychosocial and organizational factors, such as managerial cognition, risk tolerance, and strategic entrepreneurial orientation, shape firms’ willingness and ability to engage in sustainability-oriented investment and innovation [41]. This helps explain why SOEs may be more capable of using green technological innovation (GTI) to support process digitization, intelligent resource management, and digital value creation. Resource dependence theory further explains why the effect of GI on digital value (DV) may be stronger in SOEs. Compared with non-state-owned enterprises (Non-SOEs), SOEs usually have better access to government subsidies, bank credit, policy resources, and green finance support [42]. These resources allow them to absorb the high upfront costs, long payback periods, and operational risks associated with green investment projects [43]. By contrast, Non-SOEs, especially private firms, often rely more heavily on internal funds and market-based financing. Their limited access to policy support and external resources may reduce their tolerance for large-scale green innovation projects and make them more inclined toward short-term investment strategies [44,45]. In addition, green investment is embedded in a broader business and innovation ecosystem involving regulators, investors, technology providers, research institutions, and market actors. SOEs’ stronger connections with these ecosystem participants may further enhance their ability to transform GI into GTI and, ultimately, DV.

Therefore, under the combined influence of institutional alignment and resource advantages, SOEs are better positioned to transform green investment into digital value. This study proposes the following hypothesis:

H3. *Compared with Non-SOEs, green investment has a stronger positive effect on the digital value of SOEs.*

2.6.2. Region

Regional conditions shape how effectively firms convert green investment (GI) into corporate digital value (DV). From the perspective of institutional theory, firms in different regions face varying levels of policy support, market development, environmental regulation, and digital infrastructure [46]. These institutional differences influence firms' incentives and capabilities to integrate GI with digital transformation. Resource dependence theory further suggests that regional disparities in innovation resources, technological talent, green finance, and public support affect firms' ability to transform GI into green technological innovation and digital value. In China, firms in the eastern region usually benefit from a more developed market environment, stronger digital infrastructure, advanced green technologies, and richer innovation resources. They are also embedded in more mature innovation ecosystems involving regulators, investors, technology providers, research institutions, and market actors. These conditions enable firms to combine GI with digital transformation more effectively through technological innovation, data integration, and intelligent upgrading [2]. Therefore, the positive effect of GI on DV is expected to be strongest in the eastern region. Firms in the central region are undergoing industrial transformation and digital upgrading, but the effect of GI may be constrained by weaker technological accumulation, innovation capacity, and resource allocation efficiency [17]. In the western region, firms face greater limitations in green technology R&D, digital talent, innovation resources, and digital infrastructure. Although government support through green finance, fiscal subsidies, and regional development policies has increased, the relatively weak digital and innovation foundation may limit the conversion efficiency of GI into DV [18].

Therefore, regional heterogeneity may affect the GI–DV relationship through differences in institutional support, resource endowment, and digital development conditions. This study proposes the following hypothesis:

H4. *The positive effect of green investment on corporate digital value exhibits regional heterogeneity, being strongest in the eastern region, followed by the central region, and weakest in the western region.*

2.7. Theoretical Framework

The hypothesized research model is presented in Figure 1.

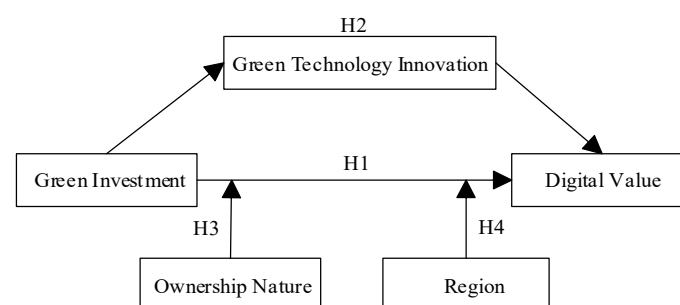


Figure 1. Conceptual model.

3. Research Methodology

3.1. Measures

3.1.1. Independent Variable

Green investment. To ensure academic rigor and empirical validity, research data should be accessible, representative, and consistent with the conceptual definition of the variable [47]. Previous studies have commonly measured green investment using investment in environmental pollution control. Building on this approach, Ren et al. [19] further incorporated investment in water conservancy construction and forestry to capture a broader scope of green investment. Following the definition of green investment adopted in this study and the measurement approach of Chen and Ma [48], this study measures green investment by aggregating listed firms' expenditures on environmentally related projects, including carbon reduction, clean technology, ecological governance, energy conservation, sewage treatment, green production, and other sustainability-oriented activities.

3.1.2. Dependent Variable

Digital value. Based on the conceptual definition of corporate digital value and drawing on the measurement approaches of Wu et al. [49] and Zhang et al. [35], this study measures digital value using information related to listed firms' digital transformation, digital intangible assets. The relevant data are collected and processed to capture firms' annual digital value creation. To control for the potential influence of firm-size differences, the extracted data are standardized, thereby generating the annual digital value indicator for each firm. The final measure reflects the extent to which firms create digital value through digital technology adoption, data resource utilization, digital asset formation, and digital capability development.

3.1.3. Mediating Variables

Green technological innovation. Since this study examines the mechanism through which green investment affects corporate digital value, green technological innovation is measured by the number of firms' green patent. Compared with total patent counts [50], green patents are more directly related to environmental protection, energy conservation, clean production, pollution reduction, and resource efficiency, and thus better capture the innovation outputs induced by green investment. Compared with other measurement indicators (such as R&D investment), the number of green patents can not only more clearly show the actual technological innovation results, but also accurately assess the competitiveness of firms in the technology market and their return on investment in innovation [51]. It is an indicator for evaluating the representativeness and rationality of corporate green, technological innovation activities [3].

3.1.4. Control Variables

To account for firm-level heterogeneity and reduce potential omitted-variable bias, this study includes a set of firm-specific control variables that may affect the dependent variable [52–54]. These variables include the proportion of independent directors, firm size, firm age, financial leverage, profitability status, asset structure, and CEO duality. Incorporating these controls improves the explanatory power of the empirical model and enhances the reliability and robustness of the estimated results. The definitions and measurements of all variables are reported in Table 1.

Table 1. Variables and measures.

Variables	Symbol	Measures
Dependent Variable		
Digital Value	DV	Digital transformation, etc.
Independent Variable		
Green Investment	GI	Environmental protection expenditure, etc.
Mediating Variable		
Green Technology Innovation	GTI	Number of Green Patents
Control Variables		
Corporate Size	SIZE	$\ln(1 + \text{total corporate assets})$
Leverage	LEV	Corporate Financial Leverage
Corporate Age	AGE	Years of listing
CEO Duality	DUAL	1, the CEO is also the chair of the board; 0, otherwise.
Ratio of Independent Directors	IDR	Number of independent directors/number of board members
Nature of profit and loss	LOSS	1, the net profit for the year was positive; 0, otherwise
Asset Structure	AS	Fixed assets/total assets
Fixed Effects		
Year	Year	Year Dummy Variable
Firm	Firm	Firm Dummy Variable

3.2. Data Collection

The sample period begins in 2012, when the 18th National Congress of the Communist Party of China elevated ecological civilization construction to a national strategy and green development became increasingly integrated into China's economic and social development agenda. Considering the capital scale, market influence, and representativeness of listed firms, this study uses 15,244 firm-year observations of A-share listed companies on the Shanghai and Shenzhen Stock Exchanges from 2012 to 2024. Green Technology innovation and other information were also taken from the CNRDS Green Patent Database and the CSMAR database. The ST and PT listed companies with significant data variations are removed from the data gathered during the prior study period in order to guarantee the data's consistency and comparability. Simultaneously, the data of financial industry companies (banks, insurance companies, etc.) was removed because their financial indicators and business models differ significantly from those of other industries, which could cause bias in the results. Additionally, the data are shrink-tailed to lessen the impact of outliers, increase data stability, and improve interpretability.

3.3. Econometric Model

3.3.1. Basic Regression Model

To empirically test the proposed hypotheses, this study employs ordinary least squares (OLS) regression. Model 1 is specified to examine the effect of green investment on corporate digital value.

$$DV_{i,t} = \alpha_0 + \alpha_1 GI_{i,t} + \alpha_n \text{Controls}_{i,t} + \mu + \varepsilon_{i,t} \quad (1)$$

In the model, i and t denote firm and year, respectively. $DV_{i,t}$ represents the corporate digital value of firm i in year t , and $GI_{i,t}$ denotes the green investment of firm i in year t . $\text{Controls}_{i,t}$ refers to the set of control variables. μ represents the fixed effects of year and firm, and $\varepsilon_{i,t}$ is the random error term.

3.3.2. Mediation Effect Model

To further examine the mediating role of green technological innovation, this study develops a mediation model based on Model 1, as specified in Equations (2) and (3).

$$GTI_{i,t} = \beta_0 + \beta_1 GI_{i,t} + \beta_n Controls_{i,t} + \mu + \varepsilon_{i,t} \quad (2)$$

$$DV_{i,t} = \gamma_0 + \gamma_1 GI_{i,t} + \gamma_2 GTI_{i,t} + \gamma_n Controls_{i,t} + \mu + \varepsilon_{i,t} \quad (3)$$

Formula (2) is the regression model of the explanatory variable GI on the mediating variable GTI; Formula (3) is the regression model of the explanatory variable GI and the mediating variable GTI on the explained variable DV. Among them, GTI represents technological innovation, $GTI_{i,t}$ represents the mediating variable value of enterprise i in year t , and the definitions of the remaining variables are the same as those of Formula (1).

The following three requirements are typically met by the intermediary effect model: Regression model 1 examines whether GI has a significant effect on DV; model 2 goes on to discuss whether GI significantly enhances GTI; and model 3 examines whether GI can significantly improve DV in the context of investment. When all three of the aforementioned criteria are met, it can be concluded that GI can enhance GTI and have a good impact on DV. Additionally, there is a considerable correlation between TI and DV. Thus, in this case, GI can indirectly improve DV by increasing GTI.

4. Empirical Research

4.1. Descriptive Statistics

Data analysis in this study is conducted using Stata 19.0. Table 2 presents the descriptive statistics for all variables used in this study, while Table 3 reports the results of the Pearson correlation analysis and variance inflation factor (VIF) test. As shown in Table 3, all VIF values are within the range of 1 to 5, with a mean VIF of 1.22, indicating that the model does not suffer from severe multicollinearity and remains stable and interpretable.

Table 2. Variable descriptive statistics.

Variable	Obs	Mean	SD	Min	Max
DV	13,047	2.818	1.156	0	7.168
GI	13,047	16.395	2.518	5.659	21.608
GTI	13,047	0.425	0.833	0	3.871
SIZE	13,047	22.588	1.306	18.349	28.644
LEV	13,047	0.448	0.198	0.0153	1.592
AGE	13,047	3.016	0.309	1.386	4.304
DUAL	13,047	0.718	0.596	0	4
IDR	13,047	37.498	5.487	14.29	80
LOSS	13,047	0.137	0.344	0	1
AS	13,047	0.264	0.161	0	0.954

Table 3. Pearson correlations among the variables and VIF.

	DV	GI	GTI	SIZE	LEV	AGE	DUAL	IDR	LOSS	AS	VIF
DV	1										
GI	−0.061 ***	1									1.46
GTI	0.114 ***	0.173 ***	1								1.08
SIZE	0.034 ***	0.518 ***	0.214 ***	1							1.76
LEV	0.0130	0.282 ***	0.126 ***	0.461 ***	1						1.39
AGE	0.0110	0.079 ***	−0.057 ***	0.182 ***	0.119 ***	1					1.06
DUAL	0.066 ***	−0.071 ***	−0.019 **	−0.120 ***	−0.080 ***	−0.00700	1				1.02
IDR	0.030 ***	0.00300	−0.00400	0.00900	−0.00500	0.0110	−0.043 ***	1			1.00
LOSS	0.031 ***	−0.016 *	−0.023 ***	−0.068 ***	0.238 ***	0.084 ***	0.019 **	0.024 ***	1		1.12
AS	−0.236 ***	0.217 ***	−0.056 ***	0.126 ***	0.120 ***	0.019 **	−0.067 ***	−0.026 ***	0.094 ***	1	1.08
Mean VIF											1.22

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

4.2. Basic Regression

To clearly examine the relationship between GI and DV, this study applies OLS regression to the panel data. The Hausman test shows that the correlation between the error term and the explanatory variables is statistically significant ($\lambda^2 = 1642.51$, $p < 0.01$), leading to the rejection of the null hypothesis. This indicates that the fixed-effects model is more appropriate for the regression analysis [55].

Table 4 reports the results of the baseline regression model. Column (1) presents the relationship between GI and DV without control variables or fixed effects; column (2) reports the relationship after introducing fixed effects but without control variables; and column (3) presents the results after adding both control variables and fixed effects, where $\alpha = 0.0096$. The results show that GI has a significant positive effect on DV in all three specifications, with significance at the 0.1% level. Therefore, Hypothesis 1 is supported.

Table 4. Basic regression model results.

Variable	(1) DV	(2) DV	(3) DV	(4) GTI	(5) DV
GI	0.0157 *** (4.2917)	0.0219 *** (5.8898)	0.0096 ** (2.5400)	0.0077 ** (2.5094)	0.0092 ** (2.4374)
GTI					0.0519 *** (4.8175)
_cons	2.5608 *** (41.6402)	2.4522 *** (39.7476)	−0.4225 (−0.7395)	−0.1801 (−0.3645)	−0.4125 (−0.7233)
Controls	No	No	Yes	Yes	Yes
Year-Firm-fixed	No	Yes	Yes	Yes	Yes
N	15,244	14,801	14,801	14,798	14,798
adj. R ²	0.001	0.759	0.766	0.674	0.766
F	18.42 ***	34.69 ***	33.9 ***	3.07 ***	33.19 ***

Note: t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.3. Mediation Effect Test

As shown in Table 4, column (4) shows that green investment significantly and positively affects GTI ($\beta_1 = 0.0077$, $p < 0.05$), and column (5) reflects the impact of GI and GTI on DV, and the results show that both GI and GTI have a significant positive impact on DV ($\gamma_1 = 0.0092$, $p < 0.05$; $\gamma_2 = 0.0519$, $p < 0.001$). The bootstrap results are shown in Table 5. The results indicate that the indirect effect of green technology innovation is 0.0006, with a 95% confidence interval of [0.0041, 0.0065], excluding 0, indicating a significant mediating effect. The direct effect is 0.0043, and the total effect is 0.0049. Further calculations reveal that the mediating effect accounts for 12.17% of the total effect, indicating that green technology innovation is a crucial transmission mechanism for green investment to enhance the digital value of enterprises. In summary, this study concludes that TI mediates between GI and DV, therefore hypothesis 2 is valid.

Table 5. Bootstrap test results.

Effect	Coef	Bootstrap	z	p	95% Confi.	
					LLCI	ULCI
Indirect effect	0.0053	0.0006	8.6929	0.000	0.0041	0.0065
Direct effect	−0.0103	0.0043	−2.3918	0.017	−0.0188	−0.0019

4.4. Robustness Test

First, to ensure the model is concise and has good estimation capabilities, and to avoid problems such as multicollinearity and overfitting caused by an excessive number of control variables, this study explored the robustness issues brought about by the control variables by adjusting them and rerunning the regression. The results shown in column (1) of Table 6 are consistent with the main conclusions.

Table 6. Robust empirical results.

Variable	(1) DV	(2) DV	(3) DV	(4) DV
GI	0.0087 ** (2.2794)		0.0070 * (1.7069)	0.0101 *** (2.6862)
GI1		0.0071 ** (2.1245)		
Controls	Yes	Yes	Yes	Yes
Year-Firm-Fixed	Yes	Yes	Yes	Yes
_cons	−1.1314 * (−1.8327)	−0.4988 (−0.8732)	−0.4041 (−0.6569)	0.0011 (0.0019)
N	14,364	14,801	12,596	14,801
adj. R ²	0.768	0.766	0.767	0.762

Note: t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Second, to examine whether the results are sensitive to the measurement of the core explanatory variable, this study remeasures green investment using an alternative proxy and conducts the regression again. As shown in column (2) of Table 6, the coefficient of green investment remains significantly positive after replacing the core explanatory variable, indicating that green investment continues to enhance corporate digital value and that the main conclusion is robust.

Third, considering that stock market volatility and the COVID-19 pandemic may have affected corporate operations, green investment decisions, and digital transformation, this study excludes observations from 2015 and 2020 and re-estimates the model. The results in column (3) of Table 6 show that the coefficient of green investment is 0.0086 and remains significant at the 10% level. This suggests that green investment still has a positive effect on corporate digital value after excluding these exceptional years.

Finally, to reduce the influence of extreme values on the empirical results, this paper adjusts the main variables through tail truncation and conducts a new regression to verify the robustness of the conclusion that green investment affects the value of digital assets. The results presented in column (4) of Table 6 show that the estimated coefficient of green investment remains significantly positive, indicating that the research conclusion is not affected by outliers and extreme observations, and verifying the robustness of the empirical results.

4.5. Endogeneity Test

Considering that industries differ systematically in green development levels, digital transformation processes, and regulatory environments, unobservable industry-level factors may simultaneously affect corporate green investment and digital value, thereby leading to biased estimation results. To further alleviate the endogeneity concern caused by omitted industry-level variables, this study adds industry fixed effects to the baseline model. Column (1) of Table 7 shows that, after incorporating industry fixed effects, the regression coefficient of green investment remains positive and statistically significant. This

indicates that green investment continues to promote corporate digital value and further confirms the reliability of the research conclusions.

Table 7. Endogeneity test results.

Variable	(1) DV	(2) DV
GI	0.0119 *** (3.1177)	0.0096 ** (2.5400)
Controls	Yes	Yes
Year-Firm-Fixed		Yes
Year-Firm-Ind-Fixed	Yes	
_cons	−0.7847 (−1.3305)	−0.4225 (−0.7395)
N	14,298	14,801
adj. R ²	0.768	0.766

Note: t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Considering that corporate green investment behavior is not randomly determined, firms with higher levels of green investment may differ systematically from other firms in terms of size, profitability, governance quality, and innovation capability, which may lead to sample selection bias. Therefore, this study further applies the propensity score matching (PSM) method to construct treatment and control groups with similar observable characteristics, thereby alleviating the endogeneity concern and improving the robustness of the findings. Specifically, this study selects the control variables as covariates, estimates propensity scores using a Logit model, and performs matching within the common support region. The balance test results show that, after matching, the absolute values of the standardized bias (%bias) for all covariates are below 5, which is within the acceptable range. Meanwhile, none of the covariates are statistically significant in the post-matching t -tests, with all $p > |t|$ values greater than 0.1. This indicates that the differences in the main observable characteristics between the treatment and control groups have been substantially reduced. The detailed balance test results are reported in Appendix A. Based on the matched sample, the regression results in column (2) of Table 7 show that the coefficient is 0.0096 and significant at the 5% level. This result is consistent with the baseline regression, indicating that sample selection differences do not change the main conclusion.

4.6. Heterogeneity Analysis

Considering firm heterogeneity, this study further examines whether the effect of green investment (GI) on corporate digital value (DV) differs across ownership types and regions. The results are reported in Table 8. First, regarding ownership structure, the coefficient of GI is larger and more significant for state-owned enterprises (SOEs) than for Non-SOEs ($\alpha_{\text{soc}} = 0.0164 > \alpha_{\text{Non-SODV}} = 0.0002$, $p\text{-value} < 0.005$ for SOCDV). This result suggests that SOEs are more capable of converting GI into DV. A possible explanation is that SOEs are more closely aligned with national strategies such as green development and the “dual carbon” goals, and therefore face stronger institutional incentives to integrate green investment with digital transformation. In addition, SOEs generally have better access to government subsidies, green credit, policy resources, and digital transformation support, which reduces the cost and risk of green investment and improves the efficiency of transforming green resources into digital value.

Table 8. Heterogeneity analysis results.

Variable	Ownership Nature			Region	
	SOCDV	Non-SOCDV	EDV	CDV	WDV
GI	0.0164 ** (2.3888)	0.0002 (0.0324)	0.0109 ** (2.0840)	0.0053 (0.6196)	−0.0055 (−0.5517)
_cons	0.3517 (0.3631)	−0.8954 (−1.0236)	−1.2584 (−1.6351)	−2.0199 (−1.3121)	4.1569 *** (3.0001)
Controls	Yes	Yes	Yes	Yes	Yes
fixed	Yes	Yes	Yes	Yes	Yes
N	4988	7349	7699	2587	2246
adj. R ²	0.745	0.786	0.778	0.745	0.749
F	13.09 ***	13.11 ***	16.53 ***	5.35 ***	9.5 ***

Note: t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Second, for the regions where enterprises are located (EDV: Eastern Corporate Digital Value; CDV: Central Corporate Digital Value; WDV: Western Corporate Digital Value), this study finds that the significant degree of the impact of GI in enterprises in different regions on DV decreases from east to west ($\alpha_{EDV} = 0.0109 > \alpha_{CDV} = 0.0053 > \alpha_{WDV} = -0.0055$, p -value < 0.005 for EDV). This suggests that the impact of corporate GI on DV is strongest in the eastern region, followed by the central region, and is less pronounced in the western region compared to the central and western regions, supporting the validity of Hypothesis 4. Although firms in central and western regions may have greater room for improvement, the transformation of GI into DV depends not only on investment input but also on complementary conditions such as digital infrastructure, innovation resources, skilled labor, capital markets, and government service capacity. Eastern China has more mature digital infrastructure, stronger innovation ecosystems, and more developed green finance and technology markets, enabling firms to combine green investment with data integration, intelligent upgrading, and digital business innovation more effectively. By contrast, firms in central and western regions face greater constraints in technological accumulation, talent availability, financing channels, and digital application capacity, which weakens the conversion efficiency of GI into DV. Therefore, regional institutional environments and resource endowments jointly shape the heterogeneous value effects of green investment.

5. Conclusions and Implications

5.1. Conclusions

This study examines the systemic mechanism through which green investment (GI) affects corporate digital value (DV) and the mediating role of green technological innovation (GTI), using 15,244 firm-year observations from 2012 to 2024. The findings are as follows. First, GI significantly enhances DV, indicating that firms engaging in green investment are more likely to achieve higher levels of digital value creation. From a systems perspective, green investment operates as a resource allocation mechanism within the corporate socio-technical system. By investing in green projects, firms can improve environmental technologies, reduce carbon emissions, and advance pollution and carbon reduction goals. These activities also strengthen environmental management capabilities and resource utilization efficiency, thereby supporting sustainable development and enhancing corporate value.

Second, this study provides a new perspective on how green investment contributes to corporate value creation. The results show that part of the positive effect of GI on DV is transmitted through GTI. Specifically, GI encourages firms to conduct green technological innovation, promotes technological upgrading, improves production efficiency and

resource utilization, and ultimately enhances digital value. The mediating role of GTI therefore provides evidence that green investment does not affect DV only through direct resource allocation, but also through a systemic innovation-driven transformation process in which green resources are converted into technological capabilities, digital operations, and value creation outcomes.

This study further reveals that the GI–DV relationship is contingent on ownership structure and regional context. On the one hand, the stronger effect observed among state-owned enterprises (SOEs) suggests that green investment generates greater digital value when firms are embedded in a more coordinated institutional and organizational system. For SOEs, green investment is not only a market-oriented investment decision but also part of a broader policy implementation system linked to China’s “dual carbon” strategy and digital economy agenda. This enables SOEs to align environmental objectives, financial resources, innovation activities, and digital transformation more effectively. In contrast, non-state-owned enterprises (Non-SOEs) often operate under stronger short-term performance pressure and less stable resource coordination mechanisms. As a result, the transformation of GI into DV may be less systematic and more dependent on immediate financial returns. This finding indicates that ownership structure shapes the internal consistency of the green–digital transformation system and influences how effectively firms convert green investment into digital value.

On the other hand, the regional heterogeneity results further show that the positive effect of GI on DV is more pronounced in eastern China. From a systems perspective, this suggests that green investment creates digital value more effectively when firms operate within a mature regional innovation system. In the eastern region, market mechanisms, digital infrastructure, financial services, technology networks, and policy support are more closely connected, allowing green investment to interact more efficiently with digital technologies, data resources, and innovation activities. This systemic complementarity strengthens the conversion of green inputs into digital value outcomes. By contrast, in the central and western regions, green investment may still promote digital development, but the conversion process is constrained by weaker system integration and lower coordination among capital, technology, talent, and digital application scenarios. Therefore, the heterogeneous findings indicate that the value effect of GI depends not only on the scale of green investment itself but also on the quality of the organizational and regional systems in which such investment is implemented.

5.2. Policy Implications

Polymakers and business strategists can gain valuable insights from this study:

First, the government should prioritize initiatives related to green technology and favor specific policies, such as green credit and tax incentives, when developing regulations, as green investments significantly enhance company performance. Companies should recognize the strategic importance of green investments in their sustainable development efforts and actively promote their own green transformations based on their unique characteristics.

Second, the government should support the creation of digital and green cities, nurture an innovative ecosystem, create a favorable investment climate, and promote industrial greening, as green investments drive technological innovation that boosts corporate digital value. Businesses should leverage the advantages of green innovation and technological advancements to align with their strategic objectives and develop a digital, green, and intelligent ecological framework for growth.

Third, policymakers should pay closer attention to non-state-owned enterprises, accurately assess their green development potential, and provide more appropriate financial

and policy support. Compared with state-owned enterprises, non-state-owned enterprises face greater constraints in transforming green investment into digital value. Therefore, these firms should actively pursue green projects that match their development strategies, strengthen green management capabilities, and improve their competitiveness in green industries.

Fourth, the effect of green investment on digital value remains relatively limited among firms in the central and western regions. Governments should expand policy and financial support for these regions, not only to promote the transformation of traditional manufacturing but also to accelerate the green transition of firms with high energy consumption and pollution intensity. Firms in these regions should move beyond short-term or peripheral benefits of green investment, broaden their green investment activities, accelerate green upgrading, and develop competitive advantages in the green market.

5.3. Research Limitations

Although this study provides several findings, it also has certain limitations that suggest directions for future research. First, the measurement of green investment used in this study does not distinguish which specific types of green projects contribute more strongly to corporate digital value. Future studies could classify green investment into different dimensions and further examine the value effects of specific project categories. Second, while this study examines the heterogeneous effects of green investment across ownership types and regions, these effects may also vary according to managerial characteristics and governance structures. Future research could explore whether CEO influence, board characteristics, or executive incentives moderate the relationship between GI and DV. Finally, this study focuses on listed companies on the Shanghai and Shenzhen Stock Exchanges. Future research could expand the sample to include different types of firms and further compare the effects of GI across the primary, secondary, and tertiary industries.

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Appendix A

Table A1. Standardized Biases Before and After Matching.

Variable	Unmatched	Matched	Mean		%Bias	%Reduct Bias	t-Test		V(T)/V(C)
			Treated	Control			t	$p > t $	
Size	U		23.105	22.071	86.2		53.22	0.000	1.76 *
	M		23.093	23.082	0.9	99.0	0.49	0.627	0.97
Lev	U		0.49204	0.40408	45.7		28.19	0.000	0.92 *
	M		0.49199	0.4923	−0.2	99.7	−0.10	0.924	0.87 *

Table A1. Cont.

Variable	Unmatched Matched	Mean		%Bias	%Reduct Bias	t-Test		V(T)/V(C)
		Treated	Control			t	$p > t $	
AGE	U	3.0308	3.0014	9.5		5.88	0.000	0.99
	M	3.0311	3.0234	2.5	73.7	1.53	0.126	0.96 *
DUAL	U	0.68436	0.75044	−11.1		−6.85	0.000	0.89 *
	M	0.68562	0.69565	−1.7	84.8	−1.04	0.298	0.90 *
IDR	U	37.559	37.437	2.2		1.36	0.173	1.10 *
	M	37.559	37.518	0.8	65.9	0.45	0.651	0.98
LOSS	U	0.13054	0.14393	−3.9		−2.40	0.016	.
	M	0.1309	0.1359	−1.5	62.6	−0.91	0.365	.
AS	U	0.29201	0.23549	35.6		21.95	0.000	1.34 *
	M	0.29143	0.29463	−2.0	94.3	−1.04	0.297	0.67 *

Note: t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

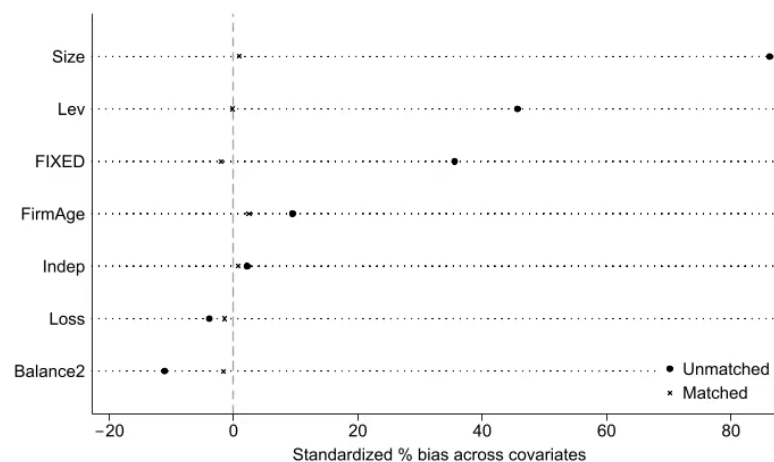


Figure A1. Standardized bias before and after matching.

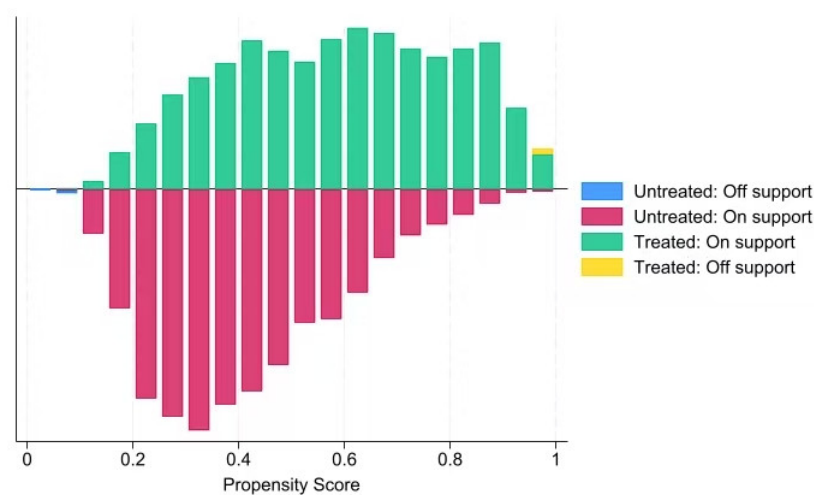


Figure A2. Propensity score common support.

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