



Impact of Urban Digital Economy on ESG Performance: Do Technological and Business Model Innovation Matter

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Abstract: The rapid development of the digital economy is a critical national strategy for the Chinese government, with the establishment of digital economy platforms as a key component. Simultaneously, both the government and enterprises have embraced the concept of sustainable development. Since corporate environmental, social, and governance (ESG) performance serves as a crucial micro-indicator of sustainability, it is essential to investigate whether the digital economy platforms developed by the Chinese government can enhance the ESG performance of relevant companies. This paper first examines the impact of urban digital economy platform construction on corporate awareness of ecological and environmental protection, social responsibility, and governance practices. It then proposes two primary mechanisms—technological innovation and business model innovation. Finally, empirical evidence is presented based on a sample of 107 urban CSI 300-listed companies in China, using data from 2015 to 2019. The analysis yields three key findings: (1) the construction of urban digital economy platforms significantly improves the ESG performance of companies in the region; (2) the impact on the social subindex is not significant, but the effect is more pronounced in non-state-owned enterprises, the manufacturing sector, and the eastern region; and (3) business model innovation plays a more significant role in driving ESG performance compared to technological innovation. This study contributes to the understanding of how digital economy platforms influence corporate ESG performance.

Keywords: Digital economy platform, Business model innovation, corporate ESG performance, Data of listed companies in China

1. Introduction

China's economy has transitioned from prioritizing rapid growth to focusing on high-quality, sustainable development. Large, listed companies are central to driving economic progress, and the development of the digital economy has become a critical national strategy (Liu et al., 2022). Both elements are crucial for achieving the country's new objectives. On the one hand, listed companies must adopt more sustainable and high-quality development models, focusing on ecological protection, social responsibility, and enhanced governance while contributing to macroeconomic development. On the other hand, global uncertainties, such as geopolitical conflicts, protectionism, and the COVID-19 pandemic, have significantly impacted the global economy (Takahashi & Yamada, 2021) and individual firms (Habib & Mourad, 2023; Habib et al., 2024). In response to the economic downturn, the Internet has become increasingly essential for people's daily lives, encompassing activities such as learning, working, and socializing, thereby accelerating the growth of digital services, communications, and entertainment (Mo et al., 2023). China's digital economy has continued to expand and is now regarded as the next primary economic phase, following the agricultural and industrial economies (Guo et al., 2020). Therefore, developing digital economy platforms has become a critical infrastructure for economic growth, supporting Chinese companies in achieving sustainability goals amidst slow economic recovery and global trade protectionism (Chen et al., 2022).

Sustainable development has always been central to high-quality growth and is highly valued by all sectors of society. Enterprises serve as the fundamental units of economic activity. Environmental, Social, and Governance (ESG) principles encourage companies to protect the environment, assume social responsibility, and enhance governance systems throughout their development—critical components of sustainability (Li et al., 2024). Habib (2022) finds a significant and positive impact of ESG on firm value. Habib (2024) further indicates that a firm's ESG performance can decrease the likelihood of financial distress. Habib (2024) suggests that firm performance (FP) is essential in strengthening the link between a firm's ESG practices and its total enterprise value (TEV). As a result, corporate ESG performance has been recognized as a vital indicator of sustainable or high-quality development. Strong ESG performance aligns with China's 14th Five-Year Plan goals, which aim for "higher quality, more efficient, fairer, more sustainable, and safer development." Consequently, various sectors in China are actively exploring ways to improve corporate ESG performance, with the digital economy providing an essential opportunity.

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Many scholars are optimistic about the role of urban digital economy development in boosting the ESG performance of regional firms (Wang & Tang, 2024). These scholars suggest that the growth of the digital economy, driven by advancements in technologies such as big data and artificial intelligence, helps companies achieve green production (Mansouri & Momtaz, 2022), reduce governance costs (Sama et al., 2022), and fulfill social responsibilities (Yu et al., 2020). Technological innovation is typically seen as the primary mechanism driving improved ESG performance in the context of the digital economy. However, digital economy development is reflected not only in technological advances but also in comprehensive upgrades across concepts, systems, technologies, markets, and regulations (Priyadarshi, 2022). From an enterprise perspective, the growth of the digital economy in cities has provided advanced technologies and disruptive changes to traditional business models, such as B2C or C2C. Business model innovation is currently considered a form of innovation with a broader and deeper scope than technological innovation (Mo et al., 2023). This raises the question: Is business model innovation the primary mechanism by which digital economy development influences ESG performance, with technological innovation being a contributing factor? This issue has not been fully explored, creating a research gap that needs to be addressed.

To fill this research gap, this study examines 387 listed companies from 107 cities in 29 provinces across China, all constituting the CSI 300 index during the sample period (2015–2019). The analysis reveals four key findings: First, developing digital economy platforms in a city enhances the ESG performance of companies in that city. Specifically, for each 1-unit increase in the digital economy platform construction level, the ESG performance of CSI 300-listed companies improves by approximately 0.338. Second, while the social impact subindex shows no significant change, the effect is more pronounced in non-state-owned enterprises, the manufacturing sector, and the eastern region of China. Third, business model innovation plays a more significant role in influencing ESG performance in the digital economy than technological innovation.

This study contributes to the literature on digital economy platforms and corporate ESG performance in several ways:

- **Empirical Evidence on ESG Performance Enhancement:** The study provides empirical evidence that urban digital economy platform development can improve corporate ESG performance, supporting the theory that digital infrastructure is vital for fostering sustainable business practices. While previous literature suggests that digital economy development boosts ESG performance, this study distinguishes between the environmental, social, and governance components, revealing that the digital economy has a more significant impact on the environmental and governance aspects than on the social dimensions.
- **Mechanisms of Influence:** The study identifies two key mechanisms—technological innovation and business model innovation—that deepen our understanding of how digital economy platforms influence corporate sustainability. It finds that business model innovation has a more significant effect on ESG performance than technological innovation, challenging the common view that prioritizes technological advances. This insight suggests that companies should focus equally on innovating their business models and adopting new technologies, marking a significant contribution to the research.
- **Contextual Insights:** The study offers valuable insights into how digital economy platforms impact different types of enterprises, particularly highlighting that the effects are more prominent in non-state-owned enterprises and the manufacturing sector in eastern China. This regional and sectoral context enhances our understanding of how local and industry-specific factors influence the relationship between digital economy development and ESG performance, providing practical insights for policymakers and business leaders.
- **Policy Relevance:** By linking government support for digital economy platforms to improvements in corporate ESG outcomes, the study emphasizes the importance of policymakers promoting digital initiatives as part of broader sustainability strategies. This research underscores the potential for digital economy platforms to advance corporate responsibility and environmental stewardship, offering actionable recommendations for public policy.
- **Framework for Future Research:** This study lays the groundwork for future research on how digital economy platforms affect ESG performance. It encourages further exploration of the complex interactions between digitalization, innovation, and sustainability, providing a framework for future investigations into these critical areas.

Together, these contributions enhance understanding of the intersection between the digital economy and corporate sustainability, offering a solid foundation for academic inquiry and practical application.

2. Theoretical Background

2.1. Key Concepts

The term "digital economy" first emerged in the 1990s. In 1996, Tapscott (1996) was the first to describe the impact of the computer and internet revolution on business behaviour. Later, in 2002, Kim (2002) provided the first clear definition of the digital economy, describing it as an economy in which goods and services are traded in an informational form. With advancements in information technology and the increasing digitization of the economy and society, the scope and meaning of the "digital economy" have evolved. In 2016, the G20 Initiative on Development and Cooperation in the Digital Economy defined the digital economy as one that utilizes digitized knowledge and information as crucial production factors, modern information networks as critical carriers, and information and communication technologies as significant drivers of efficiency improvements and structural optimization. This definition is widely accepted in academic circles and is used in this paper.

The ESG (Environmental, Social, and Governance) was officially proposed in 2004 by the UNGC (2004), encompassing three core dimensions—environmental, social, and governance. The fundamental goal of ESG is to balance the sustainable development of the economy, society, and the environment. Today, evaluating corporate value based on ESG performance has become one of the critical criteria for mainstream international investors, and numerous international organizations have adopted ESG-related indicators. For example, the fourth edition of the Sustainability Reporting Guidelines (SRG) issued by the Global Reporting Initiative (GRI) prioritizes environmental and social issues, with 34 environmental items across 12 categories and 48 social items across 30 categories. While China's ESG system is relatively new, it has developed rapidly in recent years. The Overall Plan for the Reform of the Ecological Civilization System, released in September 2015, mandates the establishment of a mechanism for mandatory environmental disclosure by listed companies in the domestic financial market.

The business model concept first appeared around 1957 but lacked a formal definition at the time. Over the years, the meaning and scope of business models have evolved, and scholars have yet to reach a consensus on a standard definition. Osterwalder (2005) proposed that the business model consists of nine key components: value proposition, target customers, channels, customer relationships, revenue sources, core resources, key activities, essential partnerships, and cost structure. This framework is known as the “nine elements” business model theory. In contrast, Chinese scholars have proposed a “six-factor” business model theory (Wei et al., 2020), which includes positioning, business system, profit model, essential technology resources, cash flow, and enterprise value. This model is better suited to the Chinese context, and this paper uses it as the basis for constructing indicators of business model innovation.

2.2. Relevant Theories

This paper is based on the two most fundamental economic theories: (a) the theory of sustainable development and (b) the theory of innovation. The former explains why companies should develop according to ESG concepts, and the latter is the theoretical basis for why the digital economy's development can affect companies' ESG performance.

The theory of sustainable development proposes economic and social development that meets the needs of the present without jeopardizing the ability of future generations to meet their needs. Equity, continuity, and commonality are the three basic principles of sustainable development theory. Sustainable development theory aims to achieve common, coordinated, equitable, efficient, and multidimensional development (Brown, 1981).

Schumpeter's theory (Schumpeter, 1939) of innovation gained academic recognition. Schumpeter's theory of innovation has five drivers: new markets, new materials, production processes, organizational approaches, and product design. ESG is a developmental model of corporate sustainability. It is a composite innovation model, which includes new technologies, new ideas, and new ways of organization (Priyadarshi, 2022).

2.3. Theoretical Links Between Digital Economy, Business Model Innovation, and ESG

The development of ESG is a practical application of the sustainable development theory. Fundamentally, the rapid expansion of the digital economy has increased companies' costs in positioning, business systems, profit models, essential technological resources, cash flow, and enterprise value while simultaneously reducing costs across various processes. This dynamic ultimately drives companies toward more sustainable development.

From a technological perspective, digital technologies can support environmental sustainability by enabling energy conservation and emission reduction. For example, intelligent control systems can optimize energy consumption, and adopting renewable energy sources can help reduce carbon emissions (Hughes et al., 2021). Additionally, digital technology facilitates green supply chain management by tracking the environmental impacts of products throughout their lifecycle, thus enabling more efficient environmental management and emission reductions (Jun et al., 2024).

Beyond technology, the rapid growth of the digital economy has transformed business models and advanced the ESG agenda through organizational strategies. The rise of the Internet has diversified business models, and the digital economy fosters ESG development through the distinctive features of the “Internet+” business model:

First, one of the critical characteristics of the Internet+ business model is its platform-based operation, which brings together a wide range of users, suppliers, and service providers through open and shared platforms. This enables the optimal allocation of resources and value creation (Mo et al., 2023). This approach enhances resource efficiency, reduces waste, and minimizes environmental pollution, supporting ESG objectives.

Second, data is central to driving decision-making within the Internet+ business model. By collecting and analyzing user behavior and market trends, companies can better understand market demands, optimize their products and services, manage resources more efficiently, and minimize their environmental impact.

Third, the Internet+ business model encourages cross-border integration and innovation, creating new business models by combining valuable resources from different sectors. This innovation promotes the development and application of green technologies, enhancing the environmental performance of companies (Fatimah et al., 2023).

Lastly, the Internet business model enables companies to offer customized products and services tailored to consumers' needs and preferences, addressing individual demands (Alsayegh et al., 2020). This personalization enhances social welfare and increases the social recognition of companies, further advancing ESG goals.

3. Literature Review and Hypotheses Development

ESG performance revolves around assessing a company's non-financial performance. The "E" stands for the environment, and it means measuring a company's ability to control pollution emissions, use natural resources such as energy and water, and evaluate the impact of its business activities on environmental indicators such as greenhouse gas, carbon footprint, and biodiversity. The "S" focuses on the social aspect and covers a company's performance regarding employee welfare and health, supply chain management, product responsibility, and social welfare. The "G" refers to governance. The section first describes the impacts of digital economy development on the three dimensions of environment, society, and governance based on the existing literature. It proposes relevant hypotheses to be empirically tested. Subsequently, the logic of the literature deduces the role of innovation as a mechanism in the impact process. It proposes different hypotheses on the mechanisms of technological and business model innovation.

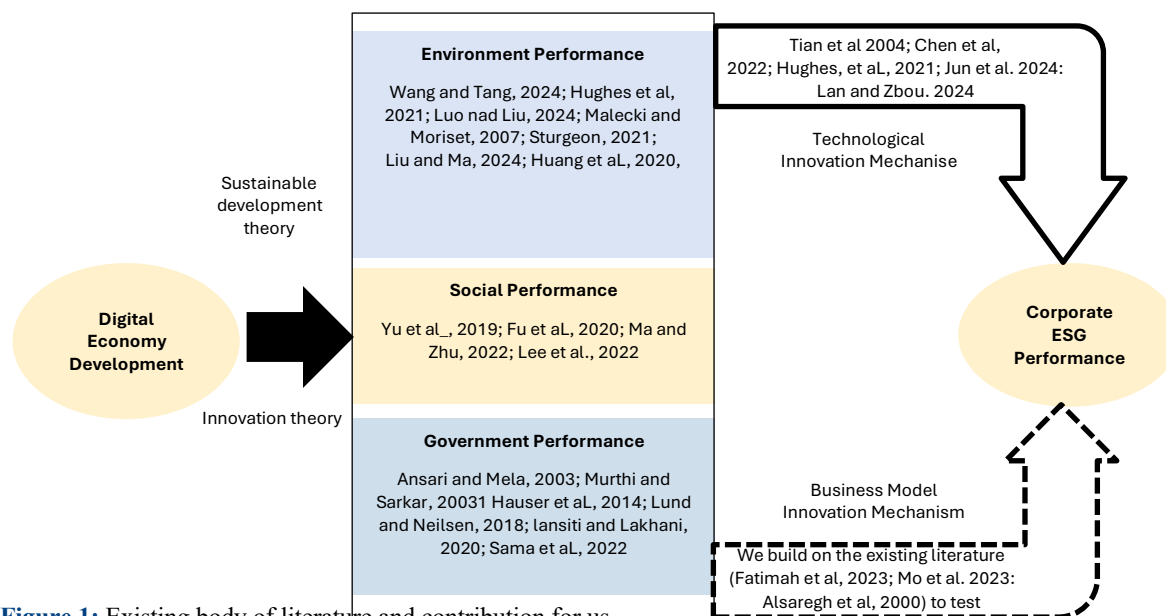


Figure 1: Existing body of literature and contribution for us

3.1. Digital Economy Building Impacts Business Green Performance

Digital economy development facilitates innovation and resource allocation, which in turn promotes green economic efficiency and technological innovation levels (Wang & Tang, 2024). This is due to optimizing innovation activities and processes through information processing capabilities enhanced by digital technologies, leading to shorter innovation cycles and improved conversion efficiency of innovation outcomes (Hughes et al., 2021). The digital economy fosters a collaborative environment among various innovation entities such as enterprises, governments, and universities, ensuring the efficient configuration of innovation resources (Luo & Liu, 2024). This collaboration enhances the ability to conduct strategic experiments, gather market information, and improve the quality and novelty of innovations, all of which contribute to enhanced entrepreneurial performance (Mansouri & Momtaz, 2022).

Moreover, the digital economy boosts green innovation by enabling firms to reduce production costs, improve operational efficiency, and expand their customer base. It attracts investment by optimizing material foundations and environments for green R&D activities and promoting investment aggregation within cities (Malecki & Moriset, 2007). This is further supported by the fact that the digital economy reduces transaction costs and improves market efficiency, breaking down geographical barriers and enhancing the connectivity between different market actors (Sturgeon, 2021).

For regulators, the growth of the digital economy has significantly reduced tracking and verification costs (Liu & Ma, 2024). The digital economy has made it easier for governments, investors, the media, and others to access relevant information on listed companies. This forces companies to take responsibility for environmental issues and avoid polluting emissions, to reduce penalties from governments and public pressure (Huang et al., 2020, 2022).

3.2. Digital Economy and Corporate Social Responsibility

Because digital technology and corporate social responsibility are two hot topics in recent years, we also summarize the studies on the influence of cultural and technological factors on corporate social responsibility. Yu et al. (2019) showed that Culture is a bridge for enterprises to fulfill their social responsibility. Through cultural construction, enterprises have narrowed the gap in employee remuneration and made the distribution of resources more equitable. Enterprises in areas with strong traditional and regional cultures, who have spread their cultures to the grassroots level of their organizations through technological developments, have increased their incentives to give back to society through charitable giving (Yu et al., 2020).

Ma and Zhu (2022) used Chinese data to examine the relationship between the digital economy and high-quality green development. They suggested that the digital economy can directly drive high-quality green development, and industrial structure adjustment and green technology innovation are significant mediators. Lee et al. (2022) proposed that a firm's brand value is heavily affected by the ESG achievement of an interconnected environment.

3.3. Digital Economy and Corporate Governance

Many scholars support the role of the digital economy in corporate governance, especially in reducing governance costs. Ansari and Mela (2003), Murthi and Sarkar (2003), and Hauser et al. (2014) explained that digital activities are always automatically recorded and stored. Thus, the tracking costs significantly decrease via a digital economy platform. Goldfarb and Tucker (2019) pointed out that a digital economy platform could create new opportunities for marketers in promotion, pricing, and product offerings.

With the rapid development of digital platform construction, the governance of digital services has attracted the attention of the whole society. As a result, information disclosure, intellectual property rights, and data security systems have been gradually emphasized in recent years. These help release the information asymmetry among government, companies, and investors and promote firms' sustainable growth (Lund & Neilsen, 2018). Iansiti and Lakhani (2020) showed that digital platforms can significantly lower the restrictions on scale, scope, and learning through artificial intelligence technology. Sama et al. (2022) proposed that corporate governance based on digital technologies resolves the problems among consumers, employees, and other salient stakeholders, while increasing the firm's emphasis on truthful disclosures, enhanced transparency, improved equitable allocation of organizational resources, and heightened trust relationships.

In summary, From the above analysis, it can be seen that the rapid development of the urban digital economy has enabled firms to gain more technological advances, reduce the cost of handling or participating in social activities, and improve the efficiency of corporate governance, thus ultimately enhancing corporate ESG performance. Therefore, the following Hypothesis 1 is proposed for empirical testing:

H1: *The rapid growth of the digital economy has boosted companies' ESG performance.*

3.4. Digital Economy, Technological Innovation, and Corporate ESG Performance

There is a positive correlation between a firm's ESG performance and its level of green technological innovation (Tian et al., 2024). Companies motivated by market pressures are incentivized to engage in green innovation to align with investor values and norms, thus achieving higher market evaluations and maintaining a favorable corporate image in the context of the widespread adoption of green development concepts. Additionally, solid social responsibility performance facilitates stable relationships with stakeholders, enabling companies to secure resources necessary for innovation activities and bolstering competitive advantages (Chen et al., 2022). Digital technology can help enterprises achieve energy conservation and emission reduction, for example, by optimizing energy consumption through intelligent control systems and adopting renewable energy and other measures to reduce carbon emissions (Hughes et al., 2021). In addition, digital technology can also promote green supply chain management, tracking the environmental impact of products throughout the supply chain through digital means to achieve more efficient environmental management and emission reduction (Jun et al., 2024).

The application of digital technology in governance is mainly reflected in enhancing governance efficiency and transparency. For example, blockchain technology realizes the non-tampering and transparent sharing of information and improves the fairness and transparency of governance. In addition, digital technologies can also promote digital transformation within enterprises (Lan & Zhou, 2024), for example, by optimizing the decision-making process and improving governance efficiency through technologies such as artificial intelligence and extensive data analysis. Therefore, Hypothesis 2, which is subject to empirical testing, is proposed:

H2: *Technological innovation plays a mechanistic role in developing the digital economy for corporate ESG performance.*

Currently, most academic research starts with the technical aspects of the digital economy to analyze the role of the development of the digital economy in promoting corporate ESG. However, few scholars have observed that the arrival of the digital economy era has also changed enterprises' business model. In addition to technology, the rapid development of the digital economy has changed companies' business models and facilitated the ESG process at the level of organizational approach (Fatimah et al., 2023).

The emergence of the Internet has diversified enterprises' business models. The digital economy can promote the development of enterprise ESG because the characteristics of the business model of the Internet+ promote the development of enterprise ESG. The intersection of the digital economy and corporate ESG performance is dynamic and multifaceted. Companies that effectively integrate digital tools into their business models can enhance ESG performance, meet stakeholder expectations, and create long-term value. As business models evolve, their role in shaping sustainable business practices and enhancing corporate accountability will only grow (Mo et al., 2023).

Under the Internet business model, enterprises can provide customized products and services according to consumers' needs and preferences to meet their individual needs (Alsayegh et al., 2020). This model helps to improve social welfare and enhance the social recognition of enterprises. Therefore, Hypothesis 3, which is subject to empirical testing, is proposed:

H3: *Business Model Innovation as an Influential Mechanism of Digital Economy Development for Corporate ESG Performance.*

4. Methodology

4.1. Research Context

Based on the above analysis, the inherent relationship between digital economy development and sustainability

requires further empirical testing. In recent decades, China has emphasized improving the digital economic attributes at the city level (Guo et al., 2020), such as digital infrastructure (Pan et al., 2022), digital technology innovation (Cai & Zhu, 2020), and digital network development (Pan et al., 2021) resulting in fiber optic network available in all cities and more than 450 million people easily access to 5G net. Specifically, it is assumed that constructing a city's digital platform will significantly reduce the cost of incident tracking and handling and corporate governance processes for companies in the region (Pan et al., 2022). Therefore, the paper considers whether firms headquartered in the city with a digital economy platform can enhance their ESG performance. More importantly, we explore what the underlying mechanisms could be.

4.2. Empirical Design

We empirically tested the following model specification to formally investigate the relationship between digital economy platform construction and corporate ESG performance.

$$esg_{it} = \beta_0 + \beta_1 digital_{it} + \mathbf{X} \cdot \boldsymbol{\gamma} + city_i + year_t + u_{it} \quad (1)$$

In model (1), the dependent variable *denotes the ESG performance of publicly listed firm i* at year *t*. In line with Tang (2022) and Broadstock et al. (2021), we proxy the performance using the rating data from the SynTao Green Finance database, which contains both an overall ESG indicator and sub-indicators for each of the three aspects in the overall rating. Moreover, SynTao provides more than 80 detailed component scores to compute these indicators. This enables us to dig deeper into the mechanisms through which the digital economy can affect corporate ESG performance. The scores (0–100) of the overall ESG rating *esg* and the three sub-indicator scores of environmental, social, and governance are directly used as our proxies for non-financial corporate performance.

Digital is the independent variable in the model (1), which reflects the digital economy platform construction level in cities. Liu (2020) and Pan et al. (2021) obtained the provincial level of digital economy development indicators using a weighting and an entropy value method, respectively. In order to further measure the development of digital economy platforms in detail in different regions, Pan et al. (2022) and Zhao Tao et al. (2020) constructed digital economy platform variables using the principal component analysis method.

Based on this, the paper refers to the Pan et al. (2022) and Zhao Tao et al. (2020) studies and selects the Peking University Digital Inclusive Finance Index (Guo Feng et al., 2020), the per capita income of telecommunication business, the ratio of information transmission computer services and the software employees to urban employees, the number of Internet broadband access users per 100 people, and the number of cell phone users per 100 people as measurement indicators, and added elements reflecting scientific research and education—the number of general higher education schools and public library book collections—and reduced the dimensionality of the above seven indicators through the factor analysis method advocated by MacCallum (1999). This obtained the final level of the digital economy platform construction variable, *digital_{it}*. To test the robustness of the empirical results, the principal component analysis and entropy value method were used for dimensionality reduction synthesis to obtain the other variables—*digitals* and *digitale*.

Following Feng et al. (2022) and Takahashi and Yamada (2021), *x* is a vector containing firm-level control variables in five aspects: size, age, financial performance, financial leverage, and market concentration. Their proxies are calculated in Table 1. In the robustness test section, we added macro- and city-level variables, such as the economic policy uncertainty index and the natural logarithm of the city's GDP population growth rate, to mitigate the potentially omitted variable bias. All of the above control variables have been used extensively in the prior literature, controlling for the current status of firms in other parts of their production operations. The fixed effect variables are *firm*, which denotes regional dummies, and *year*, which denotes year dummies. Finally, *u* is the usual random disturbance term.

Table 1: Variable list

	Variable	Variable Construction	Data Sources	Purports to Measure...
Dependent Variables	Esg			Integrated corporate environmental, social, and governance performance evaluated by scores
	Environment	Score	SynTao Green Finance Database	Corporate environmental performance evaluated by scores
	Social			Corporate social performance evaluated by scores
	Governance			Corporate governance performance evaluated by scores
Main Explanatory Variables	Digital _f	Indicators obtained by factor analysis	Peking University Digital Inclusive Finance Index	Indicators of digital economy platform construction in cities where listed companies are located
	Digital _p	Indicators obtained by principal component analysis	China City Statistical Yearbook	
	Digital _e	Indicators obtained by entropy method		

	Variable	Variable Construction	Data Sources		Purports to Measure...	
Mechanism Variables	Patent	Number of patents	CSMAR database		technological innovation	
	Model				business model innovation	
Control Variables	Lngdp	The natural logarithm of GDP of the city where the publicly listed company is in	China Statistical Yearbook	City	Regional development	economic
	Poprate	Population growth rate in the city where the publicly listed company is in				
	Uncertain	Economic uncertainty index	Economic Uncertainty Database	Policy	The overall economic environment caused by policies	
	Size	The natural logarithm of total assets	CSMAR database		Primary operation conditions and financial positions of publicly listed companies	
	Age	The year of the observation of a publicly listed company minus the year when it was established				
	Roa	Return on assets				
	Debt	Total liabilities divided by total assets				
	Hhi	Herfindahl Index				

Source: Calculated by the author

Based on the analysis of our mechanism, the construction of the digital economy platform has substantially improved the city's hardware. This has improved the operational efficiency of enterprises in the district, enriched their operational means, and reduced their operational costs. The most significant benefit of hardware improvement is the enterprise's transaction processing capacity.

In addition, the rapid development of the digital economy has also had a great impact on enterprises' business models. With the popularization of new business models and business concepts, enterprises' ESG performance will also change. Therefore, to test the two mechanisms proposed in Hypothesis 2 and 3, we conducted the following tests using data on patents and business model innovation.

$$esg_{it} = \alpha_0 + \alpha_1 digital_{it} + X \cdot \gamma + city_i + year_t + u_{it} \text{ if } patent > 0, \quad (2)$$

$$esg_{it} = \alpha_0 + \alpha_1 digital_{it} + X \cdot \gamma + city_i + year_t + u_{it} \text{ if } patent = 0, \quad (3)$$

$$esg_{it} = \alpha_0 + \alpha_1 digital_{it} + X \cdot \gamma + city_i + year_t + u_{it} \text{ if } model > median \quad (4)$$

$$esg_{it} = \alpha_0 + \alpha_1 digital_{it} + X \cdot \gamma + city_i + year_t + u_{it} \text{ if } model \leq median \quad (5)$$

In models (2) to (5), mechanisms were tested using a group approach based on Gompers et al. (2022). The mechanism variable "patent" represents the number of patents obtained by the enterprise in a given year. In contrast, the "model" variable refers to the score of the business model, which is constructed according to business model theory. Specifically, the business model innovation score is primarily based on the classic "six elements" business model theory (Wei et al., 2012).

The selected indicators are as follows: the ratio of sales to the top five customers and the ratio of purchases from the top five suppliers to reflect user orientation; the inventory turnover ratio and accounts receivable turnover ratio to reflect the business system; the return on assets and financial leverage to reflect profitability; the ratio of R&D expenses to operating revenues to reflect the ability of crucial resources; cash flow structure; basic earnings per share to represent the earnings model; and Tobin's Q value and the ACF method to reflect business model innovation. Factor analysis reduces the dimensionality of all the indicators reflecting the six factors. to (5), Based on Gompers et al. (2022), mechanisms were tested using a group approach. The mechanism variable *patent* is the number of patents obtained by the enterprise in that year. The *model* is the score of the business model constructed according to the business model theory.

4.3. Sample Selection and Data Sources

The sample used in this paper contains 387 listed companies in the CSI 300 Index across 107 cities in 29 Chinese provinces. The sample period spanned from 2015 to 2019. The data used in estimating the level of construction of the digital economy in cities came from the China City Statistical Yearbook and the Peking University Digital Inclusive Finance Index. The digital economy platform located in the firm's headquarters city might be the most direct way to improve ESG performance from the perspective of a cost and-benefit analysis conducted by a firm. The benefits of the improved hardware are most notable in the ability of the business to handle problems.

At the same time, the reason for choosing CSI 300 listed companies is that CSI 300 listed companies are the earliest economic entities among all kinds of enterprises in China to start practicing ESG concepts and have already achieved initial results, at the same time, CSI 300 listed companies are the core cells of China's economy and the

leaders of various industries, so the selection of CSI 300 listed companies as the object of the study is of typical representative significance. In addition, the Business Gateway to Green Database only presents the overall ESG performance data of CSI 300 listed companies and the sub-indicators of environment, society, and government in 2015. More data on listed companies will not be available until 2021, so in order to ensure the availability and continuity of data, we choose to focus on CSI 300 listed companies as the research object.

The research interval is from 2015 to 2019 because the ESG evaluation of CSI 300 listed companies in the SynTao Green Finance database started in 2015, while the outbreak of the new crown epidemic in 2020 will have a huge impact on the operation and development of Chinese companies. To ensure the availability and smoothness of data, 2015 to 2019 was finally chosen as the research interval.

In summary, our sample was derived from five datasets: the SynTao Green Finance database, the China Stock Market & Accounting Research Database (CSMAR), the Peking University Digital Inclusive Finance Index, the China City Statistical Yearbook, and the Economic Policy Uncertainty Database (Baker et al., 2015). Among them, the ESG ratings and detailed component scores of the CSI 300 listed companies from 2015 to 2019 were taken from the SynTao Green Finance database.

The sample firms' financial information, office addresses, and other firm-level control variables were sourced from CSMAR. The authors used this database to construct relevant corporate financial indicators. The GDP data for the provinces and cities where the listed companies are located were obtained from the annual *China City Statistical Yearbook*, and the policy uncertainty index can be found in the *Economic Policy Uncertainty Database*.

This paper also follows the standard procedure to clean the sample of a Chinese publicly listed company. The data cleaning process goes as follows. First, we excluded *ST, ST, and stocks that have been delisted. Second, we excluded observations with missing company names or headquarters locations. Then, we deleted firms without financial performance data or a host city's characteristics. Finally, this study did not consider companies in the financial and insurance industry. In the end, there were 1,203 observations, including 387 different listed CSI 300 companies in 107 cities in China. In the robustness check, we also tried a subsample that excluded observations in the manufacturing sector. All empirical analyses conducted in this paper are coded and implemented in STATA 17.

4.3. Endogeneity Concerns and Mitigation Solutions

The potential causes of the endogeneity problem include two-way causality, omitted variables, and measurement errors. To address these issues, we adopted the following methods in this paper to mitigate the bias due to endogeneity problems according to their respective causes.

4.3.1. Two-way causality

Although the strategy of building a digital economy has become a national priority, investment in this area varies by region. The level of development of the digital economy platform is closely linked to the characteristics of each city. Generally, economically developed coastal cities in the eastern region benefit from superior infrastructure, a highly skilled workforce, and institutional stability, which enables them to develop their digital economy platforms more rapidly. These cities also tend to prioritize sustainable development due to their geographical advantages. This relationship creates a bidirectional causal link between the dependent and independent variables.

To address the endogeneity issue, selecting appropriate instrumental variables is essential. These variables must meet two criteria: first, they must be correlated with the digital economy platform development in cities; second, they should be largely independent of the firm's ESG performance. Zhang et al. (2022) suggested that the climatic environment of cities influences the digital economy. Based on this, this paper uses the city's average temperature as one instrumental variable, and the average humidity as another since humidity can impact computers' operational lifespan and efficiency. Theoretically, these variables affect the digital economy platform, particularly its infrastructure and equipment operations, but they do not directly influence firm performance, thus fulfilling both criteria for valid instrumental variables.

The tests on the instrumental variables show that they passed the under-identification and weak instrument tests at the 1% significance level, confirming the model's endogeneity and the correlation between the instrumental and independent variables. Additionally, the instrumental variables could not reject the null hypothesis of over-identification at the 10% significance level, validating their exogeneity.

4.3.2. Omitted variables

If certain variables affecting ESG performance are omitted from model (1), they will be included in the random disturbance term, leading to correlations between dependent variables and error terms. This may violate the regression assumption and cause another type of endogeneity problem. According to Pan et al. (2022), regional and macroeconomic factors should be considered when investigating firm behavior. Therefore, our empirical models control for the natural logarithm of regional GDP, the population growth rate, and the economic policy uncertainty index.

4.3.3. Measurement error

We used principal component analysis and the entropy method to test robustness to measure the construction of a digital economy platform using different proxies, in addition to factor analysis for dimensionality reduction. These three methods are currently the most mainstream methods for constructing metrics through dimensionality reduction. The methods can mitigate the measurement error by validating the results using alternative measures. Sample selection error can also lead to endogeneity, but this concern was dealt with by distinguishing different regions,

different industries, and different nature of property rights in the sample.

4.3.4. Alternative specification

The Hausman test statistics show that, when comparing the fixed effect model (FE) and the mixed least squares (PLS) specification, the original hypothesis of no systematic differences can be rejected at the 1% significance level ($p = 0.000$). The same applies to comparing the FE and random effects model at the 1% significance level ($p = 0.0104$). Therefore, based on the above test results, the FE setup was chosen as the baseline technique for this paper. We also included the PLS specification and year dummies to control for the regional and time-fixed effects. To ensure the robustness of the results, the FE and PLS methods were also used in this paper for the econometric robustness tests.

The sample used in this paper comprises 387 firms and covers the period from 2015 to 2019. This requires considering heteroskedasticity and autocorrelation. We deal with these issues by using Driscoll–Kraay robust standard errors. All main variables are winsorized at the top and bottom 0.5% level in their distributions to mitigate the effect of outliers.

5. Results

5.1. Descriptive Statistics

Table 2 presents the summary statistics for each variable. The average corporate ESG performance score is 47.825, with the average scores for listed companies' environmental, social, and governance dimensions from 2015 to 2019 being 47.704, 52.411, and 43.124, respectively. The corresponding standard deviations range from 5.4 to 8.2, indicating a relatively small degree of dispersion. This suggests two key points: first, the social aspect of ESG performance is more vital than the environmental and governance aspects for CSI 300 listed companies; second, there is considerable variation in ESG scores across different companies. Therefore, identifying the factors that drive ESG performance is crucial. This paper focuses on the role of digital technology, as represented by the development of digital economic platforms.

Table 2 shows that the average level of digital economy platform development in the cities where CSI 300 listed companies are located is approximately 2.327, with the maximum value reaching 7.262. There is significant variation in digital economy platform construction across major Chinese cities, with the cities having the most advanced platforms outperforming the average by about three times. The median levels obtained through principal component analysis and the entropy method are 2.375 and 0.291, respectively. Regardless of the method used, the development of digital economy platforms varies across cities, and using different construction methods ensures the robustness of the empirical results.

There is a strong connection between enterprises' development philosophy and the infrastructure of their cities. The construction of a digital economy platform clearly reduces companies' governance costs. This paper investigates how the level of platform development influences enterprises' performance.

Table 2: Descriptive statistics

Variable	No. of Obs.	Mean	Std. Dev.	Min	25 th	Median	75 th	Max
Esg	1203	47.825	5.496	36.380	44.130	46.880	51.000	65.130
Environment	1203	47.704	8.153	28.480	42.530	46.710	51.900	71.750
Social	1203	52.411	6.416	30.510	48.510	52.270	56.060	70.590
Governance	1203	43.124	7.400	25.450	38.100	43.030	47.770	62.500
Digitalf	1203	2.327	1.780	-0.597	0.835	2.310	3.682	7.262
Digitalp	1203	2.698	2.395	-0.674	0.348	2.375	4.455	7.083
Digitale	1203	0.281	0.144	0.044	0.139	0.291	0.416	0.486
Size	1203	24.557	1.346	21.423	23.564	24.382	25.549	28.253
Age	1203	18.414	5.596	7	15	18	22	34
Roa	1203	0.059	0.056	-0.134	0.022	0.046	0.088	0.24
Debt	1203	0.501	0.199	0.043	0.351	0.515	0.662	0.894
Hhi	1203	61.16	16.39	21.1	50.99	61.643	73.319	95.173
High	1203	20.499	3.588	9.167	18.008	20.475	21.575	29.926
Humidity	1203	68.535	10.896	43.419	56.44	74.042	77.789	84.174
Uncertain	1203	2.125	0.985	0.921	1.293	2.066	2.778	3.634
Lngdp	1196	9.322	1.056	6.238	8.593	9.713	10.201	10.549
Poprate	1202	6.047	6.199	-3.150	1.060	4.960	8.530	25.180
Patent	1203	286.165	1183.925	0	0	0	104	17656
Model	1179	-0.165	0.745	-1.920	-0.614	-0.252	0.185	3.268

Source: Calculated by the author

Turning to mechanism variables, we can see that the CSI 300 companies' environmental performance generally receives the highest score on adverse environmental events. (A larger score equates to fewer negative events disclosed.) Energy savings, emission reduction, and environmental regulations follow this. Similarly, as for the

corporate governance aspect of corporate non-financial performance, negative governance events display the highest score, followed by the information and supervision sub-component, and then by corporate governance rules. These results indicate a low probability of negative governance events among companies listed in the Shanghai and Shenzhen stock exchanges. Besides, although these companies have made efforts to enhance information transparency, promulgate regulations, and strengthen corporate governance, a large room still exists for further improvement.

Finally, the descriptive statistics of our control variables tell us that the size, age, return on assets, leverage ratio, and Herfindahl indicator differ across the CSI 300 listed companies. The GDP of the sample cities also exhibits unbalanced trends in the time and geographical dimensions. Nevertheless, the means and standard deviations of each variable in Table 2 reveal that the observations of the CSI 300 listed companies used in the sample suffer from no outlier problems after Winsorization.

5.2. Baseline Regression Results

At the firm level, Table 3 reports the estimated impact of the digital economy platform construction level on the ESG performance of CSI 300 listed companies. In terms of the overall ESG score, constructing the city's digital economy platform can improve enterprises' ESG performance. A higher level of digital economy in a city can improve the ESG performance of the companies in that city. Irrespective of including firm-level controls and year-fixed effects, our results remained significant at the 1% significance level. To get a sense of the magnitude of the coefficients, when all controls and fixed effects are included, the digital economy platform construction level improves by one unit in the city where the CSI 300 listed company is located, which will increase the nearby firms' ESG performance score by about 0.338 on average. If the performances on the environmental, social, and governance aspects are evaluated separately, an increase in the level of digital economy platform construction in the home city of a CSI 300-listed company will boost the company's ESG performance score at the 1% significance level in the environmental and governance aspects but not in the social aspect. Regarding the R^2 figures in Table 2, our model's explanatory power has significantly improved after adding the year and province fixed effects. The overall level of goodness of fit is between 0.1 and 0.25.

Table 3: Baseline results

Variable	(1) ESG	(2) ESG	(3) ESG	(4) Environment	(5) Social	(6) Governance
Digitalf	1.367*** (5.271)	0.441*** (9.802)	0.338*** (5.209)	0.617*** (2.866)	-0.176 (-1.362)	0.516*** (3.625)
Size		0.0760 (0.167)	0.0260 (0.055)	-0.544 (-0.852)	0.0280 (0.051)	0.875*** (3.936)
Age		0.953*** (5.726)	1.367*** (5.682)	3.819*** (15.531)	0.925*** (4.261)	-1.468* (-1.923)
ROA		1.147 (1.463)	2.253*** (3.620)	-2.156** (-1.995)	-0.228 (-0.321)	9.950*** (4.922)
Debt		0.844 (0.727)	1.052 (0.904)	0.944 (0.722)	-0.650 (-0.938)	2.123 (1.038)
HHI		-0.031*** (-2.662)	-0.024* (-1.885)	-0.0250 (-1.468)	-0.087*** (-4.561)	0.040*** (2.997)
Cons	44.643*** (314.609)	28.808*** (3.696)	23.349*** (2.831)	-2.981 (-0.256)	40.949** (2.561)	38.843*** (4.465)
year fixed effect	NO	NO	YES	YES	YES	YES
No. of obs.	1203	1203	1203	1203	1203	1203
R^2_w	0.038	0.227	0.249	0.145	0.120	0.167

Note: ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively, and the t-values of double-tailed tests are included in parentheses. This notation applies to all tables below.

The results presented in Table 3 provide supportive evidence for the theoretical part of Hypothesis 1: The rapid growth of the digital economy has boosted companies' ESG performance. At the same time, the results also imply that the boosting effect of a digital economy on corporate ESG is heterogeneous in the environmental, social, and governance aspects. On the one hand, constructing a city's digital economy tends to be in an excellent ecological environment. By visiting them, the rapid growth of the city's digital economy has empowered companies to deal with environmental issues more efficiently. When a potential negative environmental event arises, companies are the first to be alerted, and they subsequently make timely remedial measures, which nips the problem in the bud.

On the other hand, while the environmental and governance aspects emphasize the cost side of firm operations, the social aspect relates more to the revenue side. Let us first consider the environment and governance. By saving energy and reducing emissions and by disclosing information and regulations more effectively, enterprises can significantly reduce the behaviors that generate negative externality. In contrast, firms will benefit from generating positive externalities by assuming social responsibilities such as improving employee rights and making charitable

donations. Ordinarily, realizing a positive externality takes a bit of time, and the realized outcome is also prone to fluctuations due to non-controllable factors. Therefore, the positive contribution of the construction of a digital economy to a nearby firm's social aspect performance is not as significant as the contributions made to the environmental and governance aspects.

The results of the benchmark regressions in this paper support the vast majority of scholars' views on the existence of a positive impact of digital economy development on ESG when compared to the prior literature (Yu et al., 2020; Wang & Tang, 2024). However, on the three different components of ESG, this paper finds that urban digital economic development significantly impacts both the environment and governance, but not social. This goes to the other literature, where there is a difference. As mentioned above, the performance of companies in the social domain needs more time to accumulate and has a limited effect in the short term. In future research, the sample interval can be extended further while the study's dynamic nature can be considered.

The coefficients of the firm-level controls in Table 3 show that corporate ESG performance increases with firm age and returns on assets and decreases with market concentration. These results are significant at least the 10% level of significance. In contrast, firm size and financial leverage do not significantly affect corporate ESG performance. These findings indicate that, for CSI 300-listed companies, older and better-performing companies pay more attention to improving their ESG score, and companies with low market concentration have better ESG performance. These findings are also generally consistent with existing studies.

Notably, a significant positive relationship exists between age, return on assets, and corporate ESG performance. This corroborates the results of the systematic generalized method of moments from the study by Naffa and Fain (2021). This positive association is because the CSI 300-listed companies are all large blue-chip companies. Blue-chip companies with longer histories and higher asset returns are more focused on corporate sustainability. They will devote more resources to the company's various ESG operations.

5.3. Robustness Tests

5.3.1. Alternative variables and alternative methods

Table 4 reports the estimation results using different notations of dependent variables and regression methods. From the first two columns in Table 4, it can be seen that no matter which methods of dependent variable construction are used—the principal component analysis or entropy method—the level of digital economy platform constructed by a city with listed CSI 300 companies is always positively correlated with these companies' ESG performance at least the 5% significance level. The last three columns of Table 4 show that this positive relationship is significant at the 10% level using the pooled least squares method with factor analysis and principal component analysis. These results once again validate the statement in Hypothesis 1. Hence, our findings are robust to alternative dependent variables using methods and empirical methodologies.

Table 4: Results with alternative empirical setups

	(1)	(2)	(3)	(4)	(5)
	Alternative	ways	of	Alternative	empirical methods
Variable	PCA	ENTROPY	PLS+FACTOR	PLS+PCA	PLS+ENTROPY
Digitalp	0.094** (2.145)			0.238* (1.741)	
Digitale		5.883*** (4.264)			3.742 (1.580)
Digitalf			0.289** (1.971)		
Size	0.0480 (0.105)	0.0220 (0.046)	1.039*** (5.686)	1.030*** (5.646)	1.039*** (5.701)
Age	1.533*** (6.110)	1.442*** (6.178)	0.058* (1.878)	0.060* (1.920)	0.057* (1.835)
ROA	2.294*** (3.544)	2.284*** (3.598)	-4.574 (-1.466)	-4.696 (-1.501)	-4.716 (-1.509)
Debt	0.853 (0.715)	0.945 (0.791)	0.038 (0.033)	0.065 (0.056)	0.008 (0.007)
HHI	-0.021* (-1.807)	-0.023* (-1.764)	0.010 (0.845)	0.009 (0.820)	0.009 (0.832)
Cons	20.530*** (2.679)	21.353** (2.556)	24.573*** (5.956)	24.823*** (6.017)	23.997*** (5.737)
year fixed effect	YES	YES	YES	YES	YES
province fixed effect	NO	NO	YES	YES	YES
No. of obs.	1203	1203	1203	1203	1203

	(1)	(2)	(3)	(4)	(5)
	Alternative	ways	of	computing	Alternative empirical methods
Variable	PCA	ENTROPY	PLS+FACTOR	PLS+PCA	PLS+ENTROPY
R^2/R^2_w	0.247	0.249	0.252	0.252	0.252

Source: Calculated by the author

5.3.2. More controlling variables and instrument variables

Table 5 reports the regression results using more controlling variables. It also considers instrument variables to release endogeneity issues caused by omitted variables and two-way causality. In the first five columns of Table 5, we add more control variables, considering the city's log GDP, *lngdp*; population growth rate, *poprate*; and the economic uncertainty index, *uncertain*. The intention is to release potential endogeneity problems associated with omitted variables by adding controlling variables at the regional and macro levels. The results show that the increase in the level of digital economy platform construction by a city with CSI 300-listed companies still significantly improves the ESG performance of the firms at the 1% significance level. Meanwhile, the positive contribution of constructing a digital economy platform to a nearby firm's environmental and governance performance is more significant than the contributions made to the social aspect.

The results in the last column show the regression results using a city's mean annual maximum temperature and mean annual humidity as instrumental variables. The results of the regression using instrumental variables can be seen. The digital economy platform level constructed by a city with CSI 300-listed companies is always positively correlated with these companies' ESG performance at the 5% significance level. This is consistent with the ideas in Hypothesis 1. These two results utilize different approaches to variable construction to mitigate the potential endogeneity issues associated with omitted variables and mutual causality.

Table 5: Results of additional control variables and IV

	(1)	(2)	(3)	(4)	(5)	(6)
Variable	<i>esg</i>	<i>esg</i>	<i>environment</i>	<i>social</i>	<i>governance</i>	<i>esg</i>
Digitalf	0.338*** (5.209)	0.238*** (4.238)	0.643*** (2.887)	-0.279* (-1.829)	0.269* (1.941)	1.982** (1.975)
Size	0.0260 (0.055)	0.0210 (0.045)	-0.521 (-0.785)	0.00400 (0.006)	0.860*** (4.340)	-0.135 (-0.239)
Age	1.367*** (5.682)	1.356*** (5.594)	3.747*** (15.272)	0.913*** (3.796)	-1.403* (-1.822)	0.530 (0.466)
ROA	2.253*** (3.620)	2.704*** (5.110)	-1.757** (-2.402)	0.536 (0.805)	10.072*** (7.313)	2.225 (0.653)
Debt	1.052 (0.904)	1.117 (0.886)	1.097 (0.794)	-0.257 (-0.331)	1.671 (0.840)	2.388 (1.095)
HHI	-0.024* (-1.885)	-0.028** (-2.292)	-0.031** (-1.974)	-0.091*** (-5.268)	0.040*** (3.274)	-0.0320 (-1.110)
Uncertain	-0.629** (-2.139)	-0.757** (-2.439)	-4.087*** (-13.802)	-0.278 (-0.680)	3.214*** (2.890)	
LNGDP		0.936*** (3.490)	-0.159 (-0.399)	1.088*** (7.709)	2.064*** (3.956)	
Poprate		0.077*** (3.763)	0.078*** (2.607)	0.052*** (5.156)	0.105** (2.357)	
Cons	23.928*** (2.870)	15.735** (2.127)	2.626 (0.254)	32.014* (1.955)	16.525* (1.722)	37.280 (1.582)
year fixed effect	YES	YES	YES	YES	YES	YES
No. of obs.	1203	1195	1195	1195	1195	1203
R^2_w	0.249	0.252	0.145	0.122	0.174	0.202

Source: Calculated by the author

5.3.3. Tests for Underlying Mechanisms

Tests of the impact mechanisms of technological innovation and business model innovation are reported in Table 6. As seen in the table's first two columns, the digital economy can enhance firms' ESG performance both in the sample with patents and without patents. In comparison, the significance of this result is higher in the sample with patents. The last three columns of the table show that the digital economy improves firms' ESG performance in the sample with higher scores on business model innovation. In comparison, the result is insignificant in the sample with lower scores. This suggests that while technological innovation and business model are influential mechanisms through

which the digital economy affects firms' ESG performance, the role of business model innovation is more pronounced. Hypothesis 3 is validated.

Technological innovation has long been the mechanism by which the existing literature has argued that the digital economy's development is why it affects firms' ESG performance (Hughes et al., 2021; Jun et al., 2024). Green technologies, green patents, and green designer technological innovations have the most direct effect on firms by driving their scores on environmental indicators. However, the results in Table 7 show that the benefits of the digital economy are not only in terms of technology but also in terms of positioning, business systems, profitability models, resources, cash flow, and enterprise value, to varying degrees, and that they enable firms to have better business models and ultimately better sustainability performance. Of course, each enterprise's business model is not the same. If we want to observe the heterogeneity of each enterprise's business model, we need to conduct another case study of each enterprise, which is a direction for future research.

Table 6: Mechanism Exploration

	(1)	(2)	(3)	(4)
Variable	<i>patent</i> >0	<i>patent</i> =0	<i>High business model score</i>	<i>Low business model score</i>
Digitalf	0.296*** (5.905)	0.309*** (3.043)	0.517*** (4.964)	0.0960 (0.967)
Size	0.896*** (11.468)	-1.958*** (-4.760)	-0.826** (-2.238)	0.114 (0.132)
Age	-0.419 (-1.309)	-1.138** (-2.099)	4.181*** (7.159)	1.646*** (13.116)
ROA	-0.948 (-0.568)	3.969*** (4.005)	5.350*** (3.259)	-15.223*** (-10.555)
Debt	-2.367** (-2.099)	3.408 (0.662)	3.261** (1.989)	-3.362 (-1.524)
HHI	0.009** (2.118)	-0.018* (-1.812)	-0.043** (-2.163)	0.0130 (0.503)
Cons	31.870*** (5.390)	110.649*** (6.872)	0.000 .	16.71 (0.941)
year fixed effect	YES	YES	YES	YES
No. of obs.	579	624	613	590
R ² _w	0.064	0.194	0.261	0.248

Source: Calculated by the author

Table 7 reports the results of the empirical model's heterogeneity analysis. The first two columns show the difference in the significance of the relationship between the construction of a digital economy and the company's ESG performance among enterprises with varying property rights. The ESG performance of both SOEs and non-SOEs is enhanced with the construction of a digital economy, but the effect on non-SOEs remains significant at the 1% level. In comparison, the effect on an SOE is insignificant at the 10% level.

The main reason is the inherent relationship between the SOEs. On the one hand, they have a more vital ability to handle negative events; on the other hand, they are more resistant to shocks than non-SOEs. Non-state-owned enterprises are more focused on the impact of negative events. If their ability to handle them substantially improves, their ESG performance will take a qualitative leap forward.

Table 7: Heterogeneity Analysis

	(1)	(2)	(3)	(4)	(5)	(6)
Variable	SOE	Non-SOE	Manufacturing industry	Other industries	Eastern region	Midwestern region
Digitalf	0.138 (0.912)	0.508*** (3.447)	0.824*** (4.811)	-0.183 (-1.047)	0.215*** (2.703)	0.844 (1.215)
Size	2.015*** (2.787)	-0.664* (-1.924)	1.015*** (4.816)	-1.587 (-1.535)	-0.558 (-0.759)	1.348*** (8.879)
Age	2.490*** (6.917)	-3.244*** (-16.921)	-1.056 (-0.740)	1.888*** (9.471)	1.286*** (7.770)	1.152*** (7.389)
ROA	-6.492*** (-8.995)	4.647*** (4.724)	1.069 (0.827)	4.969*** (10.262)	3.517* (1.961)	0.0870 (0.017)
Debt	-2.302 (-1.395)	2.783* (1.846)	1.240 (1.287)	0.228 (0.097)	1.006 (0.551)	-0.936 (-0.681)
HHI	-0.112***	-0.009	0.002	-0.073***	-0.003	-0.107***

	(1)	(2)	(3)	(4)	(5)	(6)
Variable	SOE	Non-SOE	Manufacturing industry	Other industries	Eastern region	Midwestern region
	(-4.201)	(-0.494)	(0.139)	(-4.751)	(-0.144)	(-3.405)
Cons	-36.495***	110.766***	37.855*	58.911***	38.215**	0.000
	(-3.635)	(10.912)	(1.820)	(2.834)	(2.546)	(0.000)
year fixed effect	YES	YES	YES	YES	YES	YES
No. of obs.	680	523	613	590	912	291
R ² _w	0.272	0.252	0.259	0.273	0.230	0.327

Source: Calculated by the author

Columns (3) and (4) of Table 7 show the difference in the significance of the relationship between the construction of a digital economy and the company's ESG performance between manufacturing and other industries. The effect of the digital economy is more significant for CSI 300 companies in the manufacturing industries than in other industries. The main reason is the higher proportion of manufacturing companies listed in the CSI 300.

Columns (5) and (6) of Table 7 show that the difference in the significance of the relationship between the construction of the digital economy and the company's ESG performance among different regions is more significant. The effect of the digital economy is significantly pronounced for CSI 300 companies in the eastern region.

The possible reason is that the construction of the digital economy and CSI 300 companies in the eastern region are much more extensive than that in the central and western regions, resulting in the digital economy growing more rapidly and, thus, a high awareness of ESG for companies in eastern regions. Therefore, the effect of the digital economy platform on corporate ESG performance is more significant.

To summarize, the results from Table 2 to Table 6 not only validate the main hypothesis of this paper, which is that the construction of a digital economy platform enhances corporate ESG performance, but also reveal two impact mechanisms of this enhancement: an ability to process the adverse environmental and governance events, and the corporate governance system. The paper also utilizes various approaches to mitigate heteroskedasticity, autocorrelation, and endogeneity problems due to mutual causality, omitted variables, and measurement errors; therefore, the results are more robust.

6. Discussion

6.1. Theoretical Implications

This study contributes to the growing literature on the intersection of digital economy platforms and corporate ESG performance. By empirically demonstrating that the construction of urban digital economy platforms enhances ESG performance, particularly in non-state enterprises and specific sectors. Then, the impact of urban digital economy development on both the green and governance aspects of business is more significant, but the impact on society is less pronounced. This result is because by assuming social responsibilities such as improving employee rights and making charitable donations, firms will benefit from generating positive externalities. Ordinarily, realizing a positive externality takes time, and the realized outcome is also prone to fluctuations due to non-controllable factors. This research extends the theoretical understanding of how digital infrastructure influences sustainable development.

6.2. Managerial and Policy Implications

The work in this paper is helpful for investors to 1 understand corporate sustainability and that the growth of the digital economy significantly impacts the environmental, social, and governance performance of firms. By examining this impact, investors can better understand the sustainability performance of firms in the digital economy environment and thus make more informed investment decisions. (2) Assessing investment risks, the digital economy's development may bring environmental and social issues, such as high energy consumption and data security. By studying the impact of the digital economy on ESG, investors can better assess the associated risks and adjust their investment strategies accordingly. (3) Discovering investment opportunities and the positive impact of the digital economy on ESG also deserves attention. For example, digital technology can help companies improve resource utilization efficiency and reduce pollution emissions, thereby improving ESG ratings. Investors can seek investment targets with potential growth by understanding these opportunities.

Studying the impact of the digital economy on ESG is also beneficial to business managers: (1) Grasping the development path of corporate sustainability; by studying the impact of the digital economy on ESG, business managers can understand how the digital economy affects the environmental, social, and governance performance of their companies so that they can formulate appropriate strategies to enhance corporate sustainability. (2) Helps identify management risks; developing the digital economy may bring new environmental, social, and governance risks. By studying these impacts, business managers can better identify and manage these risks to ensure the long-term stable development of their enterprises. (3) Further enhancement of corporate reputation: The development of the digital economy can enhance the social reputation of enterprises, especially in terms of assuming social responsibility and enhancing corporate reputation in the digital transformation process. Business managers can study these impacts and formulate strategies to enhance their companies' social recognition and reputation.

From a policy perspective, the research advocates for government support in developing urban digital economy platforms, emphasizing that such platforms can facilitate corporate responsibility and sustainable practices.

Policymakers should consider fostering environments that promote technological and business model innovation to maximize the positive impacts on ESG performance.

6.3. Limitations and Future Research Opportunities

While this study provides valuable insights, it is not without limitations. The focus on CSI 300-listed companies may limit the generalizability of the findings to smaller or less established firms. Future research could expand the sample to include a broader range of companies across various regions and sectors to validate and extend these results. Additionally, exploring the longitudinal effects of digital economy platform construction on ESG performance could provide deeper insights into the sustainability trajectories of enterprises. Future studies could also investigate the elements of business model innovation that are most effective in enhancing ESG performance and the role of government policies in facilitating these innovations.

7. Conclusion

This paper uses over 80 ESG component indicators to construct an overall ESG score and delves into the influence mechanism of digital economy platform development. The findings confirm that developing a digital economy platform can enhance nearby firms' non-financial performance. This helps illuminate how a city's digital economy development can impact business management practices. To further ensure the robustness of our results, additional tests, such as decomposing ESG indicators, using alternative variables, and validating with different samples, are conducted, addressing potential endogeneity issues and providing valuable insights for future research in related fields.

To examine the impact of digital economy platform construction on corporate ESG performance, this paper proposes that building such platforms improves the ability to address environmental and governance challenges and enhances corporate governance systems, thereby boosting ESG performance. Empirical analysis using data from 459 CSI 300 listed companies across 29 provinces and 107 cities in China from 2015 to 2019 shows that increasing the level of digital economy platform construction in a city leads to better ESG performance among firms located there. Specifically, for each unit increase in a city's digital economy platform level, the ESG performance of companies in that city increases by approximately 0.338. These results establish a positive link between digital economy platform development and corporate ESG performance, providing strong empirical evidence for the positive effects of digital economy development.

However, the enhancement effect of building a digital economy platform on corporate social performance is less pronounced than its impact on environmental and governance factors. This is because social performance tends to focus more on a company's revenue generation, while environmental and governance factors are more concerned with costs. While companies benefit from positive social responsibility activities, these benefits are often delayed and volatile. In terms of influence mechanisms, business model innovation plays a more significant role than technological innovation.

Moreover, the enhancement effect of digital economy platform construction is more pronounced for non-SOE enterprises and manufacturing firms in the eastern region. The results highlight the heterogeneity of this effect, emphasizing that the marginal impact of digital economy platform development on corporate ESG performance is more significant when the number of enterprises is higher, the degree of digitization is greater, and the relationship between government and enterprises is weaker.

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