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How Does Digital Transformation Increase Corporate Sustainability? The Moderating Role of Top Management Teams

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Abstract: Digitization is a megatrend that shapes the economy and society, driving major transformations. Enterprises, as the most important microeconomic entities, are critical carriers for society in conducting digital transformation and practicing sustainable development to achieve socioeconomic and environmental sustainability. Exploring the relationship and mechanisms between digital transformation and sustainable corporate development is crucial. This study investigates the influence of digital transformation on sustainable corporate development as well as its moderating mechanisms. A two-way fixed effects model is used on a research sample of Chinese A-share listed companies in Shanghai and Shenzhen from 2010 to 2020. Three methods are used for robustness testing to alleviate endogeneity issues. The empirical results show that digital transformation can significantly enhance sustainable corporate development, whereas empowered management and highly educated employees are essential complementary human resources that effectively strengthen the contribution of digitalization to sustainability. Additionally, internal controls are internal drivers that have a positive moderating effect on the digital transformation to improve corporate sustainability. This study reveals that digital transformation is an important tool for promoting corporate sustainability, broadening the literature in related fields, and providing insights for corporate management and government policymakers to advance corporate sustainability.

Keywords: digital transformation; corporate sustainability; managerial power; employee education level; internal control

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1. Introduction

With the advent of Industry 4.0, digitalization has become a major trend. Digitalization, with digital technology as a core element, is leading society and the economy in the digital age [1]. Digital transformation (DT) is becoming an increasingly strategic focus for building competitive and sustainable economic advantages in many countries [2]. Hanelt et al. [3] defined digital transformation as "organizational change triggered and shaped by the widespread diffusion of digital technologies". From embracing artificial intelligence and big data analytics to leveraging cloud computing and the Internet of Things (IoT) [4], companies are using digital technologies to adapt to changing customer expectations, disruptive market forces, globalization, regulatory requirements, and talent needs [2,5]. Governments are competing to place them on the agenda [6–8], and business decision makers and researchers are scrambling to exploit their potential [9]. In the digital revolution, corporate digital transformation has become a fundamental factor in business success, enabling companies to innovate, grow, and stay ahead of the competition [10].

Sustainability continues to be one of the main topics of concern for companies. Confronted with various global challenges, the COVID-19 pandemic, energy crisis, climate crisis, and political instability, coupled with high stakeholder concerns, the development of an ongoing competitive advantage in a volatile and changing market environment is a major concern for companies [11,12]. Sustainability is a complicated notion that refers to

economic, environmental, and social development that serves the demands of the present without interfering with the needs of future generations [13–15]. The 2030 Agenda, agreed upon by the United Nations in September 2015, identifies digital technologies as achievable tools for accomplishing SDGs [16]. Wang and Chen [17] showed that digital transformation is a key strategy for enterprises to become more resilient to external shocks and achieve sustainable development. Such technologies are increasingly used by top corporations to transform their business models and adapt their organizational and operational approaches to balance their economic, environmental, and social impacts, which may have a significant impact on sustainability [2,14]. Thus, it is important to explore the relationship between digital transformation and sustainable corporate development.

The existing literature has examined the influence of digital transformation in terms of firm productivity [18], organizational structure [19], organizational resilience [11], organizational performance [20], and firm innovation [21], which optimize production and business models [22], promote industrial structure upgrading [23], and achieve efficient allocation and utilization of resources [24], thereby improving the efficiency of firm operations, R&D, and management [25]. Simultaneously, digitalization empowers corporate innovation [10], thus improving the financial, operational, and environmental performance of organizations [26,27], enhancing organizational resilience [17], and achieving sustainable development goals [28]. However, the existence of a positive correlation between DT and sustainability has not been firmly established [15,29]. According to a survey of over 300 senior managers, DT and environmental performance correlate with an inverted U pattern [5]. The use of digital technologies, represented by ICT, can reduce carbon emissions, but the vast scale of development brought about by over-investment may generate considerable energy demands and companies still struggle to obtain an effective return from the high investment costs [28,29], thus giving rise to the "Solow paradox" or "digital transformation paradox" [27,30]. Smith et al. [31] also mentioned that the adoption of innovations not only adds economic potential but also potential social challenges. For example, manufacturing and assembly companies face significant cost pressures when expanding the use of digital technologies. However, they cause considerable job losses and pose significant challenges to the sustainability of businesses and society [32]. While there is optimism about the prospects for sustainable development provided by digitization, it is critical to maintain a high degree of awareness [26,33,34]. Merely undergoing digitalization may not be enough to yield a positive impact on the sustainable performance of companies. Active corporate governance is required to accompany digital transformation and ensure its effectiveness in achieving a positive sustainable performance impact.

Top management teams shape a company's digital strategy. Recent studies have shown that top managers are leading organizational change agents [35], corporate strategy shapers [36], and business model innovators [10], and play a crucial role in an organization's DT process. This role cannot be performed without power. Bertrand and Schoar [37] confirmed that the power of individual managers affects a company's decision-making behavior and performance. Certo et al. [38] and Finkelstein et al. [39] found that top managers' decision-making power and leadership affect the implementation and effectiveness of a firm's strategy. Most empirical studies discuss executive characteristics [40,41], and few studies have been conducted on strategic leadership. Therefore, this study deepens our understanding of the connection between DT and corporate sustainability from the perspective of management teams and their power.

Human resources (i.e., employees' knowledge and skills) are an important component of a company and are becoming core competencies [41]. Ruiz-Pérez et al. [42] demonstrated that employees play a significant role in corporate sustainability by engaging in sustainable behaviors. In addition, corporate digital transformation is regarded as a high-technology value-added technological change that frequently necessitates highly educated individuals by investigating the impact of corporate digital transformation on employee education structure in state-listed companies. Liu et al. [43] showed that corporate digital transformation raises the demand for personnel with undergraduate degrees, while decreasing the

demand for employees with high school diplomas and below. Employees with a bachelor's degree or higher are rare, precious, difficult to replicate, and irreplaceable qualities of long-term human resources. We expect employees with higher levels of education to be better positioned to leverage digital technologies and sustainability initiatives to create value for their stakeholders in a digital context. The literature provides information on the impact of highly educated employees on monitoring firm behavior [44], the quality of accrued profits [45], productivity, and innovation [46]. Consequently, there is a need for empirical testing to examine whether the effects of highly educated employees on firms are indeed transferred to digital transformation, which subsequently influences firms' behavior towards sustainability.

Internal controls are essential components of corporate governance. Without an efficient internal control system, businesses in the economic market cannot attain sustainable and prosperous growth [47]. Intense market competition and instability in the external environment exacerbate management, operational, and decision-making risks in the digital transformation process [5]. A high-quality internal control system can restrain managers' speculative behavior, smooth communication channels with stakeholders, rapidly identify and prevent risks, improve operational efficiency, and create a good internal environment for digital transformation [48–50]. Meanwhile, the widespread deployment of a new generation of information technologies has dramatically increased the effectiveness and responsiveness of all aspects of internal control [17], facilitating the gathering and recognition of internal and external risks, enabling more efficient and effective operations, and achieving long-term corporate development goals.

China is well-suited for digitalization research. As the world's most populous country and the second largest economy, China's digital development is immense. According to the Digital China Development Report (2022) [51], China's digital economy will reach CNY 50.2 trillion in 2022, ranking second in the world in terms of total volume and increasing its share of GDP to 41.5%, and the digital economy has become an important engine for stable growth and transformation, with digital technology being widely applied in various fields. Studying China's digital transformation can provide rich cases and data, and a comprehensive understanding of the impact of digitalization on microeconomic entities [26]. In addition, the Chinese government places a significant emphasis on digital transformation, recognizing it as a vital component in achieving strategic sustainable development goals. With a clear vision for sustainable development, the Chinese government has identified digital transformation as a critical driver to achieve these objectives. Exploring China's digital transformation journey provides valuable insights for other nations, particularly developing countries, as they embark on a shared path towards sustainable development. First, based on the data from A-share listed companies in Shanghai and Shenzhen from 2010 to 2020, the impact of DT on their sustainable development is empirically tested using a two-way fixed effects model, followed by robustness tests to mitigate the endogeneity issue. Second, from the perspective of corporate governance, we explore how managerial power, employee education level, and internal control influence digital transformation and corporate sustainability.

The contributions of this study are as follows. Firstly, from a microscopic perspective, this study investigates the impact of digital transformation on corporate sustainability. Reis and Melão [52] highlighted that sustainability is a new dimension that has yet to be addressed in the existing literature, and empirical studies between DT and sustainability are still scarce. The existing literature on DT and sustainable development focuses on literature analysis methods [15], macro-level sustainability [53], and industry-level sustainability [54], whereas firm-level empirical studies do not provide sufficient evidence to demonstrate the relationship. This study creatively and empirically investigates the positive impact of digital transformation on corporate sustainability from the perspective of micro-enterprises, demonstrating the economic and environmental value of digital transformation in developing countries while supplementing the literature on sustainability. Second, this study expands and validates the micro-mechanisms that influence corporate

sustainability as a result of digital transformation. Unlike previous studies that look at the impact of DT on sustainability from the outside environment, such as industry competition and market turbulence, this paper examines the organization itself from the perspective of corporate governance and discovers that management teams, employees, and internal controls are important complementary resources for corporate digital transformation to empower sustainable development. In addition, while most previous studies analyze the impact on companies from the standpoint of executive characteristics, this research explores management teams and their power in a novel way. This research will help to broaden the management literature and facilitate the creation of research applicable to a broader environment. Thirdly, this study reveals that digital transformation can fetch a larger sustainability premium, and thus the findings provide insights into how corporate management and government policymakers can assist businesses in achieving sustainability.

The remainder of this paper is organized as follows: Section 2 provides the theoretical background and develops the hypotheses. Section 3 describes the research methodology and data. Section 4 presents the empirical results. Finally, Section 5 presents the discussion and conclusions.

2. Theoretical Background and Hypothesis Development

2.1. Digital Transformation and Corporate Sustainability

According to resource-based theory, enterprises can achieve outstanding performance and competitive advantage by leveraging priceless, uncommon, unique, and irreplaceable resources [55,56]. With the explosive growth of digital technologies, companies consider the scarcity and uniqueness of digital resources as important factors in production that offer sustainable competitive advantages [24]. In recent years, various digital technologies have been widely used in production, sales, management, and innovation. The identification and procurement of digital resources and the matching and exploitation of resources are facilitated by the digital transformation of businesses [57]. Dynamic capability theory [58] suggests that the rational integration and allocation of resources improve enterprise capabilities. It enhances core competitiveness, provides more opportunities for organizational value generation, and enables firms to respond swiftly to alterations in their internal and external surroundings [59].

The competitive advantages of DT are reflected in the optimization of business processes and improvement of operational efficiency. Firstly, DT integrates cutting-edge technologies with conventional production elements to optimize production and operation models [1], reduce costs, and improve production efficiency [25], bringing actual output closer to the production frontier to establish competitive advantages. Secondly, the extensive utilization of digital technologies enables the timely detection of shifts in the economic and business landscape. It enhances companies' ability to swiftly extract insights, identify operational inefficiencies and bottlenecks, and subsequently devise efficient resource allocation strategies for lean and intelligent production. This leads to improved efficiency in resource utilization and enables companies to rapidly distinguish themselves from competitors, resulting in a superior economic performance [3,30]. Thirdly, in the digital era, the use of digital media enhances communication and interaction between companies and their customers, suppliers, and distributors [60]. This reduces coordination costs and improves communication efficiency, thus enabling companies to better meet their expectations and needs [61]. Technological innovation tends to shorten product development cycles and reduce costs while increasing productivity [62].

Dynamic capability theory further explores the sources of value creation for firms in dynamic environments [63]. Dynamic capabilities are key to gaining competitive advantage in a rapidly changing environment [62] and are the driving force for firms to maintain competitive advantage and achieve sustainable growth. In the context of digitalization, the dynamic capabilities of enterprises are digital identification, integration, and reconfiguration capabilities to cope with turbulent and complex business environments. Digitalization plays an important role in stimulating the dynamic capabilities of enterprises. First, with

the help of digital transformation, businesses can collect distinctive information from a variety of digital channels to follow and identify consumer requirements and preferences, and then innovate before rivals to seize market share based on customer and market insights [64]. Second, companies that implement digitalization can integrate internal and external resources in a timely manner, promote business process innovation, and drive business model innovation (BMI) [3,41]. Kohtamäki et al. [65] introduced the concept of digital servitization. Their study found that manufacturing companies are actively deploying digitalization, but have difficulty generating and delivering value from these investments and need to enhance their capabilities in servitization. Hence, it is crucial for companies to revamp their service and business models, transitioning from a product-centric approach to a service-oriented one in order to effectively cater to customer demands [66]. Additionally, digital technology plays a transformative role in reshaping both internal and external environments for corporate innovation. It optimizes innovation models and processes, fosters the proliferation of innovation activities, and consistently drives sustainable growth for businesses [67].

Digital transformation also promotes companies' positive environmental performance, improves resource efficiency, and promotes a sustainable circular economy. First, utilizing digital technologies helps firms to create sustainable business practices that reduce carbon emissions and other waste emitted into the environment [68]. Shang et al. [69] empirically examined how firms' digital transformation reduces the intensity of their carbon emissions by enhancing their technological innovation, internal controls, and environmental disclosure capabilities. Second, the digitization of industrial processes improves the efficiency of material and energy use, reduces overall energy consumption [31], and opens the door for wider acceptance of renewable energy in emerging countries, such as China. Production systems that focus on sustainable and clean processes can reduce operational costs, enhance worker safety and profitability, and minimize the ecological impact on companies [70].

In conclusion, digital transformation offers numerous benefits, such as streamlining business processes, enhancing operational efficiency, integrating internal and external resources, fostering innovation in business models, and driving upgrades in industrial structures. By leveraging digital technology and embracing continuous innovation, companies can achieve differentiated production and gain sustainable competitive advantages, thus promoting the sustainable socioeconomic and environmental development of enterprises. Based on the preceding analysis, the following hypothesis is proposed.

Hypothesis 1 (H1). *Digital transformation has a positive impact on corporate sustainable development.*

2.2. The Moderating Effect of Managerial Power

Top management theory and the literature on strategic leadership coincide in stating [38,39,71] that the role of managers is critical to ensure organizational success. Bertrand and Schoar [49] first explicitly introduced the power of individual managers into the study of firm behavior, confirming that the power of individual managers influences decision-making behaviors and firm performance. Managers in positions of power possess the authority to make critical decisions and influence the overall strategic trajectory of an organization [72]. Demerjian et al. [73] found that managers who hold greater power tend to prioritize their personal image and reputation. Based on the reputation incentive hypothesis [74], managers can use their power for the sake of corporate reputation and their own image, prioritize digital transformation initiatives consistent with corporate sustainability goals in the overall interest of the company, support innovative behaviors such as digital strategic change, and simultaneously be willing to take risks in the change process. Moreover, having greater management power facilitates the faster implementation of management decisions and empowers the active utilization of advanced digital technologies to integrate internal resources efficiently. This optimal allocation of resources enables the establishment of a robust core competitive business system, enabling the company to

gain a competitive edge in intense market competition and fostering easier achievement of sustainable growth [39].

According to the managerial power theory proposed by Bebchuk and Fried [75], the primary responsibility of management is to handle information related to an organization's internal resources and external uncertainties. To effectively address these internal and external events, managers are endowed with certain powers, including organizational, ownership, expertise, and reputational powers [72]. Managers possessing a greater extent of these powers may have access to more resources, decision-making authority, and influence over other employees, enabling them to shape the trajectory of sustainable organizational development [9,38]. First, the strong expert power that managers possess enables them to reach and construct a wide range of relationships inside and outside the company, generate and gain more information advantages, solve the various problems and obstacles that naturally exist in the DT process, and mitigate the uncertainty caused by digitalization on the road to sustainability [13]. Second, organizational and ownership power enables managers to allocate resources effectively and provide abundant material, financial, and human resources for digitally empowered sustainability. These resources are invested in digital technologies and processes that improve sustainability performance, such as renewable energy systems and eco-friendly supply chains, thus minimizing waste and reducing the environmental impact of the enterprise. Third, the effective implementation of a company's digital transformation and sustainability strategies requires the participation of all parties, but the process may face various kinds of resistance, and management can make full use of reputation power to mobilize different stakeholders to actively participate [76] and shape a sustainable digital transformation culture for long-term development [2].

Overall, managerial power can strengthen the relationship between DT and sustainability by driving strategic decision making, resource allocation, and stakeholder engagement. When managers recognize the importance of DT and integrate it into their sustainable development efforts, they can enhance the organization's ability to achieve sustainable outcomes and long-term success. Accordingly, we propose the following hypothesis:

Hypothesis 2 (H2). *Managerial power has a positive moderating effect on digital transformation for improving corporate sustainability.*

2.3. The Moderating Effect of Employee Education Level

Human capital is an important component for companies to gain core competencies and sustainable competitive advantages [42]. Human capital theory suggests that education and training can improve individuals' human capital, that is, the knowledge, skills, and abilities they possess [77]. As a source of competitive advantage for firms, Wang and Yan [78] argued that employees' ability to receive, understand, and process information is closely related to the level of education received. Thus, employees with higher education levels are more likely to comprehend digital tools, technologies, and platforms, and can effectively use digital technologies to implement sustainable practices within the organization. Additionally, highly educated employees tend to have a high degree of adaptability and learning agility. They are more accustomed to acquiring new knowledge and skills critical in the context of digital transformation. Highly qualified employees can acquire new digital skills and knowledge more quickly and convert knowledge into productivity at work, generating knowledge spillover effects and using these technologies to obtain sustainable results [79].

According to the theory of core competencies, it is important for an enterprise to have highly qualified human resources that reflect its core competencies. Better-educated employees tend to be more creative and innovative, which is crucial to green corporate innovation and digital transformation [46]. They can assist companies in innovating products, services, and business models, thereby enabling them to gain an innovative competitive advantage. In addition, better-educated and trained, highly qualified employees are more aware of their roles and responsibilities in implementing a company's sustainability

strategy, thus promoting effective internal controls by reducing management myopia to better monitor the implementation of digitalization and prevent the risks associated with digitalization [44].

From the perspective of strategic corporate development, employees are at the core of competitiveness, and employees with higher levels of education have faster technological adaptation, better learning and understanding, better innovation capabilities, and a positive influence on digital transformation for sustainable corporate development. Accordingly, we propose Hypothesis 3.

Hypothesis 3 (H3). *Employee education level has a positive moderating effect on digital transformation for improving corporate sustainability.*

2.4. The Moderating Effect of Internal Control

According to the original COSO internal control evaluation framework, well-run businesses have effective and efficient operations linked to high-quality internal control systems [47]. Previous research has shown that deficiencies in internal control are more likely to occur in younger, more complicated, rapidly growing, or financially weaker companies [80,81]. At this point, strengthening internal control can address the internal control weaknesses brought about by the digital model embedded in the organizational structure, thus improving the efficiency of organizational operations. At the same time, by disclosing high-quality internal control information to the public, the market will capture the positive momentum of companies actively engaging in digitalization to achieve sustainable development; investors and other stakeholders can perceive their digital transformation strategies as more sustainable, which will effectively reduce search costs and information asymmetry with stakeholders, and investors can obtain more comprehensive and realistic information about their operations. It not only creates a good corporate image, but also provides more resources and cooperation to the company; the company will be favored by more stakeholders in the management of compliance, and the operational efficiency will be improved, which will lead to sustainable development [50].

When confronted with digital transformation to enhance sustainable corporate performance, high-quality internal controls can maximize their role in restraining managerial speculation, minimizing risk, and reinforcing a firm's strategic objectives. First, principal-agent theory suggests that effective internal control mechanisms help to align managers' interests with the long-term sustainability goals of the organization [48]. A strong internal monitoring mechanism can weaken the self-interest of managers, reduce the risk-averse motivation of decision-makers, enhance their sustainability philosophy, and create a favorable internal environment for digitally empowered sustainability. Second, corporate risk-taking strongly depends on investments in economic resources [48]. Good internal controls can improve information transparency and reduce information asymmetry, making it easier for investors to access effective internal information, enhancing firms' ability to obtain digital financial support [82], alleviating financing constraints, and mitigating resistance to digital technological innovation. Finally, achieving strategic corporate goals relies on the effective implementation of an enterprise's internal control systems [47]. Feng et al. [83] pointed out that high-quality internal management reports can accurately reflect economic activities, quickly identify uncertainty risks in the digitalization process, and improve digital management decisions. More importantly, the efficiency and effectiveness of corporate decision making depend on good internal controls [50]. Through the timely transmission and communication of information, enterprise departments and employees at all levels have a timely and comprehensive understanding of the costs and benefits of each digital transformation project of the enterprise, forming a controlled environment in which all employees participate and supervise the effects of digital transformation implementation, thus making digital transformation in sustainable development the new norm. Sound internal controls can mitigate agency conflicts, reduce enterprise operational risks, improve operational efficiency, and provide a good internal environment for the smooth

implementation of digital empowerment sustainability strategies. Accordingly, the fourth hypothesis was as follows:

Hypothesis 4 (H4). *Internal control has a positive moderating effect on digital transformation for improving corporate sustainability.*

Integrating the above arguments, the theoretical model is presented in Figure 1.

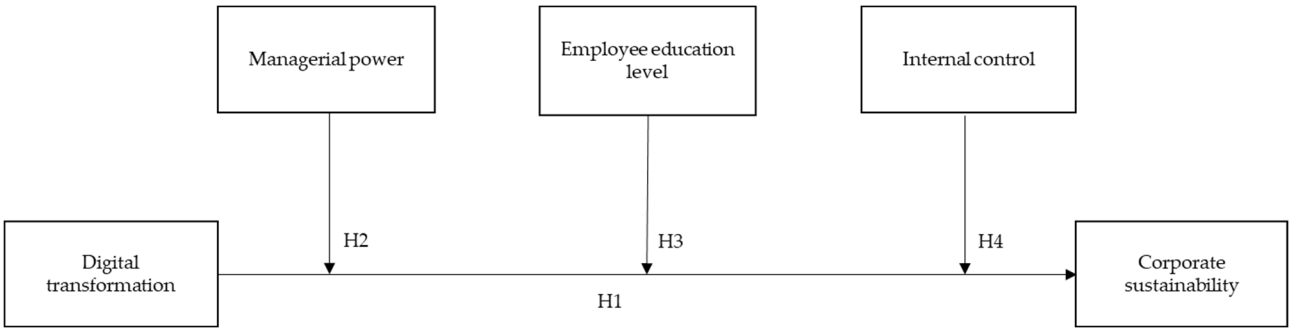

Figure 1. Theoretical model.

3. Research Methodology and Design

3.1. Sample and Data Collection

The research sample consisted of Chinese A-share listed companies in Shanghai and Shenzhen from 2010 to 2020. The sample was then screened according to the following criteria: (1) companies in the financial sector were excluded; (2) companies with irregular trading were excluded: ST&ST*&PT and delisted companies were eliminated; (3) companies with substantial missing data were excluded; and (4) the main variables are Winsorized at the upper and lower 1% levels to reduce outliers. In total, 12,544 observations were obtained. The data used in this study were obtained from the DIBO Risk Management Database, WIND Database, and China Securities Market and Accounting Research Database (CSMAR). The annual reports of listed companies were sourced from the Juchao Information Website. Multiple regression analysis was performed using STATA 16.0.

3.2. Definition and Measurement of Variables

3.2.1. Dependent Variables

Referring to the existing studies on corporate sustainability, ESG scores were selected [12], and sustainability evaluation systems were constructed through textual analysis [84]. First, the ESG indicators of listed Chinese manufacturing enterprises were missing. Second, sustainability at the firm level, which is mostly reflected in financial indicators, was referred to as the corporate sustainable development investigated in this study. In terms of indicator measurement, the most representative scholars who have studied enterprise sustainability models are Robert C. Higgins and James C. Van Horne, who have used sustainable growth rate (SGR) to judge whether an enterprise achieved sustainable growth. They both used SGR to determine whether a firm achieved sustainable growth and constructed corresponding sustainable growth models, and both models have their own characteristics. This study drew on Liao et al. [85] and adopted Van Horne's static model to measure firm sustainability by constructing a comprehensive index of profitability, the accumulation of development capital, long-term solvency, and operating capacity. The index was calculated as follows:

$$\text{SGR} = \frac{\text{net sales interest rate} \times \text{total asset turnover} \times \text{income retention rate} \times \text{equity multiplier}}{(1 - \text{net sales interest rate} \times \text{total asset turnover} \times \text{income retention rate} \times \text{equity multiplier})} \quad (1)$$

3.2.2. Independent Variables

In terms of measurement, many studies have used the method of questionnaires or interviews [5]. However, collecting comprehensive data on the digitalization of firms is challenging considering costs. Current studies mainly use the share of digitization-related intangible assets to measure DT [18], but most of these indicators have deficiencies and shortcomings that make it impossible to accurately and thoroughly evaluate DT. Quantitative studies commonly use the frequency of feature words related to DT in annual reports to illustrate the intensity of DT within an enterprise. The summary and advisory nature of annual reports are more likely to incorporate details about the DT features [26]. Therefore, it is feasible and reasonable to use the text-mining method to extract word frequencies related to digital transformation to characterize DT. The studies of Wu et al. [86] and Guo et al. [87] used a text analysis method of machine learning. Specifically, we measured the frequency of keywords related to digital transformation in the annual reports of listed companies. These terms included "digital technology applications", "artificial intelligence technology", "big data technology", "cloud-computing technology", and "blockchain technology". Detailed keywords are provided in Appendix A. The frequency of relevant words was logarithmically processed to overcome the "right bias" feature of the data, thus forming an overall indicator of digital transformation.

3.2.3. Moderating Variables

Managerial power (MP). Many studies use CEO power directly to represent the power of top management teams. In fact, a large amount of evidence shows that the entire executive team, rather than the CEO alone, is a better predictor of organizational output [72]. Therefore, the measure of management power refers to the four-dimensional model of power proposed by Finkelstein [72]. Choosing the length of tenure (the number of years of manager tenure in the position), CEO–chair duality (a value of 1, and 0 otherwise), the proportion of internal directors (insider), and management shareholding ratio (Mgshder) measures the source of management power and the monitoring constraints of corporate governance on management power. Based on these indicators, four components were synthesized into a composite index of management power using principal component analysis, drawing on the indirect measure of management power by Cao et al. [88]. The higher the index, the greater the power of the management.

Employee education level (EDU). Drawing on previous research [41,43], the percentage of employees with a bachelor's degree or higher was used to represent the educational structure. To some extent, this indicator reflects the proportion of highly educated employees in a company.

Internal control (IC). According to Liu et al. [48] and Sun et al. [82], the "internal control indicators" in the DIBO risk management database can truly and objectively reflect an enterprise's internal control status. Therefore, we took the DIBO internal control indicators from the DIBO database, multiplied them by 100, and normalized them.

3.2.4. Control Variables

Referring to previous studies [84,89], the following variables that have essential impacts on firm sustainability were controlled: firm size (Size), debt to assets ratio (Leverage), cash flow ratio (Cashflow), top shareholder ownership (Top1), and listing age (Age). In addition, dummy variables for year and industry were included in this study. Explanations for all variables are shown in Table 1.

Table 1. Variable names and definitions.

Types	Variables	Definition	Measurement
Dependent Variable	SGR	Sustainable development	Net sales interest rate × total asset turnover × income retention rate × equity multiplier/(1 − net sales interest rate × total asset turnover × income retention rate × equity multiplier)
Independent variable	DT	Digital transformation	Natural logarithm of the frequency of occurrence of the corresponding digital keywords in the annual reports plus 1
Moderating variables	MP	Managerial power	Tenure, Dual, Insider, and Mgshder, which were synthesized into a composite index using principal component analysis
	EDU	Employee education level	Employees with bachelor's degree or higher/total employees
	IC	Internal control	DIB internal control index
Control variables	Size	Firm size	Natural logarithm of total assets for the year
	Age	Listing age	Natural logarithm of the difference between the current year and the listing year plus 1
	Cashflow	Cash flow ratio	Net cash flow from operating activities/total assets
	Lev	Debt to assets ratio	Total liabilities/total assets
	Top1	Largest ownership	Shareholding ratio of the largest shareholder

3.3. Model Design

A two-way fixed effects model with individuals and years was selected to test the effect of digital transformation on sustainable corporate development. Drawing on previous studies [89,90], the following baseline regression model was constructed:

$$SGR_{it} = \alpha_0 + \alpha_1 DT_{it} + \sum Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where i and t denote the firm and year, respectively. SGR_{it} is the dependent variable, DT_{it} is the independent variable, and the controls are a set of control variables that affect corporate sustainability. In addition to industry fixed effects, individual fixed effects μ_i and the year fixed effect λ_t are also introduced. ε is the random error term.

To further validate the moderating mechanisms of the effects of managerial power, employee education level, and internal controls on digital transformation to enhance corporate sustainability, the following model was constructed by adding the interaction term of digital transformation and the moderating variables to the baseline regression model:

$$SGR_{it} = \beta_0 + \beta_1 DT_{it} + \beta_2 MP_{it} + \beta_3 DT_{it} \times MP_{it} + \sum Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where MP_{it} is a moderating variable for managerial power. If the coefficient β_3 of the interaction term is positive and statistically significant, it indicates that managerial power can enhance the positive moderating effect of digital transformation on corporate sustainable development.

$$SGR_{it} = \gamma_0 + \gamma_1 DT_{it} + \gamma_2 EDU_{it} + \gamma_3 DT_{it} \times EDU_{it} + \sum Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

where EDU_{it} is the moderating variable of the employee education level. With a positive coefficient for the interaction term, the role of corporate digitalization in sustainability is more prominent when employee education level is high.

$$SGR_{it} = \delta_0 + \delta_1 DT_{it} + \delta_2 IC_{it} + \delta_3 DT_{it} \times ICit + \sum Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

where IC_{it} is the moderating variable of internal controls. If the interaction term passes the significance test and δ_3 is greater than 0, internal controls strengthen the moderating effect of firm digitalization if digital transformation positively affects sustainability.

4. Results of the Empirical Analysis

4.1. Descriptive Statistics and Correlations

Table 2 presents the descriptive data for all the variables. The median value of corporate sustainability is 0.049 and standard deviation is 0.043, which is lower than the mean value of 0.055, indicating that the corporate sustainability of the sample companies is at a low level. The maximum and minimum values are 0.332 and −0.021, respectively, which demonstrates that corporate sustainability differs from the other samples. In terms of digital transformation, the mean value is 1.122, with a minimum value of 0 and a maximum value of 5.088, which indicates that the degree of digital transformation varies widely among Chinese enterprises. There is also a wide range in managerial power in the entire sample of companies, as indicated by the standard deviation of 1.231, which ranges from −2.226 to 3.191. Nearly half of the sample firms have a medium level of employee education, with the mean and median values of 0.237 and 0.181, respectively, ranging from 0 to 0.874. Internal control has a maximum value of 7.5 and a median value of 6.615, which is considerably greater than the mean value of 5.958, illustrating that the sample entities have a high quality of internal control.

Table 2. Descriptive statistics.

Variables	N	Mean	SD	Min	Median	Max
SGR	12,544	0.055	0.043	−0.021	0.049	0.332
DT	12,544	1.122	1.266	0	0.693	5.088
MP	12,544	0.342	1.231	−2.226	0.222	3.191
EDU	12,544	0.237	0.203	0	0.181	0.874
IC	12,544	5.958	1.985	0	6.615	7.5
Size	12,544	21.631	1.149	19.349	21.512	25.274
Lev	12,544	0.365	0.194	0.044	0.347	0.833
Age	12,544	1.868	0.906	0	1.946	3.258
Cashflow	12,544	0.045	0.063	−0.15	0.045	0.233
Top1	12,544	0.34	0.139	0.09	0.321	0.724

Note: This table presents the descriptive statistics of the main variables in this study. Our sample included 12,544 observations between 2010 and 2020. All the variables are defined in Table 1.

Table 3 presents the Pearson correlation coefficients obtained before the regression analysis to test for multicollinearity. The table exhibits a notable coefficient of 0.030 between DT and SGR, confirming the validity of the initial hypothesis. When conducting regression analysis, it is ideal for the variables to be logically sound and mutually independent, with no concerns of multicollinearity. As evidenced by the correlation analysis, all the correlation coefficients are <0.8. Furthermore, the variance inflation factor values for all variables are less than 3, and the average VIF value is 1.47, indicating that there are no serious multicollinearity problems in the main model.

4.2. Analysis of the Empirical Results

Digital Transformation and Corporate Sustainability

Table 4 presents the baseline regression results for digital transformation and corporate sustainability. Column (1) shows that the regression coefficient of DT is positive and statistically significant at the 1% level. Therefore, digital transformation has a positive impact on sustainability, thus supporting H1. As shown in column (2), both the coefficient of DT and the interaction term (DT × MP) are significantly positive at the 1% level, at 0.0032 and 0.0014, respectively. Thus, managerial power positively moderates the impact of digital transformation on corporate sustainability, supporting H2. In column (3), the coefficient of DT is 0.0031 and the coefficient of the interaction term (DT × EDU) is 0.0120, both of

which are significantly positive at the 1% level. This indicates that the role of corporate digitalization in sustainability is more prominent when employee education levels are high. Thus, H3 is supported. In column (4), the coefficients of DT and the interaction term (DT × IC) are considerably positive at 0.0031 and 0.0010, respectively, demonstrating that internal controls strengthen the moderating effect of digital transformation on corporate sustainable development. Therefore, H4 is supported.

Table 3. Results of the correlation analysis.

Variables	SGR	DT	MP	EDU	IC	Size	Lev	Age	Cashflow	Top1
SGR	1									
DT	0.121 ***	1								
MP	0.052 ***	0.154 ***	1							
EDU	0.078 ***	0.424 ***	0.082 ***	1						
IC	0.034 ***	0.089 ***	−0.097 ***	0.070 ***	1					
Size	0.052 ***	0.045 ***	−0.364 ***	0.044 ***	0.314 ***	1				
Lev	0.040 ***	−0.061 ***	−0.269 ***	−0.051 ***	0.175 ***	0.566 ***	1			
Age	−0.076 ***	0.017 *	−0.385 ***	0.002	0.506 ***	0.625 ***	0.412 ***	1		
Cashflow	0.283 ***	−0.014	−0.038 ***	−0.054 ***	0.069 ***	0.070 ***	−0.127 ***	0.072 ***	1	
Top1	0.069 ***	−0.129 ***	−0.055 ***	−0.089 ***	−0.024 ***	0.098 ***	0.058 ***	−0.042 ***	0.050 ***	1

Note: This table presents the Pearson correlations among the main variables in this study. * and *** indicate statistical significance at the 10% and 1% levels, respectively.

Table 4. Results of the regression analysis.

	(1)	(2)	(3)	(4)
	SGR	SGR	SGR	SGR
DT	0.0034 ***	0.0032 ***	0.0031 ***	0.0031 ***
	(6.4577)	(6.0684)	(5.8652)	(5.8929)
MP		0.0003		
		(0.5276)		
DT × MP		0.0014 ***		
		(4.5091)		
EDU			0.0018	
			(0.3961)	
DT × EDU			0.0120 ***	
			(6.2648)	
IC				0.0025 ***
				(9.5455)
DT*IC				0.0010 ***
				(5.3181)
Size	0.0002	0.0003	−0.0001	−0.0008
	(0.1619)	(0.2944)	(−0.0940)	(−0.7584)
Lev	0.0326 ***	0.0315 ***	0.0316 ***	0.0370 ***
	(8.2550)	(7.9625)	(7.9922)	(9.3319)
Age	−0.0053 ***	−0.0062 ***	−0.0058 ***	−0.0133 ***
	(−4.0997)	(−4.7357)	(−4.4910)	(−8.0028)
Cashflow	0.1557 ***	0.1552 ***	0.1558 ***	0.1564 ***
	(23.7017)	(23.6521)	(23.7601)	(23.9173)
Top1	0.0129 *	0.0129 *	0.0132 **	0.0057
	(1.9411)	(1.9397)	(1.9953)	(0.8614)
_cons	0.0312	0.0312	0.0369	0.0663 ***
	(1.2300)	(1.2286)	(1.4431)	(2.5846)
Industry	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	12,544	12,544	12,544	12,544
R^2	0.0728	0.0746	0.0764	0.0815

Note: This table presents the analysis of the impact of digitalization on corporate sustainability in column (1) and the moderating effects of managerial power, employee education level, and internal control in columns (2)–(4). *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. t-statistics are provided in the parentheses.

4.3. Robustness Tests

There is the possibility of endogeneity in the regression of causality as well as measurement error. To evaluate the reliability of the primary effects regressions, we changed the

measurement method of the independent and dependent variables and performed two-stage least squares (2SLS) regressions to solve the endogeneity problem of reverse causation.

4.3.1. Tests Based on Alternative Measurement of Dependent Variable

Following the research methodology of Sun and He [82], we expanded the Chinese lexicon of the Python package "jieba" by incorporating 197 terms from five relevant dimensions. Leveraging machine learning techniques, we then assessed the occurrence frequency of 197 phrases associated with digitization by analyzing the text from the "Management Discussion and Analysis" (MD&A) section in the annual reports. The degree of digitalization was determined by dividing the cumulative frequency of digitization-related terms by the length of the MD&A sections in the annual reports. The results of the regression analysis on the relationship between digitalization and corporate sustainability, referred to as the DIG analysis, are presented in Table 5, and are consistent with the earlier findings. Column (1) reveals that digital transformation contributes significantly to corporate sustainability with a regression coefficient of 0.0048, which remains statistically significant at the 1% level. As shown in columns (2)–(4), the coefficients of the three interaction terms are 0.0015, 0.0139, and 0.0007, respectively, and the coefficient of DT is significantly positive at the 1% level, which is consistent with the prior results.

Table 5. Robustness test: alternative measurement of the dependent variable.

	(1)	(2)	(3)	(4)
	SGR	**SGR**	**SGR**	**SGR**
DIG	0.0048 ***	0.0044 ***	0.0034 ***	0.0047 ***
	(5.3360)	(4.7513)	(3.5504)	(5.1427)
MP		0.0001		
		(0.1951)		
DT × MP		0.0015 ***		
		(2.7427)		
EDU			0.0042	
			(0.9543)	
DT × EDU			0.0139 ***	
			(4.5196)	
IC				0.0022 ***
				(8.6271)
DT × IC				0.0007 ***
				(2.5900)
Size	0.0007	0.0007	0.0005	−0.0003
	(0.6932)	(0.7093)	(0.4863)	(−0.3416)
Lev	0.0325 ***	0.0320 ***	0.0320 ***	0.0369 ***
	(8.2158)	(8.0858)	(8.0857)	(9.2804)
Age	−0.0052 ***	−0.0056 ***	−0.0055 ***	−0.0138 ***
	(−4.0310)	(−4.2701)	(−4.2147)	(−8.2733)
Cashflow	0.1549 ***	0.1545 ***	0.1548 ***	0.1556 ***
	(23.5734)	(23.5090)	(23.5783)	(23.7677)
Top1	0.0112 *	0.0114 *	0.0113 *	0.0041
	(1.6888)	(1.7240)	(1.7100)	(0.6215)
_cons	0.0190	0.0220	0.0256	0.0571 **
	(0.7522)	(0.8710)	(1.0050)	(2.2327)
Industry	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	12,544	12,544	12,544	12,544
R^2	0.0716	0.0723	0.0736	0.0784

Note: This table presents the robustness check by changing the measurement method of digital transformation. Column (1) displays the impact of DT on corporate sustainability while columns (2)–(4) display the moderating effect. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. t-statistics are provided in the parentheses.

4.3.2. Tests Based on the Alternative Measurement of Independent Variable

Referring to the previous study of Ji et al. [89], we chose growth rate as a proxy for sustainability since companies with stronger sustainable development capabilities typically have higher sustainable growth rates. The formula is as follows:

$$\text{SGRA} = \frac{\text{return on net assets} \times \text{earnings retention rate}}{1 - \text{return on net assets} \times \text{earnings retention rate}} \quad (6)$$

Consistent with the results of the previous regression analysis, the results reported in Table 6 column (1) show that digital transformation makes a considerable contribution to sustainable business growth, with a regression coefficient of 0.0043, which remains significantly positive at the statistical level of 1%. The inclusion of moderating variables in the regression is demonstrated in columns (2)–(4). The coefficients of the three interaction terms are 0.0018, 0.0157, and 0.0016, and the regression coefficient of digital transformation is significantly positive at the 1% statistical level, verifying the robustness and reliability of the empirical results of this study.

Table 6. Robustness test: alternative measurement methods of the independent variable.

	(1)	(2)	(3)	(4)
	SGRA	**SGRA**	**SGRA**	**SGRA**
DT	0.0043 ***	0.0041 ***	0.0040 ***	0.0037 ***
	(7.1366)	(6.7883)	(6.6217)	(6.2172)
MP		0.0001		
		(0.1230)		
DT × MP		0.0018 ***		
		(4.9662)		
EDU			−0.0013	
			(−0.2610)	
DT × EDU			0.0157 ***	
			(6.7325)	
IC				0.0009 ***
				(3.1126)
DT*IC				0.0016 ***
				(7.6197)
Size	−0.0046 ***	−0.0045 ***	−0.0049 ***	−0.0045 ***
	(−4.0460)	(−3.9195)	(−4.2534)	(−3.9295)
Lev	0.0388 ***	0.0373 ***	0.0374 ***	0.0396 ***
	(8.5448)	(8.2106)	(8.2381)	(8.6836)
Age	−0.0176 ***	−0.0188 ***	−0.0184 ***	−0.0176 ***
	(−11.8530)	(−12.4922)	(−12.3300)	(−9.1885)
Cashflow	0.1693 ***	0.1688 ***	0.1694 ***	0.1695 ***
	(22.4520)	(22.4010)	(22.5043)	(22.5379)
Top1	−0.0021	−0.0019	−0.0017	−0.0031
	(−0.2760)	(−0.2530)	(−0.2228)	(−0.4082)
_cons	0.1616 ***	0.1620 ***	0.1662 ***	0.1639 ***
	(5.5543)	(5.5571)	(5.6629)	(5.5552)
Industry	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	12,544	12,544	12,544	12,544
R^2	0.0934	0.0957	0.0979	0.0986

Note: This table presents the robustness check by changing the measurement method of corporate sustainability. Column (1) displays the impact of DT on corporate sustainability, while columns (2)–(4) display the moderating effect. *** indicate significance at the 1%. t-statistics are provided in the parentheses.

4.3.3. Testing Based on Two-Stage Least Squares

Endogeneity problems can arise when examining the influence of digital transformation on sustainability. This is due to the potential issue of reverse causality, where

the relationship between digitalization and sustainability can affect the dependability of earlier findings. For companies, those with a stronger focus on sustainability are more likely to actively embrace digital transformation. In this study, we referred to the existing studies [89] and used the mean value of digital transformation in the same year in an industry other than our firm as an instrumental variable for DT (DT_{mean}) to overcome the endogeneity problem of mutual causality with the help of 2SLS. Table 7 shows the results of the instrumental variable regression. The regression coefficient of digital transformation is 0.0160 at the 1% significance level after using the instrumental variables, indicating that DT plays a vital role in promoting sustainable development. In addition, the Kleibergen–Paap rk LM statistic is 103.62 (equivalent to a *p*-value of 0), demonstrating that the instrumental factor is identifiable (see Table 7). We can rule out the possibility of weak instrumental variables using the Cragg–Donald Wald F statistic and the Kleibergen–Paap Wald rk F statistic, with 167.57 and 118.77, respectively, both of which are larger than the Stock–Yogo weak identification test at the 10% significance level (16.38), rejecting the hypothesis of weak identification. According to the results of the instrumental variable test, digital transformation can significantly improve organizational sustainability, and this conclusion is reliable. The instrumental variable regression results led to the conclusion that digital transformation can significantly improve enterprise sustainability, which is consistent and reliable.

Table 7. Robustness test: 2SLS regression.

	Stage 1	**Stage 2**
	DT	**SGR**
DT		0.0160 ***
		(3.5430)
DT_{mean}	0.5267 ***	
	(12.9448)	
Size	0.2013 ***	−0.0024
	(10.8277)	(−1.5527)
Lev	−0.0821	0.0335 ***
	(−1.1065)	(7.3343)
Age	0.1327 ***	−0.0072 ***
	(5.4553)	(−4.8397)
Cashflow	−0.2200 *	0.1582 ***
	(−1.7849)	(19.8768)
Top1	−0.8440 ***	0.0241 ***
	(−6.7845)	(2.6635)
Industry	Yes	Yes
Firm	Yes	Yes
Year	Yes	Yes
N	12,538	12,328
R^2	0.3349	0.0196
Number of ID	2137	1927
Kleibergen–Paap rk LM statistic	103.62 (Chi-sq(1)p-val = 0.0000)	
Cragg–Donald Wald F statistic	167.57	
Kleibergen–Paap Wald rk F statistic	118.77	
10% maximal IV size	16.38	

Note: This table presents the robustness check using 2SLS regression. DT_{mean} is the instrumental variable at Year-Industry level. * and *** indicate statistical significance at the 10% and 1% levels, respectively. t-statistics are provided in the parentheses.

5. Discussion and Conclusions

5.1. Discussion

The advent of digital technologies, such as the Internet of Things, artificial intelligence, blockchain, and big data analytics, is heralding the onset of the digital era. The significance of digital transformation as a strategic priority is growing, as it enables the establishment of competitive advantages and sustainable development benefits for national economies [2].

Enterprises, being the most crucial microeconomic entities, play a pivotal role in driving digital transformation and shouldering the responsibility for sustainable development. Enterprises are earnestly embracing digitalization to pursue breakthroughs and transformations in the digital economy [91]. Consequently, it is worthwhile to investigate whether they can attain competitive advantages and foster sustainable development.

Digital transformation is a subject of significant interest in both academic and practical circles, while sustainability practices are widely acknowledged by businesses. In the recent research, Zhang et al. [25] argued that digital transformation has the potential to enhance operational and production efficiency through cost reduction and innovation. Tian et al. [92] revealed that digital transformation contributes to enterprises' risk-taking capabilities by enhancing operational flexibility and improving access to financing. Similarly, Wang and Han [93] concluded that digital transformation can effectively mitigate corporate fraud and enhance overall business quality. More importantly, digital transformation provides significant incentives for companies to embrace greater environmental responsibility, leading to reduced carbon emissions through the adoption of green technology innovations and improved corporate governance practices [90,94]. Interestingly, Feroz et al. [95] defined sustainable digital transformation (SDT) and further clarified the convergence between sustainability and digital transformation. As the importance of sustainability continues to grow in the business world, there is a rising interest in research that combines SDGs with DT. In this context, this study empirically investigated the positive impact of digital transformation on corporate sustainability from the perspective of micro enterprises, demonstrating the economic and environmental value of digital transformation. In terms of digital transformation, a more comprehensive and scientific measurement using the text-mining method to extract word frequencies related to DT in the annual reports was used. Van Horne's static model was selected to measure corporate sustainability. A two-way fixed effects model was adopted, and empirical testing showed that the digital transformation of Chinese enterprises can greatly enhance their sustainability and boost their confidence and determination to accelerate their digital transformation process.

Our finding is in line with the term "digital imperative" mentioned by Guandalini et al. [15] in their article. Governments and policymakers can seize this positive impact as a chance to expand investment in corporate digital transformation, establish enabling policies and regulations that foster a conducive environment for businesses to undertake transformation initiatives and promote and incentivize digital transformation initiatives that are consistent with sustainability goals. More importantly, companies must actively embrace digitalization as an important strategic resource for their companies, promote the optimization and upgrading of their industrial structures, and continuously build competitive advantages to achieve long-term sustainable development [26].

In addition, sustainable development in digitally empowered enterprises cannot be successfully implemented without positive corporate governance. Top management teams play an important role in corporate value creation and ensuring organizational success. This paper explored that empowered management actively embraces digitalization for the sake of the company's reputation and its image, continuously explores its path to achieve sustainable corporate development, makes the right strategic decisions, and uses its power resources to deal with various problems and obstacles in the process of digital transformation and obstacles in the process of digital transformation, and contribute to the sustainable creation of digitalization. As a result, the management team and its power resources are a significant complementary resource for enterprise digitization. For the top management team, digital transformation provides an opportunity to effectively promote corporate sustainability efforts. Senior management can exhibit digital leadership by incorporating digital transformation into the company's sustainability vision, mission, and overall strategy, as well as creating long-term goals and digital development plans from a large picture view to achieve long-term corporate growth [96].

Furthermore, human capital is an important component for companies to gain core competencies and sustainable competitive advantages [41]. Ruiz-Pérez et al. [42] showed

that the process of sustainable development depends on the participation of the workforce through the implementation of sustainable behaviors. This study further found that employees with higher levels of education play a positive role in digital transformation for corporate sustainability because of their ability to adapt faster to technology, better learning and understanding, and better ability to innovate. In the digital economy context, companies highly prioritize the acquisition of top-tier talent. Skilled and educated employees, along with the knowledge spillover effect they provide, are crucial drivers of digital transformation and sustainable development. These individuals serve as a significant force and valuable asset for organizations, propelling them towards successful digitalization and fostering long-term sustainable growth. Moreover, internal control is an important component of corporate governance. Top-notch internal controls play a dual role in facilitating both effective and efficient operations, as well as making substantial contributions to the sustainable development of enterprises [50]. Within the digital realm, high-quality internal controls can further enhance their impact by curbing managerial speculative behavior, minimizing operational risks, reinforcing a company's strategic objectives, and cultivating a favorable internal environment for sustainable digital empowerment.

5.2. Conclusions

As mentioned by many scholars [15,97], the megatrends of sustainability and digitalization are reshaping the economy and society and are responsible for major transformations. In this study, we examined the relationship between digital transformation and corporate sustainability of Chinese companies based on A-share listed companies in Shanghai and Shenzhen in China from 2010 to 2020 using a two-way fixed effects model. Meanwhile, from the perspective of corporate governance, the moderating roles of managerial power, employee education level, and internal control in the relationship between digital transformation and corporate sustainable development were analyzed from three perspectives. The following key points can be drawn from the discussion. (1) Digital transformation can significantly improve corporate sustainability. The reliability of the results was reinforced by three robustness tests, confirming that digitalization is a significant driver of sustainable development advantages for enterprises. Digital transformation facilitates efficient resource allocation and utilization, enhances total factor productivity, drives the transformation of business models, and upgrades industrial structures. By leveraging digital technology and embracing continuous innovation, enterprises can achieve differentiated production and secure sustainable competitive advantages. Consequently, this contributes to the continual enhancement of socioeconomic and environmental sustainability. This finding is consistent with those of most previous studies [84,89,95], where digital transformation led to a higher sustainability premium. (2) Managerial power plays a positive moderating role in digital transformation to improve corporate sustainability. Management behavior influences corporate decision making and strategic orientation. Empowered management teams actively embrace digitalization and make the right strategic decisions for the sake of the company's reputation and image while using power resources to deal with various problems and obstacles in the process of digital transformation. (3) The sustainable development process depends on the participation of well-educated employees. Better educated employees, as a core element for enterprises to gain competitive advantage, not only actively adapt to new technologies and practices but also rapidly convert their acquired digital knowledge, technologies, and competencies into productivity and generate knowledge spillover effects. At the same time, they are aware of their responsibilities for the firm's long-term growth and oversee the digitalization process to prevent management shortsightedness. (4) Effective internal controls have a positive influence on the digital transformation and sustainable development of enterprises. Strong internal controls help to mitigate agency conflicts, minimize risks stemming from information asymmetry, enhance operational efficiency, and foster a conducive internal environment for the successful implementation of digital empowerment and sustainable development strategies.

5.3. Implications of the Study

First, only a limited number of empirical studies have investigated the impact of corporate digital transformation on sustainability, considering the current landscape of the digital economy and sustainable development. This research aimed to bridge this gap by empirically examining the positive influence of digital transformation on corporate sustainability at the micro-level, thereby enhancing our understanding of corporate sustainability within the context of the digital era. Furthermore, the existing literature has paid limited attention to the exploration of how organizations, including stakeholders and various functions, can leverage synergies during the digital transformation process to achieve sustainability objectives [15]. Consequently, this study explored the moderating role of top management teams, employees, and organizations in the relationship between digital transformation and corporate sustainability, from a corporate governance perspective. By refocusing the literature on management and expanding the existing body of knowledge on the subject, this research contributes a fresh perspective to the field.

This study has several practical implications, which are as follows.

(1) The government perspective. There is a need to enhance financial and technical support for digital transformation initiatives within enterprises. Governments should acknowledge the significance of digital transformation as a crucial means to enhance the sustainability of businesses. Policymakers ought to implement effective measures that promote technology investments and offer targeted incentives, such as national Industry 4.0 programs. These actions not only foster the sustainability and resilience of business development in the face of challenges, such as the COVID-19 pandemic and global uncertainties, but also ensure the long-term success and adaptability of enterprises.

(2) The corporate perspective. Firstly, companies should develop a digital transformation strategy that integrates sustainability goals, aligns digital initiatives with overall business strategies, and recognizes the potential of digital technologies for driving sustainability [15]. By actively transforming their business models, companies can enhance their competitive advantage through the effective use of digital technologies, thereby contributing to sustainable development objectives. Secondly, companies should prioritize genuine digitalization rather than mere informatization or networking. By leveraging digital technology, companies can establish seamless connectivity across various functions, such as procurement, production, marketing, finance, and human resources, thereby improving planning, coordination, monitoring, and control processes and eliminating "information silos". Thirdly, digital transformation is a high-technology value-added transformation that often requires more qualified personnel. Companies can retain more high-quality "brains" by signing long-term contracts. Fourthly, it is essential to prioritize employee education, professional growth, and training to enhance their career development within the organization. This includes guiding employees with lower educational levels towards acquiring new skills and redirecting their career paths towards more specialized roles. Simultaneously, companies should actively encourage employees to pursue further education to expand their knowledge and qualifications, aligning with the evolving demands of the digital era. The organization can play an active role by sponsoring individuals to pursue higher education, facilitating their personal career development while also meeting the company's specific needs in the digital landscape. Furthermore, organizations should implement training programs aimed at enhancing employees' understanding of the principles and requirements of corporate sustainability. Such initiatives will help employees to comprehend their roles and responsibilities in driving sustainable development goals within the company [98].

(3) The management perspective. To promote digital transformation and sustainable development, it is crucial to foster digital awareness and cultivate a digital mindset within the organization. When managers recognize the positive impact of digital transformation on business growth, they actively prioritize enhancing the digital

capabilities of the company. They utilize their authority to drive the digitalization process, thereby providing strong support for open innovation and sustainable practices. Firstly, managers should possess a vision of digitizing their organizations and acknowledge the significance of digital capabilities for long-term competitiveness. They must leverage their influence to guide companies in embracing the opportunities presented by the digital era. Secondly, managers need to acquire a solid understanding of digitalization fundamentals and enhance their digital awareness. This entails gaining comprehensive knowledge of digital technologies and their operational management. By doing so, managers can effectively lead their companies in developing a corporate culture, organizational structure, and management team that align with the demands of the digital age [96].

5.4. Limitations and Future Directions

This study has the following limitations. (1) When examining the competitiveness of employees, we focused solely on the categorization of knowledge and skills, specifically considering individuals with a bachelor's degree or higher. However, the influence of skilled individuals who possess digital competence and technical knowledge but do not hold a bachelor's degree on corporate sustainability remains unexplored. Future research endeavors could investigate the impact of this aspect to further refine our understanding of how human capital affects firm sustainability in the context of digital transformation. (2) Our study provided an intra-organizational explanation for the conundrum of the relationship between digitalization and corporate performance. There are additional variables that can influence corporate sustainability, such as green performance, including minimizing waste generation, promoting renewable energy sources, and adopting circular economy practices. Active stakeholder engagement, involving customers, suppliers, investors, and local communities, is another significant factor. Future research aims to explore this intriguing issue from those perspectives, examining the impact of these variables on corporate sustainability. (3) Firms of varying sizes possess distinct degrees of digital maturity, and the opportunities and threats associated with digital transformation may have different impacts on firm sustainability. Thus, future research could encompass small- and medium-sized enterprises (SMEs) in China, as well as businesses from various other nations, as potential subjects of investigation to explore how businesses can be sustainable in the age of the digital revolution.

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Appendix A. Detailed Keywords

Artificial intelligence	Artificial intelligence, business intelligence, image interpretation, investment decision support system, intelligent data analysis, intelligent robot, machine learning, deep learning, semantic search, biometric technology, face recognition, speech recognition, authentication, automatic driving, natural language processing.
Big data technology	Big data, data mining, text mining, data visualization, heterogeneous data, credit investigation, augmented reality, mixed reality, virtual reality.

Cloud computing technology	Cloud computing, stream computing, graph computing, memory computing, multi-party security computing, brain like computing, green computing, cognitive computing, fusion architecture, hundred million concurrence, EB level storage, the Internet of things, information physics system.
Blockchain technology	Blockchain, digital currency, distributed computing, differential privacy technology, smart financial contract.
Digital technology application	Mobile Internet, industrial Internet, internet medical, e-commerce, mobile payment, third-party payment, NFC payment, smart energy, B2B, B2C, C2B, C2C, O2O, Internet connection, smart wear, smart agriculture, smart transportation, smart medical, smart customer service, smart home, smart investment consultant, smart culture and tourism, smart environmental protection, smart grid, smart marketing, Digital marketing, unmanned retail, Internet finance, digital finance, Fintech, financial technology, quantitative finance, open banking.

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