sustainability

Article

Digital Transformation, Green Technology Innovation and Enterprise Financial Performance: Empirical Evidence from the Textual Analysis of the Annual Reports of Listed Renewable Energy Enterprises in China

Yangjun Ren [1,2,*] and Botang Li [3]

[1] School of Economics and Trade, Changzhou Vocational Institute of Textile and Garment, Changzhou 213164, China
[2] Jiangsu Institute of Costume Culture, Changzhou Vocational Institute of Textile and Garment, Changzhou 213164, China
[3] School of Port and Shipping Management, Guangzhou Maritime University, Guangzhou 510725, China
* Correspondence: yjren@cztgi.edu.cn

Abstract: Digital transformation in renewable energy enterprises offers critical opportunities for China's green orientation and sustainable growth. Based on a statistical data of Chinese A-share listed renewable energy companies, we explore the effects of digital transformation on a company's financial performance and the mediating role of green technology innovation. The findings indicate that there is a driving effect of digital transformation on renewable energy companies' financial performance. Our results remain valid after a series of robustness tests. Furthermore, a heterogeneous analysis indicates that enhancing digital transformation only positively affects the financial performance of state-owned firms and firms in the eastern area, and the driving effect of digital transformation is greater for large firms. In addition, green technology innovation plays a complete mediating role in digital transformation's impact on renewable energy enterprises' financial performance. Specifically, when a renewable energy company has digital transformation, it has better green technology innovation leading to better financial performance. Our results provide vital implications for promoting the effectiveness of digital transformation in the development of renewable energy enterprises.

Keywords: digital transformation; financial performance; renewable energy enterprises; green technology innovation; China

check for updates

Citation: Ren, Y.; Li, B. Digital Transformation, Green Technology Innovation and Enterprise Financial Performance: Empirical Evidence from the Textual Analysis of the Annual Reports of Listed Renewable Energy Enterprises in China. *Sustainability* **2023**, *15*, 712. https://doi.org/10.3390/su15010712

Academic Editor: Mohammed Lotfy

Received: 23 November 2022
Revised: 17 December 2022
Accepted: 27 December 2022
Published: 30 December 2022

1. Introduction

As the digital economy expands, digitalization has become a significant global trend [1]. A rising number of enterprises have been embracing digital transformation (DT) with edge-cutting technologies to respond to this trend [2]. DT, as a process of data collection, storage and analysis using advanced digital technologies, has become a strategic selection for many firms to improve productivity [3,4]. As a result of the deep adjustments in technology and the market environment brought about by the advent of the digital economy, more and more Chinese firms are turning to digital technologies to encourage organizational optimization and speed up the pace of innovation in products and services, thus creating new momentum for China's economic expansion [1]. In 2021, there were over 1000 listed enterprises with the digital economy as the primary sector, with listed digital companies spanning almost all industries.

China's rapid economic growth has brought about the challenges of energy deficiency and environmental degradation. Enhancing the ecological environment has become essential to China's economic growth strategy. Considering that the use of renewable energy can alleviate these issues [5,6], an increasing number of domestic enterprises are moving their attention to renewable energy and new energy [7]. Accelerating the growth of the renewable energy industry is a crucial part of the world's energy structure transformation and a critical path to achieving the global carbon neutrality target [8]. Moreover, industrial innovation and technological progress based on renewable energy have become significant drivers of global economic growth, and the focus of international competition will shift to control the value chain of low-carbon technologies represented by renewable energy [9]. China is vigorously promoting the strategic adjustment of its energy structure, actively developing renewable energy resources.

More importantly, listed renewable energy enterprises shoulder the critical mission of driving general enterprises to increase production and generate income, optimizing the energy structure and promoting the healthy development of the renewable energy industry. Meanwhile, their financial performance level represents the reality and growth prospects of the renewable energy industry. Consequently, digital technology should be integrated into the entire development process of renewable energy companies to completely fulfill their DT strategy and enhance corporate performance [10,11]. In 2022, China Energy Administration has issued the "14th Five-Year Plan for Science and Technology Innovation in the Energy Sector" and proposed to speed up the development of new energy and digital energy, which fully recognizes the importance of digital technology in enhancing the structural transformation of energy consumption. Thus, it is evident that it has become a social consensus to accelerate renewable energy enterprises' DT and to achieve digital technology coverage of the renewable energy industry.

Although many Chinese firms are interested in DT, it is challenging to judge if it will result in effective performance improvement and increase enterprise value. Fitzgerald et al. [12] reported on the phenomenon of a digital technology paradox. Specifically, managers recognize the benefits of DT adoption but are disappointed with the effectiveness of digital technology for their firms. According to a Wipro Digital survey in 2017 in the US, half of the senior respondents believed that the DT process in their firms was challenging and ultimately unsuccessful. Moreover, DT implementation is complicated owing to the enormous costs, learning curve, and necessary changes [1]. In addition, the renewable energy industry's DT adoption has several areas for improvement in infrastructure, application services, and digital technologies [13,14], which results in a low level of integration between the digital economy and the renewable energy sector.

Therefore, one fundamental question emerges: Does DT promote the financial performance of China's renewable energy companies in the new digital economy? If so, what are the inherent transmission mechanisms for the effects of DT on renewable energy companies' financial performance? The resolution of these issues is relevant to the effective promotion of renewable energy companies' DT and the development of relevant renewable energy policies. Green technology innovation (GTI) mainly refers to innovation activities that aim to enhance energy saving and emission reduction, reduce environmental pollution and use renewable energy. Moreover, Green technology innovation, a new form of traditional innovation from the perspective of ecological civilization, emphasizes the harmonization of economic, social and ecological benefits, which is considered a critical force for sustainable economic development [15]. In addition, DT is naturally embedded in the concept of green development and can provide a strong internal driving force for green technology innovation. Thus, does DT contribute to green technology innovation? Can DT improve renewable energy enterprises' financial performance by driving green technology innovation? Nevertheless, studies on these issues are still rare. This study aims to explore the influence of DT on a renewable energy enterprise's financial performance in China. Further, we focus on the mediating role of green technology innovation in DT affecting renewable energy enterprises' financial performance.

Using the textual analysis method, we measure the extent of a renewable energy company's DT based on its annual report. Then, we use a sample of China's A-share listed renewable energy enterprises for the period of 2009–2021 in our study. The findings reveal that increased DT promotes a renewable energy company's financial performance. Different renewable energy enterprises in the sample have different responses to DT strategy, depending on ownership type, scale, and region. DT has a positive impact on the financial performance of state-owned firms (SOF) and firms in the eastern area, and the marginal effect of DT is greater for large firms. Furthermore, consistent with intuition, green technology innovation plays a crucial mediating role in the process of DT promoting renewable energy enterprises' financial performance. Specifically, DT can significantly improve green technology innovation, thereby contributing to improving a renewable energy company's financial performance. In addition, a series of robustness tests verify the benchmark model's findings, confirming that there is a positive correlation between DT and renewable energy companies' financial performance.

This research contributes to existing studies in the following ways. First, this paper answers the research question that whether DT can contribute to the growth of renewable energy companies. Most previous research focuses on the role of DT in a company's financial performance [16–19]. Moreover, some scholars have argued that DT may enhance corporate performance by boosting operating efficiency, decreasing costs, and fostering innovation [20–24]. However, these studies do not carry out targeted research on renewable energy enterprises. We bring DT and renewable energy enterprises' financial performance into a unified analytical framework. By using textual analysis to measure firms' DT level, we can calculate to what degree DT has enabled renewable energy enterprises to make more efforts in performance improvement. Overall, this is the first research to explore the influence of DT on the renewable energy industry's growth systematically adopting firm-level data. Moreover, its pertinence and feasibility are more substantial than the universal study of the relationship between DT and firm performance.

Second, this research helps understand whether DT affects renewable energy enterprises' financial performance differently across firms' ownership types, scales, and regions. The differences in operation features between SOF and non-state-owned firms (NSOF), and the regional heterogeneity in China have a vital influence on corporate performance [25–27]. Thereby, this paper contributes to the existing studies and gives insight into the influence of DT on the development of renewable energy enterprises. Moreover, it provides important lessons for developing differentiated DT policies to improve renewable energy enterprises' financial performance.

Third, from the perspective of green technology innovation, this study endeavors to analyze the transmission mechanisms for the impact of DT on a renewable energy company's financial performance. Previous research on DT has mainly examined its direct impact on firm performance [28–30], lacking insight into the indirect pathways through which DT affects enterprise performance. Green technology innovation is a core factor influencing corporate performance improvement [31,32]. Thus, exploring whether DT enhances renewable energy enterprises' financial performance by promoting green technology innovation is essential for understanding the inherent mechanisms underlying the impact of DT on corporate performance.

The remainder of this research is organized as follows. Section 2 covers the related literature and hypotheses. Section 3 describes the methodology and data. Section 4 summarizes and discusses the research results. Section 5 gives the conclusions and policy implications.

2. Literature Review and Hypotheses Development

2.1. Literature Review

Academic circles are divided on the definition of DT. Fitzgerald et al. [12] defined it as the use of digital technology for major business transformation, including promoting user experience, streamlining operational models, and developing new business models. Mergel et al. [33] interpreted it as a demand to maintain a high degree of market competitiveness in the digital economy by offering goods and services online and offline utilizing new technologies. Reis [34] described it as using new digital technologies to accomplish critical business changes and improve users' quality of life by delivering superior services. Verhoef et al. [35] and Schallmo et al. [36] defined it as the use of digital technology to gather, cleanse, and analyze data to extract valuable business information, which may be used to assess new digital business models and assist firms in creating corporate value and enhancing performance. To summarize, DT may be summed up as "enterprise plus technology plus data", which is characterized by efficiency improvement, model innovation, and value creation. Furthermore, this description is in line with current research on DT [30]. In addition, through digital technology, DT fundamentally enhances the optimization and innovation of production methods, organization and business models [23]. Firms use DT to make strategic behavioral changes by weighing up their resources and external environment, thus creating corporate value and achieving competitive improvements.

At present, there is little research on whether DT can increase corporate performance, and the findings also differ. Some research has found that traditional digital technologies have no significant effect on corporate performance [37]. Nevertheless, some scholars argue that DT and corporate performance are positively correlated based on quantitative and empirical research [28–30]. DT can analyze the personalized demands of users and increase the breadth and depth of data analysis through new participants, enhancing the quality of goods and services and reshaping the value-creation mechanism of stakeholders in the traditional business model [38]. Similarly, Lorenzo et al. [39] believed that DT could enhance enterprise innovation based on a sample of small US firms. Llopis-Albert et al. [40] explored the effects of DT on corporate performance and stakeholder satisfaction in the vehicle sector, revealing that a DT strategy resulted in increased profitability and competitiveness. Ribeiro-Navarrete et al. [41] used training in digital tools and social networks to quantify the extent of DT. Furthermore, they verified the promoting effect of DT on financial performance in the service sector. In addition, some scholars have pointed out that the greater the quality of DT, the greater the organization's productivity [16,41].

To summarize, the literature implies that DT improves an enterprise's financial performance. However, the evidence is unclear because of the non-comprehensive nature of exploring an enterprise's DT in the studies. Moreover, most evidence comes from manufacturing or services, and the renewable energy industry is not emphasized. In addition, in the field of sustainable theory, green technology innovation and technology are essential factors influencing the green economy. Some research argues that DT can drive a company's technological innovation, which ignores the effects of DT on green technology innovation. Meanwhile, it is still being determined whether DT has the function of improving renewable energy enterprises' financial performance by promoting green technology innovation. Thus, there is still potential to investigate the influence of DT on a renewable energy company's financial performance and the mediating role of green technology innovation.

2.2. Hypotheses Development

This research hypothesizes that if a renewable energy company has DT, its financial performance is better than one without DT for three reasons. First, DT can effectively improve a firm's operational efficiency. The widespread use of digital technology can improve production tools' efficiency, significantly reducing maintenance and inventory costs and increasing productivity. Moreover, if a company selects a DT strategy, it represents its ambition to create corporate value by applying diverse digital technologies to its operations. Moreover, a company's goal of pursuing DT will be integrated into the corporate culture, improving its motivation and competitiveness [42,43].

Second, DT can help an enterprise reduce operational costs. Using digital technologies such as big data, cloud computing, and machine learning, an enterprise can collect and analyze helpful information from R&D, raw material procurement, product manufacturing, and product sales, thereby improving communication efficiency between the upstream and downstream of the industrial chains and reducing production and management costs. Furthermore, the advancement of digital technology may effectively address the issue of information asymmetry, reducing firms' costs of information collecting, product creation and contract fulfillment and enhancing their resource utilization efficiency [44,45]. In addition, through DT, there is more effective communication between shareholders and managers, managers and employees, contributing to cost savings for a firm.

Third, the applications of digital technologies and internet business models have also given rise to a new form of sharing economy. The sharing of technology, equipment and services among firms can lower the threshold for resource utilization and production costs, effectively solving the shortage of production capital and improving the allocation of production materials [46]. In addition, DT enables firms to access new information and relationships, thus fostering innovation and market globalization [47]. Collectively, a DT strategy promotes a company's operational efficiency, cost savings and innovation. Consequently, if a company has DT, its financial performance is higher than one without DT. Thus, the first hypothesis is proposed as follows:

Hypothesis 1. *DT has a positive impact on renewable energy enterprises' financial performance.*

DT can not only reduce the consumption of resources in the economy and society and achieve energy-saving and environmental protection, but also break through the limitation of time and space through the effective use of data and information, thus promoting the optimization of resource use among different regions or organizations. Overall, green development is integrated into the essence of DT, which can provide a strong internal driving force for green technology innovation in renewable energy enterprises. First, DT can optimize the allocation of internal and external resources, stimulate the innovation potential of enterprises and provide an internal impetus for green innovation activities [21]. In fact, green innovation activities are complex and long-term, requiring enterprises to have strong resource integration capabilities. Using digital technology can effectively reduce the cost of information utilization, strengthen the collaboration between enterprises and improve the allocation of resources, thus promoting the smooth implementation of green innovation activities in enterprises [48]. In addition, not only does DT promote information sharing and knowledge integration, but it can also refine new information and knowledge, which helps to stimulate enterprise innovation and increase intellectual capital [49]. Second, DT can enhance external oversight and mitigate conflicts over internal innovation activities. Compared to traditional innovation, green technology innovation has a higher degree of information opacity in the development and application of results, making it difficult for company managers to monitor it effectively [50]. However, the widespread use of digital technologies can help firms grasp the latest innovation data and visualize their innovation activities in a timely manner, thus reducing their monitoring costs. Moreover, it reduces conflicts between different levels within the company and promotes green technology innovation. Third, the existing innovation models can be improved by DT. By building digital platforms to achieve broader collaboration with multiple innovation actors, such as external research institutions and consumers, firms can improve their integrated open innovation model, stimulate their green technology innovation and have a positive effect on the quality and quantity of innovation activities.

Green technology innovation, as an essential part of an enterprise's sustainable growth strategy, improves its ability to respond to the challenges of the natural environment and achieve sustainable development, thus improving its competitiveness and corporate performance [51]. First, green technology innovation can help firms gain more profits through green technology [31,32]. Moreover, by producing green and innovative products to occupy more green market share, firms can gain users' trust to inspire green purchasing behavior, improving their market competitiveness [52]. Second, if a firm has green technology innovation, it can reduce its operating costs, thus improving firm performance. Chen et al. [53] argued that through green technology innovation, firms not only enhanced the protection of the natural environment but also reduced the economic penalties they endured because of environmental pollution. Zhu et al. [54] demonstrated that firms used cutting-edge green technologies to solve environmental pollution problems and reduced the costs of environmental pollution control. Dangelico and Pontrandolfo [55] founded that green technology innovation could promote resource utilization efficiency and reduce operating costs, thereby improving corporate performance. Third, green technology innovation can bring differentiated competitive advantages to firms, thus improving their financial performance. Chiou et al. [56] believed that green technology innovation, with originality and difficulty of imitation, created barriers for potential competitors and improved a firm's economic efficiency. Phan and Baird [57] revealed that firms would accumulate a lot of green technologies and knowledge in green technology innovation, improving their ability to cope with environmental uncertainty and enhancing their environmental management systems, which will promote their core competitiveness and sustainable improvement in financial performance. The above discussion leads to the second hypothesis:

Hypothesis 2. *DT can indirectly enhance renewable energy enterprises' financial performance by promoting green technology innovation.*

3. Data, Variables and Methods

3.1. Data

This research surveys a panel data of Chinese A-share listed new energy vehicle enterprises. The sample examination period is set to 2009–2021. The beginning of 2009 is an attempt to eliminate the effects of the global financial crisis in 2008, which may hamper an enterprise's financial performance and its ambition to undertake DT. To effectively evaluate the impact of DT on corporate performance, we delete enterprises as follows: (1) ST and *ST listed enterprises; (2) enterprises with missing financial data. The final sample has 793 firm-years. The financial data is collected from the CSMAR databases. In addition, to overcome the effect of extreme values on the empirical results, we winsorize the continuous variables at the 1% and 99% levels.

3.2. Variables

3.2.1. Explained Variables

The explained variable is enterprise performance. Accounting-based measures ROA and ROE are chosen over market-based measures like Tobin's Q. One possible reason is that accounting-based measures are vulnerable to investor expectation and manager's profits manipulation [58]. Moreover, Hutchinson and Gul [59] argued that accounting-based measures could better evaluate the management level of a firm. Therefore, we use ROA (net income to total assets ratio in percent) and ROE (net income to shareholder equity in percent) to represent a renewable energy company's financial performance.

3.2.2. Explanatory Variable

The core explanatory variable is DT in the research. Verhoef et al. [35] pointed out a company's DT included digital technology application, business model innovation, and digital strategy. The third component builds on the first two. Referring to Gal et al. [60], we focus on the first two to calculate a company's DT level.

This research uses the following steps to collect a company's DT information. Firstly, using Python software, we do textual analysis on the annual reports of renewable energy companies to identify the keywords associated with DT. Specifically, we use a dictionary of 49 and 42 keywords relevant to the underlying technology and practical application for the textual analysis. Secondly, after identifying a renewable energy company's annual report with the keywords, we use Python to count the number of distinct different digital technologies and business model innovations in a renewable energy company's annual report. Finally, the occurrences of each keyword are counted and summed to determine the total number of occurrences in an annual report. Furthermore, the natural logarithm of 1 plus the total number of occurrences is used as a proxy variable for DT.

3.2.3. Mediating Variable

The mediating variable is green technology innovation (GTI). This paper uses the total number of green patent applications to evaluate a renewable energy company's green technology innovation level. Specifically, the number of green invention patent applications and the number of green utility model patent applications are summed to get the total number of green innovation patent applications. Moreover, the natural logarithm of 1 plus the total number of green innovation patent applications is used to measure GTI.

3.2.4. Control Variables

This paper control six variables thought to influence firm performance, including enterprise size (ES), revenue growth rate (RGR), asset liquidity (AL), equity multiplier (EM), board independence (BI), and the ownership of the largest shareholder (LS). Specifically, ES is measured as the natural logarithm of year-end total assets. AL is defined as current assets divided by current liabilities. The ratio of total assets to shareholder equity is used for measuring EM. BI is measured as the number of independent directors to board size ratio in percent. OS is represented by the percentage ownership of the largest shareholder. Table 1 presents the descriptive statistics.

Table 1. Descriptive statistics.

Variables	Obs.	Mean	S.D.	Min	Max
ROA	793	0.0358	0.0402	−0.0282	0.4388
ROE	793	0.0910	0.0796	−0.0789	0.7833
DT	793	1.7197	1.0650	0.0000	3.2958
GTI	793	0.4815	0.7252	0.0000	3.9512
ES	793	22.4598	1.2812	17.7826	25.8970
RGR	793	0.1264	0.2058	−0.4682	2.1797
AL	793	0.5372	0.1354	0.1344	0.7643
EM	793	2.1952	1.2478	1.0164	6.1431
BI	793	31.4631	4.2617	27.2830	45.7928
LS	793	29.5367	9.6491	12.2845	67.2832

3.3. Econometric Methods

The benchmark model is Equation (1), where ROA_{it} is return on assets, and ROE_{it} is return on equity. DT_{it} is digital transformation. X_{it} is a series of control variables. μ_i and δ_t are the individual and time fixed effects, respectively. ε_{it} is the error term.

$$ROA_{it}(ROE_{it}) = \beta_0 + \beta_1 DT_{it} + \beta_2 X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

This research also explores whether green technology innovation has a mediating role in the mechanism. Our mediating effect references Baron and Kenny [61]. Using the stepwise regression method, we construct the following model:

$$GTI_{it} = \theta_0 + \theta_1 DT_{it} + \theta_2 X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

$$ROA_{it}(ROE_{it}) = \phi_0 + \phi_1 GTI_{it} + \phi_2 DT_{it} + \phi_3 X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

where GTI_{it} represents green technology innovation, namely the mediating variable. The specific test steps are as follows: First, if β_1 is significant, follow-up test is carried out. Second, when β_1 is significant, θ_1, ϕ_1, and ϕ_2 are tested in three cases. If θ_1, ϕ_1, and ϕ_2 are all significant, there is a partial mediating effect. If θ_1 and ϕ_1 are all significant, but ϕ_2 is not significant, a complete mediating effect can be considered. If either θ_1 or ϕ_1 is not significant, the bootstrap sampling method is used to test whether the mediating effect exists.

4. Results Analysis and Discussion

4.1. Baseline Findings and Robustness Tests

The benchmark regression findings are detailed in Table 2. The findings of Columns (1) and (2) reveal that when only fixing the individual and time effects, DT has a significantly positive effect on the renewable energy enterprises' ROA and ROE, indicating that enhanced DT contributes to improving a renewable energy company's financial performance. In columns (3) and (4), the coefficients of DT remain positively significant at 1% after adding all the control variables. In column (3), for instance, the coefficient of DT is 0.0442, suggesting that a one percentage point increase in the level of DT increases a firm's ROA by 0.0442 percentage points. Hypothesis 1 is verified.

Table 2. Benchmark results.

Variables	ROA	ROE	ROA	ROE
	(1)	(2)	(3)	(4)
DT	0.0540 *** (4.21)	0.0708 *** (5.88)	0.0442 *** (4.64)	0.0648 *** (4.77)
ES			0.0359 *** (4.75)	0.0205 *** (4.20)
RGR			0.0248 *** (4.14)	0.0270 *** (4.71)
AL			0.5312 *** (3.07)	0.5385 *** (4.11)
EM			−0.1635 * (−1.85)	−0.1147 * (−1.70)
BI			−0.0390 (−1.28)	−0.0785 (−1.54)
LS			0.0536 *** (6.21)	0.0791 *** (5.36)
_cons	3.8560 *** (11.79)	2.5740*** (9.12)	−1.1987 *** (−6.01)	−1.7394 *** (−7.16)
IE	YES	YES	YES	YES
YE	YES	YES	YES	YES
Obs.	793	793	793	793
R^2	0.2310	0.2136	0.2491	0.2270

Note: * $p < 0.1$, *** $p < 0.01$. T-statistics are in parentheses.

Control variables, if significant, carry the anticipated signs. For example, the coefficients of ES, RGR, AL and LS positively influence renewable energy enterprises' financial performance, illustrating that when a firm has a large scale, growing profitability, strong assets liquidity and significant-top shareholder ownership, its financial performance will be enhanced. With a negative coefficient, EM has passed the significance test, revealing that a higher equity multiplier blocks renewable energy enterprises' financial performance.

To determine the reliability of the benchmark model's findings, we carry out a series of robustness tests. First, the rapid spread of the COVID-19 pandemic in China in 2020 has had a phased impact on our economic and social development. To avoid the ongoing effects of the COVID-19 pandemic, we eliminate the observations for 2020 and 2021 in the regression analysis. Second, financial leverage (the ratio of total liabilities to total assets) can directly affect a company's profitability, and the age of a company may influence its vitality and innovation to some extent. Therefore, this study adds the two variables to the benchmark model to address endogeneity issues because of omitting variables. Third, total factor productivity calculated by the LP method is used as an alternative indicator for corporate performance. Specifically, we use the number of employees and net fixed assets of a firm as labor and capital input variables, respectively, and a firm's operating income as the output variable. In addition, the intermediate input variable is the total of all costs excluding depreciation and amortization. For brevity, the coefficients of control variables are not reported hereafter. The findings of Columns (1)–(6) in Table 3 demonstrate that DT still significantly drives renewable energy enterprises' financial performance, consistent with the benchmark model's results. Hypothesis 1 is again supported.

Table 3. Robustness tests.

Variables	Excluding the Observations in 2020 and 2021		Adding Control Variables		Alternative Indicator for Corporate Performance
	ROA	ROE	ROA	ROE	TFP
	(1)	(2)	(3)	(4)	(5)
DT	0.0376 ***	0.0615 ***	0.0325 ***	0.0619 ***	0.0214 ***
	(4.98)	(4.81)	(4.56)	(3.45)	(3.29)
_cons	−3.0425 ***	−3.6116 ***	−2.7599 ***	−3.3842 ***	−2.1633 ***
	(−9.785)	(−11.05)	(−6.25)	(−8.69)	(−8.10)
Control Variables	YES	YES	YES	YES	YES
IE	YES	YES	YES	YES	YES
YE	YES	YES	YES	YES	YES
Obs.	671	671	793	793	793
R^2	0.2585	0.2349	0.2756	0.2157	0.2557

Note: *** $p < 0.01$. T-statistics are in parentheses.

4.2. Heterogeneous Effects

4.2.1. Ownership Heterogeneity

In this section, to compare the magnitude of the effects of DT, the entire sample is separated into two subsamples based on firms' ownership: SOFs and NSOFs. The specific findings are shown in Table 4. In Columns (1) and (2), we obtain findings consistent with the benchmark regressions. The coefficients of DT are significantly positive, suggesting that DT plays a driving role in the performance improvement of the state-owned renewable energy firms. However, the findings of Columns (3) and (4) reveal an insignificant effect of DT on the non-state-owned renewable energy firms' financial performance. SOFs have distinct advantages over NSOFs in terms of access to resources [62], allocation [63], and government subsidies [64]. Moreover, SOFs have better access to valuable information on government policies and financial subsidies than NSOFs. In addition, banks play a critical role in financing a firm's DT strategy. However, they are likely to discriminate against some firms based on ownership type, allowing SOFs to use their natural advantages to drive DT. Conversely, NSOFs find it challenging to benefit from external investment, which hinders their DT progress.

Table 4. Heterogeneity analysis of ownership.

Variables	SOFs		NSOFs	
	ROA	ROE	ROA	ROE
	(1)	(2)	(3)	(4)
DT	0.0428 ***	0.0739 ***	0.0256	0.0571
	(4.26)	(4.34)	(1.54)	(1.13)
_cons	−3.7655 ***	−2.4438 ***	−2.3080 ***	−2.1759 ***
	(−9.62)	(−6.11)	(−7.15)	(−5.15)
Control Variables	YES	YES	YES	YES
IE	YES	YES	YES	YES
YE	YES	YES	YES	YES
Obs.	260	260	533	533
R^2	0.2782	0.2973	0.1413	0.1286

Note: *** $p < 0.01$. T-statistics are in parentheses.

4.2.2. Scale Heterogeneity

To investigate the heterogeneity impact according to firm scale, this research divides the whole sample into large and small firms according to firms' total assets. The findings of Table 5 reveal that DT can effectively improve renewable energy enterprises' financial performance regardless of their scale differences. However, the driving effect of DT is greater for large firms (weaker for small firms). This conclusion is in line with the fact that small firms are more vulnerable to financial and technical obstacles when adopting DT. Large firms are unlikely to encounter financial barriers in their DT. Meanwhile, they have sufficient resources to build digital infrastructure and develop autonomous innovation capabilities. In addition, large firms have a tremendous advantage in setting up digital management systems and overcoming critical technical challenges, improving their core competencies and building a sustainable competitive advantage by integrating internal and external resources and enabling interactive innovation around data, business processes and organizations. As a result, the contribution of DT to corporate performance is effectively leveraged in large firms compared to small firms.

Table 5. Heterogeneity analysis of firm scale.

Variables	Above Mean		Below Mean	
	ROA (1)	**ROE (2)**	**ROA (3)**	**ROE (4)**
DT	0.0404 *** (4.87)	0.0711 *** (5.22)	0.0359 ** (2.07)	0.0532 ** (2.13)
_cons	−2.1637 *** (−6.90)	−2.9384 *** (−8.62)	−2.5007 *** (−6.16)	−2.7951 *** (−7.39)
Control Variables	YES	YES	YES	YES
IE	YES	YES	YES	YES
YE	YES	YES	YES	YES
Obs.	312	312	481	481
R^2	0.2917	0.2325	0.2439	0.2047

Note: ** $p < 0.05$. *** $p < 0.01$. T-statistics are in parentheses.

4.2.3. Regional Heterogeneity

To explore the heterogeneous influence of DT on renewable energy companies' financial performance among different parts, this paper separates the whole sample into three subsamples according to firms' location: the eastern, central, and western regions. The findings of Columns (1) and (2) in Table 6 are consistent with the benchmark findings, revealing that DT has a positive effect on corporate performance in the east. However, as can be seen from Columns (3)–(6), DT has no significant impact on companies in the central and western areas. A distinctive feature is the uneven development across regions due to government policies, regional resource endowments, factor mobility, and the interplay among these factors [65–68]. Overall, the eastern area is more developed than the central and western regions, particularly in terms of infrastructure, technical innovation, and the environment for innovation and industrial growth. Thus, renewable energy enterprises in the eastern area are able to adopt DT to improve their financial performance. However, it is challenging for renewable energy enterprises in the central and western regions to leverage the performance-enhancing role of DT.

4.3. Mediating Effects

Table 7 presents the mediating effect model's regression findings. In the above research, we have demonstrated that DT can effectively improve renewable energy enterprises' financial performance. Column (1) reveals that the influence of DT on green technology innovation is positive and significant, indicating that DT can effectively improve renewable energy enterprises' green technology innovation. Green technology innovation is also shown to have a positive effect on the renewable energy enterprises' ROA and ROE in Columns (2) and (3). However, the estimated coefficients and significance of DT have decreased and are insignificant, revealing that green technology innovation presents a complete mediating effect. This further demonstrates that DT can drive the renewable energy enterprises' financial performance through green technology innovation. As explained in Hypothesis 2, DT can optimize the allocation of internal and external resources, strengthen external oversight and reduce the renewable energy enterprises' agency conflicts between different levels, which provide lasting momentum for green technology innovation. Furthermore, green technology innovation can help the renewable energy enterprises make more profits, reduce operating costs and provide them with a differentiated competitive advantage, thus improving their financial performance.

Table 6. Heterogeneity analysis of region.

Variables	Eastern Region		Central Region		Western Region	
	ROA	**ROE**	**ROA**	**ROE**	**ROA**	**ROE**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
DT	0.0424 ***	0.0633 ***	0.0241	0.0432	0.0245	0.034
	(4.56)	(5.14)	(1.55)	(1.35)	(1.49)	(1.22)
_cons	−2.3190 ***	−2.8526 ***	−2.6935 ***	−2.0890 ***	−1.4802 ***	−2.8521 ***
	(−6.59)	(−8.08)	(−6.61)	(−7.07)	(−4.87)	(−4.54)
Control Variables	YES	YES	YES	YES	YES	YES
IE	YES	YES	YES	YES	YES	YES
YE	YES	YES	YES	YES	YES	YES
Obs.	553	553	169	169	91	91
R^2	0.318	0.2947	0.1292	0.1569	0.134	0.1478

Note: *** $p < 0.01$. T-statistics are in parentheses.

Table 7. Mediating effects.

Variables	GTI	ROA	ROE
	(1)	**(2)**	**(3)**
DT	0.0561 ***	0.0364	0.0549
	(4.14)	(1.02)	(1.18)
GTI		0.1275 ***	0.1851 ***
		(3.65)	(5.18)
_cons	−2.0335 ***	−3.5440 ***	−4.6186 ***
	(−5.28)	(−7.27)	(−8.13)
Control Variables	YES	YES	YES
IE	YES	YES	YES
YE	YES	YES	YES
Obs.	793	793	793
R^2	0.2509	0.2808	0.2961

Note: *** $p < 0.01$. T-statistics are in parentheses.

5. Conclusions and Policy Implications

Using the panel data of Chinese listed renewable energy enterprises from 2008 to 2021, this research explores the influencing mechanisms of DT driving renewable energy enterprises' financial performance. The main contribution of this study is to construct a detailed empirical framework to evaluate the relationship among DT, green technology innovation and renewable energy enterprises' financial performance, narrowing the gaps of existing research. The results confirm that DT can effectively enhance a renewable energy company's financial performance. The findings are robust to excluding specific samples, adding control variables and selecting alternative explained variable. Moreover, the driving effect of DT on corporate performance is significant for SOFs and firms in the eastern area, and is greater for large firms. We further find that green technology innovation plays a complete mediating role in DT and business performance. Specifically, DT can indirectly drive renewable energy enterprises' financial performance through green technology innovation.

This study provides several crucial policy implications for better leveraging DT. First, green innovation, as a way of corporate activity that integrates the two development concepts of innovation and green, plays a crucial role in improving corporate performance. Emphasis should be placed on the corporate governance role to promote the renewable energy enterprises' green technology innovation. On the one hand, the firms should strengthen the equipment of digital hardware facilities and optimize the original management model, improving the technical and management bases for DT. On the other hand, the firms should improve their information disclosure mechanism and construct a digital exchange ecosystem for cross-border sharing, thus reducing the degree of information asymmetry within and outside the firms. Second, China's renewable energy industry is typically a policy-oriented industry. The government should formulate targeted preferential policies or action plans for DT and improve the green innovation policy system to create a favorable environment to stimulate innovation, thus improving the expected benefits of firms' green innovation activities and achieving the goal of effectively enhancing their motivation for green technology innovation. Moreover, we should guide the deep integration of digital technology with firms in terms of green products, green processes, organization structures and management processes, promoting green technology innovation, green transformation and performance enhancement in firms. The third is related to the heterogeneous effects of DT. Depending on the sensitivity of firms to DT under various conditions, including ownership, scale, and geographical location, we should adjust the level of support for DT accordingly. For instance, government subsidies can be increased in NSOFs and firms in the central and western regions. Moreover, financial institutions should accurately assess the financial conditions of different types of enterprises to provide personalized financial services and enhance the scientific allocation of resources, thereby promoting the vitality of small enterprises and ensuring the stability of large enterprises.

This research has its potential limitations. First, the study sample only covers Chinese A-share listed renewable energy companies. The domestic unlisted firms and firms that are not listed in the A-share market are not explored in our analysis because of data unavailability. Future research should consider more renewable energy firms to verify the findings. Second, although this research empirically investigates the effects of DT on renewable energy companies' financial performance and the mediating role of green technology innovation, there is a lack of deep discussion on the theoretical influencing mechanisms that affect the relationship among DT, green technology innovation and renewable energy enterprises' financial performance. Thus, constructing a theoretical model to describe the relationship would be innovative in future research. Third, this research draws our findings from one single country. It might be desirable and meaningful to investigate another emerging country.

Author Contributions: Conceptualization, Y.R.; methodology, Y.R. and B.L.; validation, Y.R. and B.L.; formal analysis, Y.R. and B.L.; data curation, Y.R.; writing—original draft preparation, Y.R. and B.L.; writing—review and editing, Y.R. and B.L.; supervision, Y.R.; project administration: Y.R.; funding acquisition, Y.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Natural Science Research Project in Jiangsu Province Universities (20KJB630015), Philosophy and Social Science Research Project of Jiangsu Province Universities (2020SJA1278) and Excellent Teaching Team of "Blue Project" of Jiangsu Universities in 2020 (2020).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Zhai, H.Y.; Yang, M.; Chan, K.C. Does digital transformation enhance a firm's performance? Evidence from China. *Technol. Soc.* **2022**, *68*, 101841. [CrossRef]
2. Ma, D.; Zhu, Q. Innovation in emerging economics: Research on the digital economy driving high-quality green development. *J. Bus. Res.* **2022**, *145*, 801–813. [CrossRef]
3. Dey, K.; Saha, S. Influence of procurement decisions in two-period green supply chain. *J. Clean. Prod.* **2018**, *190*, 388–402. [CrossRef]
4. Adner, R.; Puranam, P.; Zhu, F. What is different about digital strategy? From quantitative to qualitative change. *Strat. Sci.* **2019**, *4*, 253–261. [CrossRef]
5. Moriarty, P.; Honnery, D. Can renewable energy power the future? *Energy Pol.* **2016**, *93*, 3–7. [CrossRef]
6. Wang, Z.; Dong, X. Determinants and policy implications of residents' new energy vehicle purchases: The evidence from China. *Nat. Hazards* **2016**, *82*, 155–173. [CrossRef]
7. Akintande, O.J.; Olubusoye, O.E.; Adenikinju, A.F.; Olanrewaju, B.T. Modeling the determinants of renewable energy consumption: Evidence from the five most populous nations in Africa. *Energy* **2020**, *206*, 117992. [CrossRef]
8. Sheikh, M.A. Energy and renewable energy scenario of Pakistan. *Renew. Sust. Energ. Rev.* **2010**, *14*, 354–363. [CrossRef]
9. Ostergaard, P.A.; Duic, N.; Noorollahi, Y.; Kalogirou, S. Renewable energy for sustainable development. *Renew. Energ.* **2022**, *199*, 1145–1152. [CrossRef]
10. Yuan, X.; Liu, X.; Zuo, J. The development of new energy vehicles for a sustainable future: A review. *Renew. Sustain. Energy Rev.* **2015**, *42*, 298–305. [CrossRef]
11. Hao, H.; Ou, X.; Du, J.; Wang, H.; Ouyang, M. China's electric vehicle subsidy scheme: Rationale and impacts. *Energy Pol.* **2014**, *73*, 722–732. [CrossRef]
12. Fitzgerald, M.; Kruschwitz, N.; Bonnet, D.; Welch, M. Embracing digital technology: A new strategic imperative. *MIT Sloan Manag. Rev.* **2014**, *55*, 1–12.
13. Jaffe, A.B.; Stavins, R.N. The energy-efficiency gap: What does it mean? *Energy Pol.* **1994**, *22*, 804–810. [CrossRef]
14. Roper, S.; Tapinos, E. Taking risks in the face of uncertainty: An exploratory analysis of green innovation. *Technol. Forecast. Soc. Chang.* **2016**, *112*, 357–363. [CrossRef]
15. Wang, M.Y.; Cheng, Z.X.; Li, Y.M.; Li, J.Q.; Guan, K.X. Impact of market regulation on economic and environmental performance: A game model of endogenous green technological innovation. *J. Clean. Prod.* **2022**, *277*, 123969. [CrossRef]
16. Andriushchenko, K.; Buriachenko, A.; Rozhko, O.; Lavruk, O.; Skok, P.; Hlushchenko, Y.; Muzychka, Y.; Slavina, N.; Buchynska, O.; Kondarevych, V. Peculiarities of sustainable development of enterprises in the context of digital transformation. *Entrep. Sustain. Iss.* **2020**, *7*, 2255. [CrossRef] [PubMed]
17. Taques, F.H.; Lopez, M.G.; Basso, L.F.; Areal, N. Indicators used to measure service innovation and manufacturing innovation. *J. Innov. Knowl.* **2021**, *6*, 11–26. [CrossRef]
18. Nwankpa, J.K.; Datta, P. Balancing exploration and exploitation of IT resources: The influence of digital business intensity on perceived organizational performance. *J. Inf. Syst.* **2017**, *26*, 469–488. [CrossRef]
19. Buttice, V.; Caviggioli, F.; Franzoni, C.; Scellato, G.; Stryszowski, P.; Thumm, N. Counterfeiting in digital technologies: An empirical analysis of the economic performance and innovative activities of affected companies. *Res. Policy* **2020**, *49*, 103959. [CrossRef]
20. Shah, S.H.H.; Noor, S.; Shen, L.; Butt, A.S.; Ali, M. Role of privacy/safety risk and trust on the development of presumption and value co-creation under the sharing economy: A moderated mediation model. *Inform. Technol. Dev.* **2021**, *27*, 718–735. [CrossRef]
21. Yoo, Y.; Boland, R.J.; Lyytinen, K.; Majchrzak, A. Organizing for innovation in the digitized world. *Organ. Sci.* **2012**, *23*, 1398–1408. [CrossRef]
22. Galindo-Martín, M.A.; Casta no-Martínez, M.S.; Mendez-Picazo, M.T. Digital transformation, digital dividends and entrepreneurship: A quantitative analysis. *J. Bus. Res.* **2019**, *101*, 522–527. [CrossRef]
23. Ode, E.; Ayavoo, R. The mediating role of knowledge application in the relationship between knowledge management practices and firm innovation. *J. Innov. Knowl.* **2020**, *5*, 210–218. [CrossRef]
24. Horvath, K.; Rabetino, R. Knowledge-intensive territorial servitization: Regional driving forces and the role of the entrepreneurial ecosystem. *Reg. Stud.* **2019**, *53*, 330–340. [CrossRef]
25. Haider, Z.A.; Liu, M.; Wang, Y.F.; Zhang, Y. Government ownership, financial constraint, corruption, and corporate performance: International evidence. *J. Int. Financ. Mark. Inst. Money* **2018**, *53*, 76–93. [CrossRef]
26. Child, J.; Tse, D.K. China's transition and its implications for international business. *Int. Bus. Stud.* **2001**, *32*, 5–21. [CrossRef]
27. Liu, C.; Fang, J.; Xie, R. Energy policy and corporate financial performance: Evidence from China's 11th five-year plan. *Energy Econ.* **2021**, *93*, 105030. [CrossRef]
28. Moretti, F.; Biancardi, D. Inbound open innovation and firm performance. *J. Innov. Knowl.* **2020**, *5*, 1–19. [CrossRef]
29. Kaur, N.; Sood, S.K. An energy-efficient architecture for the internet of things (IoT). *Ieee Syst. J.* **2017**, *11*, 796–805. [CrossRef]
30. Nambisan, S. Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Enterpren. Theor. Pract.* **2017**, *41*, 2017. [CrossRef]
31. Lin, W.L.; Chean, J.H.; Azali, M. Does firm size matter? Evidence on the impact of the green innovation strategy on corporate financial performance in the automotive sector. *J. Clean. Prod.* **2019**, *229*, 974–988. [CrossRef]

32. Li, F.S.; Xu, X.L.; Li, Z.W.; Du, P.C.; Ye, J.F. Can low-carbon technological innovation truly improve enterprise performance? The case of Chinese manufacturing companies. *J. Clean. Prod.* **2021**, *293*, 125949. [CrossRef]
33. Mergel, I.; Edelmann, N.; Haug, N. Defining digital transformation: Results from expert interviews. *Gov. Inform. Q.* **2019**, *36*, 101385. [CrossRef]
34. Reis, J.; Amorim, M. *Digital Transformation: A Literature Review and Guidelines for Future Research. World Conference on Information Systems and Technologies*; Springer: Berlin/Heidelberg, Germany, 2018.
35. Verhoef, P.C.; Broekhuizen, T.; Bart, Y.; Bhattacharya, A.; Dong, Q.; Fabian, N.; Haenlein, M. Digital transformation: A multidisciplinary reflection and research agenda. *J. Bus. Res.* **2021**, *122*, 889–901. [CrossRef]
36. Schallmo, D.; Williams, C.A.; Boardman, L. Digital transformation of business models—Best practice, enablers, and roadmap. *Digit. Disruptive Innov.* **2019**, *5*, 119–138.
37. Curran, D. Risk, innovation, and democracy in the digital economy. *Eur. J. Soc. Theory* **2018**, *21*, 207–226. [CrossRef]
38. Kraus, S.; Schiavone, F.; Pluzhnikova, A.; Invernizzi, A.C. Digital transformation in healthcare: Analyzing the current state-of-research. *J. Bus. Res.* **2021**, *123*, 557–567. [CrossRef]
39. Lorenzo, A.; Simon, R.; Vito, A.; Bernardo, B. The duality of digital and environmental orientations in the context of SMEs: Implications for innovation performance. *J. Bus. Res.* **2021**, *123*, 44–56.
40. Llopis-Albert, C.; Rubio, F.; Valero, F. Impact of digital transformation on the automotive industry. *Technol. Forecast. Soc. Chang.* **2021**, *162*, 120343. [CrossRef]
41. Ribeiro-Navarrete, S.; Botella-Carrubi, D.; Palacios-Marqu'es, D.; Orero-Blat, M. The effect of digitalization on business performance: An applied study of KIBS. *J. Bus. Res.* **2021**, *126*, 319–326. [CrossRef]
42. Hakala, H. Strategic orientations in management literature: Three approaches to understanding the interaction between market, technology, entrepreneurial and learning orientations. *Int. J. Manag. Rev.* **2011**, *13*, 199–217. [CrossRef]
43. Gatignon, H.; Xuereb, J. Strategic orientation of the firm and new product performance. *J. Market. Res.* **1997**, *34*, 77–90. [CrossRef]
44. Lorenzo, A.; Carrillo-Hermosilla, J.; Del Rio, P.; Pontrandolfo, P. Sustainable innovation: Processes, strategies, and outcomes. *Corp. Soc. Responsib. Environ. Manag.* **2019**, *26*, 106–109.
45. Lin, C.; Kunnathur, A. Strategic orientations, developmental culture, and big data capability. *J. Bus. Res.* **2019**, *105*, 49–60. [CrossRef]
46. Lyytinen, K.; Yoo, Y.; Boland, R.J.J. Digital product innovation within four classes of innovation networks. *Y Inf. Syst. J.* **2016**, *26*, 47–75. [CrossRef]
47. Parida, V.; Westerberg, M.; Frishammar, J. Inbound open innovation activities in high-tech SMEs: The impact on innovation performance. *J. Small Bus. Manag.* **2012**, *50*, 283–309. [CrossRef]
48. Bajari, P.; Chernozhukov, V.; Hortagcsu, A. The impact of big data on firm performance: An empirical investigation. *AEA Pap. Proc.* **2019**, *109*, 33–37. [CrossRef]
49. Olden, J.D.; Jackson, D.A. Illuminating the "black box": A randomization approach for understanding variable contributions in artificial neural networks. *Ecol. Model.* **2002**, *154*, 135–150. [CrossRef]
50. Gilch, P.M.; Sieweke, J. Recruiting digital talent: The strategic role of recruitment in organizations' digital transformation. *Ger. J. Hum. Resour. Man.* **2021**, *35*, 53–82. [CrossRef]
51. Hart, S.L. A natural-resource-based view of the firm. *Acad. Manag. Rev.* **1995**, *20*, 986–1014. [CrossRef]
52. Miroshnychenko, I.; Barontini, R.; Testa, F. Green practices and financial performance: A global outlook. *J. Clean. Prod.* **2017**, *147*, 340–351. [CrossRef]
53. Chen, Y.S. The driver of green innovation and green image: Green core competence. *J. Bus Ethics* **2008**, *81*, 531–543. [CrossRef]
54. Zhu, P.; Chen, Y.; Wang, L.Y.; Zhou, M. Treatment of waste printed circuit board by green solvent using liquid. *Waste Manag.* **2012**, *32*, 1914–1918. [CrossRef] [PubMed]
55. Dangelico, R.M.; Pontrandolfo, P. Being green and competitive: The impact of environmental actions and collaborations on firm performance. *Bus. Strateg. Environ.* **2015**, *24*, 413–430. [CrossRef]
56. Chiou, T.Y.; Chan, H.K.; Lettice, F. Chung, S.H. The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. *Transport. Res. E-log.* **2011**, *47*, 822–836. [CrossRef]
57. Phan, T.N.; Baird, K. The comprehensiveness of environmental management systems: The influence of institutional pressures and the impact on environmental performance. *J. Environ. Manag.* **2015**, *160*, 45–56. [CrossRef]
58. Wruck, K.H.; Wu, Y. The relation between CEO equity incentives and the quality of accounting disclosures: New evidence. *J. Corp. Finan.* **2021**, *67*, 101895. [CrossRef]
59. Hutchinson, M.; Gul, F.A. Investment opportunity set, corporate governance practices and firm performance. *J. Corp. Finan.* **2004**, *10*, 595–614. [CrossRef]
60. Gal, P.; Nicoletti, G.; Rüden, C.V.; Sorbe, S.; Renault, T. Digitalization and productivity: In search of the holy grail: Firm-level empirical evidence from European countries. *Int. Prod. Mon.* **2019**, *37*, 39–71.
61. Baron, R.M.; Kenny, D.A. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical consideration. *J. Pers. Soc. Psychol.* **1986**, *51*, 1173–1182. [CrossRef]
62. Liu, X.; Xiao, W.; Huang, X. Bounded entrepreneurship and internationalisation of indigenous Chinese private-owned firms. *Int. Bus. Rev.* **2008**, *17*, 488–508. [CrossRef]

63. Luo, L.; Yang, Y.; Luo, Y.; Liu, C. Export, subsidy and innovation: China's state-owned enterprises versus privately-owned enterprises. *Econ. Polit. Stud-Eps.* **2016**, *4*, 137–155. [CrossRef]
64. Yang, Y.; Wei, J.; Luo, L.J. Who is using government subsidies to innovate? The combined moderating effect of ownership and factor market distortions. *Manag. World* **2015**, *1*, 75–86.
65. Ren, X.H.; Liu, Z.Q.; Jin, C.L.; Lin, R.Y. Oil price uncertainty and enterprise total factor productivity: Evidence from China. *Int. Rev. Econ. Financ.* **2021**, *83*, 201–218. [CrossRef]
66. Buesa, M.; Heijs, J.; Baumert, T. The determinants of regional innovation in Europe: A combined factorial and regression knowledge production function approach. *Res. Pol.* **2010**, *39*, 722–735. [CrossRef]
67. Todtling, F.; Trippl, M. One size fts all?: Towards a differentiated regional innovation policy approach. *Res. Pol.* **2005**, *34*, 1203–1219.
68. Clarysse, B.; Wright, M.; Mustar, P. Behavioural additionality of R&D subsidies: A learning perspective. *Res. Pol.* **2009**, *38*, 1517–1533.