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The Role of Digital Transformation in the Relationship between Industrial Policies and Technological Innovation Performance: Evidence from the Listed Wind Power Enterprises in China

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Abstract: With the trend of innovation-driven development and the deepening application of digital technology, the role of digital transformation in the relationship between industrial policies and enterprise innovation is becoming increasingly significant, but it has rarely been analyzed in previous studies. In order to fill this research gap, this study takes listed wind power enterprises in China from 2007 to 2021 as a sample, and it combines a large number of relevant policy documents issued by the State Council, the Ministry of Industry and Information Technology, the National Energy Administration, and other government departments to investigate the impact of digital transformation on the relationship between industrial policies and enterprise technological innovation performance. This study found that both demand-side policy and supply-side policy have significantly promoted the technological innovation performance of enterprises. There is a synergistic effect between demand-side policy and supply-side policy, and demand-side policy strengthens the promotional effect of supply-side policy on technological innovation performance. Moreover, digital transformation can promote the technological innovation performance of enterprises. Further research has found that digital transformation can strengthen the synergistic effect between demand-side policy and supply-side policy and strengthen the positive impact of demand-side policy on technological innovation performance, but that it has weakened the incentive role of supply-side policy.

Keywords: digital transformation; industrial policy; demand-side policy; supply-side policy; technological innovation performance; wind power

Citation: Chen, T.; Chen, X. The Role of Digital Transformation in the Relationship between Industrial Policies and Technological Innovation Performance: Evidence from the Listed Wind Power Enterprises in China. *Sustainability* **2023**, *15*, 5785. https://doi.org/10.3390/su15075785

Academic Editor: Antonella Petrillo

Received: 21 February 2023
Revised: 25 March 2023
Accepted: 25 March 2023
Published: 27 March 2023

1. Introduction

Digital transformation is a reshaping process based on cutting-edge digital technologies, such as the internet of things and cloud computing, which can help enterprises to create greater value by improving business processes, promoting business model innovation, and establishing new business forms that encompass large-scale network collaboration and personalized customization [1]. In recent years, a large number of enterprises from different industries have sought to continuously explore new digital technologies and have utilized the advantages of those technologies through digital transformation [2]. Digital transformation has brought many new positive impacts in many industries, such as wind power, maritime transport, banking, the agriculture and food sector, education, etc., through business model innovation, the shortening of business response times, improvements to labor productivity, and the enhancement of information collection and utilization efficiency [3–7]. With the in-depth development of enterprise digital transformation, digital-technology-related hardware and software have become key organizational resources in the process of enterprise technological innovation and policy responses [1]. In the face of sustainable development challenges such as climate change, digital transformation has also brought positive effects to the technological innovation and policy responses of renewable energy enterprises, here represented by wind power enterprises, which is of great significance to the development of a low-carbon economy [3].

In recent years, policymakers in many countries around the world have issued a series of green-development-related industrial policies to promote sustainable development and a low-carbon economy [8]. In the process of sustainable development, wind power and other renewable energy industries need a great deal of technological innovation to support the move away from traditional fossil energy consumption [9]. As they form the main body of energy consumption and innovation, enterprises are crucial in technological innovation [10]. Moreover, the relevant industrial policies have an impact on the technological innovation performance of enterprises through resource allocation, institutional support, and an improvement in expectations [11–13]. Under the development trend of digital transformation, enterprises' technological innovation activities increasingly rely on relevant digital technologies for modeling, simulation, and analysis, which can promote the connection and production of knowledge and enable enterprises to more effectively carry out technological innovation output in the form of patent inventions [1,14]. In the current environment, where R&D activities are increasingly being carried out in cooperation with research teams across organizations and countries, the implementation of digital transformation can further enable enterprises in developing countries to connect more openly with the global innovation network and cooperate in technological innovation [1]. At the same time, digital transformation based on cutting-edge digital technology can not only improve the speed at which enterprises receive and analyze industrial policy signals, but also enable them to obtain more information from external knowledge sources to help them understand and respond to said policies [14].

At present, there is still no consensus among scholars on the impact of industrial policy on technological innovation performance, and the role of digital transformation in the relationship between industrial policies and technological innovation performance also needs to be further tested. In the literature on the relationship between industrial policies and technological innovation performance, the research at the macro level focuses on the impact of different types of industrial policies on the overall output of the technological innovation system [15]. At the enterprise level, scholars have conducted more research and analysis on single policies such as R&D subsidies and tax incentives [16]. In general, the existing studies pay more attention to the analysis of specific industrial policy, or they consider the impact of several policies on the overall innovation output of the industry, and pay less attention to the impact of the joint implementation of multiple industrial policies on enterprise technology innovation performance. The systematic analysis of the interaction between various industrial policies is still insufficient [9]. At the same time, there is still a lack of relevant research on the role of digital transformation in the process of industrial policy affecting the technological innovation performance of enterprises [14].

Therefore, considering the industry specific nature of industrial policies, this study analyzed and tested the impact of industrial policies on technological innovation performance, as well as the role of digital transformation in the relationship between industrial policies and technological innovation performance based on relevant industrial policy documents and enterprise data from the wind power industry in China. The aim was to explore the role of digital transformation in the relationship between industrial policies and technological innovation performance in order to provide relevant inspiration and reference for policy designers, researchers and business managers in the development trend of enterprise digital transformation. In order to achieve this aim, the following research questions were addressed in this study:

- Do industrial policies (including demand-side policy and supply-side policy) promote or inhibit the improvement in technological innovation performance?
- Is there a synergistic effect between demand-side policy and supply-side policy?
- Can digital transformation improve technological innovation performance?
- What is the role of digital transformation in the relationship between industrial policies and technological innovation performance?

Through empirical analysis, the answers to the above questions help to understand the comprehensive mechanism of industrial policy and digital transformation in technological innovation performance, and they provide a new research perspective and theoretical support for relevant policy design and enterprise technological innovation performance improvement under the trend of digital transformation.

2. Literature Review and Hypothesis Development

2.1. Industrial Policy and Technological Innovation Performance

As a key component of sustainable development as an important means for the government to regulate economic operation, industrial policy can accelerate the pace of the transformation of the technological system in the direction of sustainable development [17]. In the process of sustainable development transformation, the technological innovations of a large number of market players form the micro basis of the larger transformation of the technological system [16]. In the process of technological innovation, an effective market incentive mechanism can provide favorable conditions for enterprises to ensure the sustainability of investment, thereby improving overall innovation output [18]. However, market failures, including information asymmetry and knowledge spillover effects, have hindered the formation of effective market incentives. Fabrizi et al. [19] have pointed out that, under the influence of market failure, the market returns obtained by enterprises from technological innovation are often significantly lower than the total social benefits. In addition, due to the relatively high technology uncertainty, long return cycle, and weak asset liquidity, new technology is not attractive to investors at the early stage of its development [20]. In order to alleviate such market failures and improve technological innovation performance, the government needs to optimize the allocation of innovation resources through corresponding industrial policies. Among these, the demand-side policy acting on the demand side and the supply-side policy acting on the supply side may provide a favorable external condition for enterprises' R&D activities [21].

The promotion of industrial policy on technological innovation performance of enterprises can be realized through three main aspects: resources, system, and cognition. First, through the targeted allocation of specific resources, industrial policies can enrich the available innovation resources for enterprises to carry out R&D activities and promote the innovation and diffusion of specific technologies [11]. A change in resource allocation also affects the speed and direction of enterprise technological innovation. Rogge and Reichardt [21] have found that the strength and scope of the role of industrial policies in resource allocation often depend on the design characteristics of demand-side policies and supply-side policies, such as the duration and effectiveness of policies, and on the interaction between different industrial policies. Second, industrial policies can affect the technological innovation performance of enterprises by adding or revising laws, rules and regulations and other local adjustments. Kivimaa and Kern [22] have pointed out that such institutional adjustments include legislation, the upgrading of temporary provisions to formal regulations, the expansion of the scope of objects covered by the policy, and the introduction of new provisions. Their research further indicates that the development of enterprise technological innovation activities requires institutional support, because the development process of new technologies often faces continuous challenges from vested interests in the old technology system. By adjusting the system, industrial policy can, on the one hand, prevent illegal competition that destroys technological innovation, and, on the other hand, alleviate the external instability caused by the obstruction of vested interests in the old technological system. At the same time, in a favorable institutional environment, the simplification of administrative approval related to technological innovation, an improvement in public service quality, and the stabilization of income expectations can also encourage enterprises to carry out innovation activities and improve their technological innovation performance [12]. Third, the public promulgation and implementation of industrial policies as a signal can change the expectations of enterprises in technological innovation activities at the cognitive level, thus affecting the innovation behavior and technological innovation performance of enterprises. This cognitive impact can be achieved in two ways, namely by providing new information and changing the original cognition.

For example, Del Río [13] found that the government issued industrial policies to promote the development of renewable energy industry as a form of new information, which in turn helped enterprise managers to form a good expectation of the return of renewable energy technology innovation. The relevant support and authorization provided by industrial policies also changed the original perception of enterprises regarding market uncertainty, which is conducive to the development of renewable energy enterprises' technological innovation activities [16]. Technological innovation activities occur widely among market entities, not merely in laboratories and universities. With the change in the enterprise managers' cognition, the favorable industrial policy environment can further promote enterprises to actively establish learning networks and enterprise technology alliances to improve the technological innovation performance [19].

2.2. Demand-Side Policy, Supply-Side Policy and Technological Innovation Performance

Industrial policies can be divided into demand-side policies and supply-side policies according to the differences in implementation priorities. Specifically, the main role of demand-side policy is to increase the market return or expand the scale of market demand for new technologies by adjusting the industrial demand side [23]. On the one hand, demand has an incentive effect on technological innovation, and an increase in demand-side product prices is conducive to increasing the expected profits of technological innovation. On the other hand, the demand side provides technological innovation with information and knowledge from the market, enabling enterprises to further understand the market demand and reducing the uncertainty of innovation activities.

Böhringer et al. [24] found that price-based demand-side policies, such as feed-in tariffs, are more effective in stimulating technological innovation activities than command-based policies (such as market quotas and development goals). By providing predictable and clear incentives to investors in the energy industry on the demand side, the feed-in tariff policy, as a demand-side policy, can more effectively promote the technological innovation performance of enterprises [25]. At present, some scholars have provided empirical evidence that the feed-in tariff policy has innovative effects in the wind power industry [24]. However, another study based on a European industrial sample pointed out that the feed-in tariff only has a positive effect on the technological innovation of the photovoltaic industry, and that it has a negative effect on the technological innovation of the wind power industry [26]. In view of the fact that the previous research conclusions have not been unified, and other factors that may affect the policy effect have not been fully considered, the impact of demand-side policies on technological innovation performance deserves further discussion. To summarize, this paper puts forward the following hypothesis:

Hypothesis 1 (H1). *The demand-side policy is positively associated with the technological innovation performance of enterprises.*

The main role of the supply-side policy is to have a positive impact on technological innovation performance from the industrial supply side by increasing technology supply and providing financial support [23]. Common and effective supply-side policies include technology introduction, transnational cooperative research plans, special technology development plans and financial support [27,28]. Under favorable conditions, introducing foreign technological resources and absorbing and transforming them are important strategies for enterprises to improve their technological innovation output [29]. In view of the limitation of innovation resources and the uncertainty of the technological path, transnational cooperative research and special technology development plans can coordinate international research resources, take advantage of foreign technological advantages, concentrate domestic innovation resources to solve key technological problems, and break through the bottleneck of technological innovation through technological diffusion. In addition, the subsidies, tax credits and other financial support provided by supply-side policies also have a positive effect on the technological innovation performance of enterprises [30].

Czarnitzki and Lopes [31] have pointed out that, on the one hand, the financial support policies implemented for technological innovation activities can reduce the R&D costs of enterprises. On the other hand, by increasing the potential income of technological innovation activities and reducing the relative capital risk, the financial support implemented for technological innovation activities will also stimulate enterprises to generate additional innovation, thus improving the performance of technological innovation. However, some traditional views posit that supply-side policies will have a crowding-out effect on enterprise R&D investment and hinder the development of enterprise technological innovation [32]. Nevertheless, after controlling for sample selection bias in their quasi-experimental study, González and Pazó [33] found that there was a complementary effect rather than a crowding-out effect between supply-side policies and enterprise R&D investment. Under the influence of the supply-side policy, the technology supply of the technological innovation of enterprises increases and the R&D cost decreases, thus providing a guarantee for the improvement in the technological innovation performance. To summarize, this paper puts forward the following hypothesis:

Hypothesis 2 (H2). *The supply-side policy is positively associated with the technological innovation performance of enterprises.*

It is worth noting that enterprises benefiting from demand-side policies are often supported by supply-side policies. In this process, the benign combination of different industrial policies can alleviate market failure, improve the competitiveness of new technologies, and provide favorable conditions for enterprise innovation activities through effective intervention [34]. At present, research focusing on a single industrial policy has tested the effectiveness of specific industrial policies in the technological system in the innovation process to a certain extent [16]. However, existing research has indicated that, due to the complexity of the technological innovation process, a single industrial policy is not sufficient to meet the needs of technological innovation in practice, and that the comprehensive application of different types of industrial policies is more conducive to a comprehensive promotion of the achievement of long-term goals [35]. Bakvis and Brown [36] have argued that the developed and proposed industrial policies should be able to provide incentives and guidance to enterprises from different perspectives as well as minimize duplication and conflict so as to ensure the reduction of policy inefficiencies caused by inconsistent policies. A country's industrial policies need to be coordinated with each other, so as to jointly improve social productivity and national innovation capacity and in order to improve its overall social welfare [37,38]. Based on the existing research, much evidence has also revealed the necessity of developing a new generation of public policies, aiming at the improvement of the quality of institutions and countries' institutional effectiveness [39,40].

Rogge and Reichardt [21] have pointed out that different industrial policies coordinated with each other can improve their effectiveness, and that the interaction between these industrial policies can have a more significant effect on technological innovation. The research of Schmidt and Sewerin [41] supports this view by finding that, though the joint implementation of different types of industrial policies may lead to conflicting requirements of some policies or higher overall implementation costs, it will also produce complementary effects between different industrial policies, thus playing a more positive role in the overall performance of technological innovation. Based on this, the relevant analysis should consider the comprehensive impact of the joint implementation of different types of industrial policies on the technological innovation performance of enterprises, rather than the role of a single industrial policy. The combination of industrial policies can reduce innovation risks through demand-side policies and increase the supply of innovation resources through supply-side policies, thus jointly promoting the improvement in technological innovation performance [23]. Therefore, there may be a significant synergistic effect between different industrial policies, and this may then strengthen the incentive effect of demand-side policy and supply-side policy on the technological innovation performance of enterprises. This synergistic effect has potentially important policy value and provides a broad research space for studying the role of industrial policies on technological innovation performance [9]. Lindman and Söderholm [22,28] have found that, at the industrial level, the implementation of the demand-side policy can affect the effectiveness of the supply-side policy on the innovation output of the renewable energy industry. However, at the enterprise level, due to the lack of sufficient relevant empirical tests, the current understanding of the comprehensive implementation effect of different industrial policies is still very limited [23]. Therefore, the impact of different industrial policies and their combinations on the technological innovation performance of enterprises needs to be further explored. To summarize, this paper puts forward the following hypothesis:

Hypothesis 3 (H3). *There is a synergistic effect between demand-side policy and supply-side policy, which can strengthen their respective role in promoting the technological innovation performance of enterprises.*

2.3. Digital Transformation, Industrial Policies and Technological Innovation Performance

With the in-depth development of enterprise digital transformation, digital technologies, represented by the internet of things, cloud computing, and artificial intelligence, have been widely applied and digital technology-related hardware and software have become key organizational resources in the process of enterprise technological innovation and policy responses [1]. The knowledge network built by digital transformation can continue to help enterprises to integrate internal and external information and innovation resources more effectively; conduct modeling, simulation, and analysis; and can improve the productivity of innovation outputs such as patents [14,42]. Specifically, the impact of digital transformation on enterprise technological innovation and policy response is reflected mainly in the following aspects.

First of all, digital transformation has improved the ability of enterprises to absorb external information and other innovative resources. This ability is conducive to the storage or integration of technology and policy-related knowledge from outside, thus helping enterprises to understand policies more effectively and to carry out technological innovation activities [43]. At the same time, digital transformation reduces the production and service costs of enterprises through the scale effect of the internet, which in turn enables enterprises to retain more leisure resources and improves their ability to absorb external knowledge and carry out innovation [42].

Afterwards, digital transformation provides business support for enterprises' technological innovation decisions, which is conducive to their timely identification of public policy orientation and technological change trends, thus allowing them to make R&D decisions consistent with their own technical and financial conditions [44].

In addition, by improving the dynamic capabilities of enterprises, digital transformation is conducive to enterprises' rapid identification and response to innovation opportunities and the challenges brought by public policy changes or market trends [45]. Enterprises with a high degree of digital transformation have significant advantages in the ability to collect and process information, and often respond more quickly and flexibly to changes in the external environment [43]. Previous studies have shown that the intensity of digital transformation can significantly enhance the ability of enterprises to generate new knowledge and achieve innovative results in a changing environment [14]. In addition, sustainable business models that are conducive to long-term development of enterprises in complex environments can also be optimized through digital transformation [46].

Finally, digital transformation is conducive to the establishment of a broader R&D partnership and an improvement in communication efficiency. The application of information technology has broken through the limitation of communication geographical distance, enabling enterprises to establish cooperative relations with governments, partner enterprises or research institutions in a larger geographical range. It is also easier for potential partners to search and understand each other's technical advantages, business needs and other details. Forman and Zeebroeck [47] have pointed out that digital transformation can effectively help R&D teams scattered in different regions to communicate their knowledge and ideas, and that it improves the communication efficiency in the process of policy response and technological innovation. At the same time, the use of standardized digital interfaces can help enterprises to establish a common language platform and a common form of communication for researchers from different backgrounds, thus enabling enterprises to effectively share specific knowledge in different fields. Within the organizations of enterprises with a high degree of digital transformation, the diffusion speed of relevant information such as policy constraints and technological innovation has accelerated, and the integration efficiency of organizational resources required for innovation has also been correspondingly improved [48]. This impact strengthens the ability of enterprises to share and apply knowledge in different fields in response to policies and innovation activities. Consequently, digital transformation may have a positive impact on enterprise technological innovation. Moreover, digital transformation may play an important role in the relationship between industrial policies and enterprise technological innovation. Therefore, this paper proposes the following hypotheses:

Hypothesis 4 (H4). *Digital transformation is positively associated with the technological innovation performance of enterprises.*

Hypothesis 5 (H5). *Digital transformation can strengthen the positive impact of demand-side policy on technological innovation performance.*

Hypothesis 6 (H6). *Digital transformation can strengthen the positive impact of supply-side policy on technological innovation performance.*

Hypothesis 7 (H7). *Digital transformation can strengthen the synergistic effect between demand-side policy and supply-side policy.*

3. Methodology

To provide a better understanding of the potential impact of industrial policies on technological innovation performance, and of the role of digital transformation in the relationship between industrial policies and technological innovation performance, a comprehensive literature review has been conducted.

In order to further conduct empirical testing based on research questions and the hypotheses, with reference to the research by Plank and Doblinger [16] and Wang et al. [49], we first examine the respective impact of demand-side policy and supply-side policy on technological innovation performance. After that, this study further examines the synergistic effect between demand-side policy and supply-side policy. Next, the impact of digital transformation on technological innovation performance is analyzed. Finally, this study analyzes the differences in the impact of demand-side policy, supply-side policy, and the synergistic effect on technological innovation performance of enterprises with different degrees of digital transformation. In addition, based on the existing literature [16,49], this study also controls for the potential impact of internal characteristics of enterprises on the empirical results.

3.1. Data Collection and Sample Description

This paper constructs a data set consisting of enterprise data and policy documents to test the previous assumptions. First of all, this paper takes the wind power enterprises listed on the Shanghai and Shenzhen Stock Exchange from 2007 to 2021 as the initial research sample, and carries out the following processing on the data: (1) elimination of the special treatment enterprise sample; (2) elimination of samples with missing key data; and (3) winsorization of all continuous variables at the level of 1% in order to avoid the influence of outliers on the conclusion. As a result, we finally obtained 836 annual observations from 89 enterprises. Enterprise patent data and other variable data are from the patent retrieval database of the State Intellectual Property Office, CSMAR database and Wind database.

Secondly, the contents and details of the policy documents are taken from the official websites of various government departments and the laws and regulations database of Peking University. Among these, the wind power feed-in tariff data in different periods and regions required to measure the demand-side policy are obtained from the wind power feed-in tariff notice documents issued by the National Development and Reform Commission (a constituent department of the State Council that formulates policies related to national economic and social development). In terms of supply-side policies, this paper collects the laws, regulations and other normative documents related to wind power that have been formulated and implemented mainly by the State Council (i.e., the Central People's Government of China, which is the highest state administrative organ), the National People's Congress (the highest state authority in China exercising national legislative power), the National Development and Reform Commission, the National Energy Administration (a national bureau that formulates and implements energy development policies), the Ministry of Industry and Information Technology (a constituent department of the State Council that formulates and implements industrial policies and standards for the industry), the Ministry of Science and Technology (a constituent department of the State Council that formulates and implements national policies related to science, technology, and innovation), and the Ministry of Finance (a constituent department of the State Council that is responsible for managing national financial expenditures) from 2007 to 2021. In order to ensure the completeness and accuracy of the policy collection, this paper examines and compares all 513 government policy documents related to the wind power industry that meet the specification level of the corresponding documents one by one, and further analyzes these policy documents below to evaluate the overall effectiveness of the supply-side policies in each year.

3.2. Measures

3.2.1. Technical Innovation Performance

This paper uses the annual patent application volume to measure the technological innovation performance (*TIP*) of enterprises. Because the diversified innovation activities of enterprises are not easy to measure uniformly, it is still difficult for the academic community to reach a unified conclusion on the measurement of technological innovation performance. Nevertheless, they all agree on the important role of enterprise patents in the study of technological innovation performance [50]. At present, the number of patent applications is also widely used as a proxy variable for technological innovation performance in research [28]. Compared with other indicators, the distribution of patents among enterprises is uneven and the quality of patents is different. By using patent data, researchers can depict some technological innovation achievements in the test, but it is still difficult to measure all forms of technological innovation in a broad definition. Therefore, to reasonably explain the empirical results, we need to recognize that this measurement method of technological innovation performance can only provide limited information and is an approximate measurement. However, data such as enterprise R&D expenditure and the economic returns of new products are often difficult to obtain completely because of the confidentiality of the relevant technical departments of the enterprise, and there are obvious omissions when measuring the performance of enterprise technological innovation [16]. In contrast, the number of patent applications is a relatively reliable measurement indicator due to the strict and consistent approval process of the State Intellectual Property Office.

In practice, the vast majority of innovative achievements with obvious economic value will be used to submit patent applications [51]. The different degrees of technological progress of enterprises can also be estimated by the type of information in patent applications. At the same time, the patent type, application date and other detailed information provided by the patent documents are publicly available for a long period of time, which is conducive to researchers' effective quantitative analysis. Considering that the impact of industrial policy combination on technological innovation performance may have a lag effect, this paper treats the explanatory variable as a lag. In the robustness test part, this paper uses the annual number of invention patent applications to measure the performance of technological innovation.

3.2.2. Demand-Side Policy

In this paper, the benchmark on-grid electricity price of wind power generation in the current year is used to measure the demand-side policy (*DSP*). The benchmark feed-in tariff is a demand-side policy based on price, which can affect the energy market price and promote the technological innovation performance of relevant enterprises through the demand side. Previous studies have shown that, among various demand-side policies for the renewable energy industry, the feed-in tariff policy has the most significant role in promoting technological innovation [24]. In addition, the increase in electricity prices also provides a clear demand-side return growth expectation for the innovation of renewable energy technology, one which can significantly promoted the performance of technological innovation [18].

In July 2009, the National Development and Reform Commission issued China's first wind power grid tariff policy, namely the Notice on Improving the Wind Power Grid Tariff Policy (FGJG (2009) No. 1906). At the initial stage, the wind power feed-in tariff gradually increased. With the wind power technology becoming more mature, the cost of power generation has gradually decreased. The feed-in tariff published by the National Development and Reform Commission has generally shown a gradual decline since 2014. According to the wind power resources and construction conditions in different regions, the benchmark feed-in price is divided into four levels. Therefore, this paper uses the benchmark feed-in tariff of wind power generation in the regions in which the enterprises are located from 2009 to 2021 to measure the demand-side policy. Considering that the feed-in tariff policy of wind power only took effect in 2009, the demand-side policy in 2007 and 2008 is recorded as 0.

3.2.3. Supply-Side Policy

This paper measures the supply-side policy (*SSP*) through comprehensive indicators based on the two dimensions of policy effectiveness and policy content.

First, the relevant policies are scored one by one according to the effectiveness of the supply-side policy of the wind power industry. Based on the existing research, this paper uses the following policy document specifications to measure the effectiveness of various policies [52]. The supply-side policy documents issued in the form of law were issued by the National People's Congress and its Standing Committee, and their policy effectiveness are the highest, with a score of 5 points. By analogy, the effectiveness of the policy documents issued by the State Council or the ministries and commissions are recorded as 4 points, the plans or opinions issued by the ministries and commissions of the State Council are recorded as 3 points, the agreements or outlines issued by the ministries and commissions of the State Council are recorded as 2 points, and the notices or announcements are recorded as 1 point as they have the weakest force.

Secondly, this paper refers to the existing indicators and scores the policy content of each supply-side policy according to the criteria in Table 1 to ensure the consistency of the evaluation indicators [49]. According to the preliminary data obtained from the analysis of policy effectiveness and policy content, this paper calculates the supply-side policy indicators as follows:

$$\mathrm{PS_t} = \sum\nolimits_{i=1}^{N} \mathrm{PE_i} \times \mathrm{PC_i}, \mathrm{t} \in (1999, 2021) \tag{1}$$

Table 1. Evaluation criteria of supply-side policy content.

Score	Description of Policy Content
5	Be able to meet at least two policies of the second, third and fourth criteria at the same time
4	Policies related to the support of domestic enterprises in their carrying out of cooperative research and development or production or independently develop key technologies of wind power
3	Policies related to wind power special technology development plans, providing corresponding financial support, or promoting the localization of wind power equipment
2	Policies related to the introduction and absorption of foreign advanced technologies or the promotion of technological exchange
1	Policies on research and development of wind power generation technology

In Formula (1), N and i, respectively, represent the number of a supply-side policies and the supply-side policy documents implemented in year t. PE_i and PC_i represent the effectiveness and content scores of policy i, respectively, and PS_t represents the total score of all supply-side policies implemented in year t. In order to comprehensively consider the time limit of policy effectiveness and eliminate the policy interference that has been abolished or expired, this paper uses Formula (2) to calculate the cumulative score of the current effective supply-side policy of the wind power industry in year t.

$$SSP_t = SSP_{t-1} + PS_t - \sum_{i=1}^{M} PE_i \times PC_i, t \in (1999, 2021) \quad (2)$$

Among these, SSP_t is the total effectiveness of the supply-side policy in year t and M is the number of supply-side policies abolished in year t.

3.2.4. Digital Transformation

In order to measure the digital transformation (*Digtal*) and learn from the existing research, this paper uses the proportion of intangible assets and fixed assets related to the digital transformation in the total assets of enterprises as an indicator [53]. Among these, assets related to digital transformation include artificial intelligence systems, cloud computing systems, internet of things platforms, manufacturing execution systems, data management systems, servers, network communication equipment, etc. Though digital transformation and informatization are difficult to completely separate from each other, in order to reflect the differences, this paper still consciously distinguishes between digital transformation and informatization in the selection of assets related to digital transformation. Digital transformation usually works in the form of multiple systems. Although the purpose of investing in specific related assets is different, a variety of digital-transformation-related resources with different functions are complementary within the enterprise. Since the assets related to digital transformation in enterprises coexist within the enterprise and play a role as a whole, if the research only focuses on a specific type of digital transformation investment within a year, the overall impact may be ignored, leading to a large deviation in the measurement [43]. Therefore, this paper focuses on the overall stock change of digital transformation and emphasizes the role of digital transformation as a whole system. In addition, in order to further analyze the sample, this paper divides the sample of enterprises into two groups according to the degree of digital transformation, placing those enterprises with a degree of digital transformation that is higher than the median into the "high degree of digital transformation" group and those others into the "low degree of digital transformation" group.

3.2.5. Control Variables

This paper selects enterprise size (*LnSize*), establishment period (*Age*), asset–liability ratio (*Lev*), geographical location (*Location*), equity concentration (*Share10*), CEO-related governance characteristic (*Dual*) and the size of the board of directors (*Board*) as the control variables. First of all, the size of the enterprise and its establishment period may affect the scale of available resources, innovation strategy, and organizational environment of the enterprise's innovation activities [54]. This paper uses the natural logarithm of the number of employees to measure the size of the enterprise, and it uses the time span from the year of establishment to the year of data observation to measure the years of establishment. Secondly, the asset–liability ratio may affect the available funds and other resources of the enterprise's innovation activities. This paper measures the asset–liability ratio of an enterprise as the ratio of its total liabilities to its total assets at the end of the year. Thirdly, considering the impact of economic and historical differences in specific regions, this paper selects the geographical location of an enterprise as the control variable, in which enterprises in the eastern region are assigned a value of 1 and those others are assigned a value of 0. Finally, from the perspective of corporate governance, equity concentration, the CEO-related governance characteristic, and the size of the board of directors may affect the decision-making speed, innovation cost and risk appetite of innovation activities [55]. This paper uses the total shareholding ratio of the top ten shareholders to measure the equity concentration, and the total number of directors to measure the size of the board of directors. In addition, this paper introduces a dummy variable, the CEO-related governance characteristic. When the CEO and chairman of the board of directors of an enterprise are the same person, the value is 1; otherwise, it is 0. In addition, this paper also controls the impact of the fixed effect of year (*Year dummies*). In order to address the potential endogeneity problems in the model, this paper further considers the explanatory variables and control variables in the model with a lag of one period.

4. Results

4.1. Descriptive Statistics and Correlations

Table 2 lists the correlation coefficients and descriptive statistical results among the variables. For the count data with a non-negative integer as the explained variable, the negative binomial regression model or Poisson regression model is generally used for the test. The standard deviation of *TIP* in this paper is greater than the mean value, which indicates that there is a problem of hyper-discrete distribution. Therefore, we use negative binomial regression model to process the data more effectively. In order to prevent the influence of multicollinearity problems on the research results, this paper carries out the co-linear variance inflation factor (VIF) test. In the test results, the maximum value of the variance inflation factor of each variable is 3.13, which is less than 10, indicating that there is no serious multicollinearity problem between the independent variables and they are therefore suitable for further regression analysis.

Table 2. Descriptive statistics and correlations.

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
TIP	137.72	360.63	1										
DSP	0.54	0.19	0.17 ***	1									
SSP	215.17	62.31	0.09 ***	0.08 **	1								
Digital	0.006	0.01	0.02 ***	0.07 *	0.13 *	1							
LnSize	7.85	1.22	0.59 ***	0.01 *	0.03 *	0.03 ***	1						
Age	14.53	6.06	−0.20 ***	0.31 ***	0.52 ***	0.05 *	−0.11 ***	1					
Lev	0.52	0.20	0.19 ***	−0.09 **	−0.01 *	0.06 *	0.45 ***	0.13 ***	1				
Location	0.59	0.49	0.15 ***	0.10 **	0.09 **	−0.05 *	−0.08 *	−0.08 *	−0.08 *	1			
Share10	9.73	22.18	0.18 ***	0.13 ***	0.47 ***	−0.03 *	0.02 *	0.26 ***	−0.02 *	0.04 *	1		
Dual	0.19	0.39	−0.12 **	0.03 *	0.03 *	−0.02 *	−0.22 ***	−0.05 *	−0.28 ***	0.10 **	0.07 *	1	
Board	9.35	1.99	−0.01 *	−0.06 *	−0.06 *	0.08 *	0.30 ***	0.02 *	0.33 ***	−0.08 *	−0.041 *	−0.26 ***	1

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

4.2. Impact of Industrial Policies and Digital Transformation on Technological Innovation Performance

This paper uses the hierarchical regression method to test the impact of demand-side policy and supply-side policy on technological innovation performance, and further test the synergistic effect between demand-side policy and supply-side policy. The first step is to carry out the regression analysis of demand-side policy and technological innovation performance, the second step is to carry out the regression analysis of supply-side policy and technological innovation performance, the third step is to take demand-side policy and supply-side policy as independent variables at the same time, and the fourth step is to introduce the product of demand-side policy and supply-side policy for further analysis. The results of the regression analysis are shown in Table 3.

Table 3. Impact of industrial policies and digital transformation on technological innovation performance.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
DSP	0.794 ***		0.664 ***	0.739 **	
	(0.223)		(0.226)	(0.284)	
SSP		0.004 ***	0.003 ***	0.001 ***	
		(0.001)	(0.002)	(0.006)	
DSP × *SSP*				0.024 ***	
				(0.009)	
Digital					9.236 ***
					(5.093)
LnSize	0.504 ***	0.458 ***	0.427 ***	0.426 ***	0.494 ***
	(0.062)	(0.061)	(0.062)	(0.060)	(0.063)
Age	0.066 ***	0.030*	0.013	0.003	0.077 ***
	(0.012)	(0.017)	(0.017)	(0.018)	(0.011)
Lev	0.454	0.347	0.556 *	0.545 *	0.382
	(0.284)	(0.286)	(0.286)	(0.285)	(0.282)
Location	−0.048	−0.158	−0.196	−0.223	0.040
	(0.174)	(0.176)	(0.177)	(0.176)	(0.173)
Share10	0.039	−0.070	0.315	0.335	−0.321
	(0.347)	(0.342)	(0.340)	(0.338)	(0.328)
Dual	0.260 **	0.273 **	0.245 *	0.233 *	0.263 **
	(0.130)	(0.128)	(0.126)	(0.124)	(0.130)
Board	0.003	0.024	0.030	0.034	0.023
	(0.030)	(0.030)	(0.030)	(0.030)	(0.031)
Constant	−4.536 ***	−4.025 ***	−4.308 ***	−5.813 ***	−4.309 ***
	(0.565)	(0.535)	(0.539)	(0.787)	(0.563)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Observation	836	836	836	836	822
Wald-chi^2	349.23	355.45	345.25	343.53	260.51

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Standard errors are in parentheses. Dependent variable is *TIP*.

In Model 1, demand-side policy has a significant positive impact on technological innovation performance (β = 0.794, $p < 0.01$), indicating that the implementation of demand-side policies has a significant role in promoting technological innovation performance, and H1 is therefore supported. Moreover, the result of Model 2 shows that supply-side policy has a significant positive impact on technological innovation performance (β = 0.004, $p < 0.01$), indicating that, with the strengthening of the effectiveness of the supply-side policy, the technological innovation performance of enterprises continues to improve, and H2 is supported. Model 4 further tests the synergistic effect between demand-side policies and supply-side policies. The regression coefficient of the interaction term is 0.024, which is significant at the level of 1%. This result shows, first, that there is a significant synergistic effect between demand-side and supply-side policies, which supports the previous Hypothesis H3. Secondly, based on the implementation of demand-side policy after 2009, the result shows that the implementation of demand-side policy strengthens the positive relationship between supply-side policy and technological innovation performance, which also provides empirical evidence for the synergistic effect between different policies in the industrial policy portfolio. In addition, in Model 5, the regression coefficient of digital transformation is 9.236, which is significant at the level of 1%, indicating that digital transformation can significantly promote the improvement in enterprise technological innovation performance, and H4 is therefore supported.

4.3. The Role of Digital Transformation in the Relationship between Industrial Policies and Technological Innovation Performance

In order to further analyze the impact of the heterogeneity of the degree of digital transformation on the relationship between industrial policies and technological innovation performance, this paper divides the sample into two groups based on the median of the degree of digital transformation of enterprises, namely "high degree of digital transformation" and "low degree of digital transformation", to test the difference in the impact of the industrial policies and the synergistic effect between policies on the technological innovation performance of enterprises with different degrees of digital transformation. The regression results are shown in Table 4.

Table 4. Grouping test results of digital transformation degree heterogeneity.

Variable	High Degree of Digital Transformation			Low Degree of Digital Transformation		
	Model 6	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**
DSP	1.058 ***		1.014 ***	0.582		0.399
	(0.317)		(0.392)	(0.358)		(0.429)
SSP		0.003 **	0.002 **		0.009 **	0.006 *
		(0.002)	(0.006)		(0.001)	(0.007)
DSP × *SSP*			0.032 ***			0.023
			(0.01)			(0.044)
LnSize	0.458 ***	0.366 ***	0.395 ***	0.505 ***	0.550 ***	0.492 ***
	(0.077)	(0.082)	(0.083)	(0.108)	(0.091)	(0.112)
Age	0.057 ***	0.029	0.000	0.055 **	−0.005	0.051
	(0.014)	(0.027)	(0.027)	(0.021)	(0.018)	(0.031)
Lev	0.758 **	0.706 *	0.705 *	−0.115	−0.867 **	−0.133
	(0.364)	(0.379)	(0.365)	(0.551)	(0.422)	(0.553)
Location	0.574 **	0.418	0.223	−0.374	0.260	−0.402
	(0.261)	(0.286)	(0.285)	(0.299)	(0.183)	(0.308)
Share10	−0.073	−0.177	0.133	−0.169	−0.147	−0.039
	(0.411)	(0.429)	(0.423)	(0.651)	(0.516)	(0.672)
Dual	0.582 ***	0.616 ***	0.469 ***	−0.229	−0.175	−0.216
	(0.173)	(0.179)	(0.167)	(0.225)	(0.186)	(0.231)
Board	0.080 *	0.102 **	0.079 **	0.025	−0.008	0.026
	(0.042)	(0.044)	(0.04)	(0.047)	(0.042)	(0.049)
Constant	−5.042 ***	−3.998 ***	−6.240 ***	−3.803 ***	−3.542 ***	−2.105 *
	(0.69)	(0.784)	(0.947)	(0.879)	(0.707)	(3.095)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observation	413	413	413	409	409	409
Wald-chi^2	199.78	210.99	205.55	103.22	98.13	105.52

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Standard errors are in parentheses. Dependent variable is *TIP*.

The results of Model 6 and Model 9 show that demand-side policy has a significant positive impact on the technological innovation performance of enterprises with a high degree of digital transformation (β = 1.058, $p < 0.01$), but has no significant impact on the technological innovation performance of enterprises with a low degree of digital transformation (β = 0.582, $p > 0.1$), indicating that digital transformation can strengthen the role of demand-side policies in promoting technological innovation performance. From another perspective, the results also show that demand-side policies mainly promote the technological innovation performance of enterprises with a high degree of digital transformation. This may be because digital transformation can help enterprises to obtain demand-side policy signals and respond more quickly, and because it enables enterprises to use digital technologies such as artificial intelligence to accelerate their research and development efficiency. The technological innovation performance of such enterprises is more motivated by the potential innovation returns from the market supported by demand-side policies. Therefore, H5 is empirically supported.

Compared with the regression results of Model 7 and Model 10, the supply-side policy has a significant positive impact on the technological innovation performance of enterprises with a low degree of digital transformation (β = 0.009, $p < 0.05$), indicating that the supply-side policy mainly promotes the technological innovation performance of enterprises with a low degree of digital transformation, but also has a weak positive impact on the technological innovation of enterprises with a high degree of digital transformation (β = 0.003, $p < 0.05$). Therefore, hypothesis H6 has no corresponding support. In addition, in order to comprehensively consider the impact of the heterogeneity of the degree of digital transformation on the synergistic effect between industrial policies, Model 8 and Model 11 incorporate the demand-side policy, supply-side policy, and the interaction of the two policies into the model for testing. The results show that the synergistic effect between demand-side policy and supply-side policy is significantly strengthened for enterprises with a high degree of digital transformation ($\beta = 0.032$, $p < 0.01$), and the comprehensive incentive effect on the technological innovation performance of enterprises has been significantly improved. However, for enterprises with a low degree of digital transformation, there is no corresponding synergistic effect between demand-side policy and supply-side policy ($\beta = 0.023$, $p > 0.1$). This may be because the information processing capabilities brought about by digital transformation can help enterprises to better integrate multiple policy resources and thereby promote the effective implementation of technological innovation activities. Under the joint influence of various industrial policies, enterprises with a high degree of digital transformation can effectively coordinate and deal with the complexity of various policies. The positive role of cutting-edge digital technologies such as big data analysis in innovation activities may also be more fully utilized, thereby strengthening the positive relationship between various industrial policies and enterprise technological innovation performance. Therefore, Hypothesis H7 is supported.

5. Robustness Checks

Since the negative binomial regression model with time delay is used in the empirical test in the previous article, the empirical results can largely avoid the interference of potential endogenous problems and reverse causal problems. Based on this, in order to further test the robustness of the research results, this paper analyzes them from the following aspects.

We replace the measurement method of technological innovation performance. Referring to the existing literature [16], because invention patents represent a higher level of achievement in the enterprise's technological innovation activities, this paper uses the number of invention patent applications to measure the performance of technological innovation. The test results show that both demand-side and supply-side policies have significant positive effects on technological innovation performance, and there is a significant synergistic effect between the two industrial policies. Digital transformation can promote the technological innovation performance of enterprises and strengthen the impact of demand-side policies. In addition, digital transformation has also strengthened the synergistic effect between demand-side policies and supply-side policies. The test results have not changed significantly, and the previous research conclusions are still robust.

The measurement of digital transformation is replaced, referring to the existing literature [43]. Because cutting-edge digital technologies, such as artificial intelligence and big data analysis, often correspond to related technologies, software, systems, and other intangible assets, this paper re-measures and re-analyzes digital transformation based on the ratio of intangible assets related to digital transformation to the total intangible assets of enterprises. The test results are basically consistent with the previous article, and the research conclusion of this paper is still valid.

We change the sample observation duration. In 2020, the global economy was impacted by COVID-19, and the business decisions of listed companies were greatly affected by external economic fluctuations and epidemic prevention policies. In order to eliminate the impact of COVID-19, epidemic prevention policies and other macro-environments, this paper selects observation data from 2007 to 2019 to conduct a new test by changing the sample interval. The test results have not changed substantially, and the previous research conclusions remain stable.

6. Conclusions, Limitations and Future Research

6.1. Conclusions

This paper takes the listed wind power enterprises in China from 2007 to 2021 as a sample and combines the relevant policy documents of the wind power industry issued by the State Council, the National People's Congress, and various government departments from 1999 to 2021 to explore the comprehensive impact of demand-side policies and supply-side policies on technological innovation performance, and it further analyzes the role of digital transformation. The main conclusions are the following.

The demand-side policy can effectively improve the technological innovation performance of enterprises as it can focus on shaping the competitive environment between old and emerging technologies in demand, affect the market return expectations of enterprises, and expand the potential market for technological innovation through government guidance and demonstration. In the process of technological innovation, uncertain technological routes, unknown demands, and a limited expected market scale bring risks and costs to enterprises. The demand-side policy can provide stable and positive expected returns and market potential for enterprise technological innovation, increase enterprise profits, attract market investment to supplement the financial resources needed for technological innovation, and help to improve the performance of technological innovation.

The supply-side policy has an obvious positive effect on the technological innovation performance of enterprises. On the supply-side, policies such as introducing and absorbing foreign advanced technologies, setting up technology development projects, and promoting technology cooperation and exchange can support enterprises in the strengthening of their international technology cooperation, in obtaining advanced technology resources from various sources at home and abroad, and in improving the technology supply. Policies such as promoting technology localization, independently developing key wind power technologies, and providing R&D funding support can reduce the R&D risks and costs of enterprises, thus supporting enterprises in the improvement of their technological innovation performance on the technology supply side.

There is a significant synergistic effect between demand-side policies and supply-side policies. The demand-side policy strengthens the role of the supply-side policy in promoting technological innovation performance, and there is a synergistic effect between industrial policies. Some previous studies have suggested that implementing different industrial policies at the same time might increase the cost of complying with different policy frameworks and weaken the impact of industrial policies on enterprise technological innovation [56]. Differing from this point of view, the empirical results of this paper confirm that the combination of industrial policies can bring beneficial complementary effects and strengthen the incentive effect of demand-side policies and supply-side policies on technological innovation performance.

Digital transformation can promote the technological innovation performance of enterprises as it can improve their ability to absorb external information and other innovative resources, provide business support for their technological innovation decisions, improve organizational agility, help them to establish broader R&D partnerships, and improve communication efficiency. The wide application of digital technology has greatly accelerated the overflow of cutting-edge knowledge and the latest research and development information. Enterprise scientific researchers can obtain the latest technical knowledge and information through the network in a timely manner. Digital transformation can help enterprises to obtain internal and external information more effectively, identify and adapt to changes in the external environment (such as the market innovation demand) in a timely manner, obtain relevant policy support, and carry out technological innovation activities according to their own conditions. In addition, technologies such as big data analysis, the internet of things, and cloud computing have promoted the dissemination and sharing of knowledge and information, enhanced innovation cooperation between enterprises, and improved the technological innovation performance of enterprises.

Digital transformation can strengthen the synergistic effect between demand-side policies and supply-side policies. The demand-side policy plays a more significant role in promoting the technological innovation performance of enterprises with a high degree of digital transformation, while the supply-side policy plays a stronger role in promoting the technological innovation performance of enterprises with a low degree of digital transformation. On the one hand, enterprises with a high degree of digital transformation are more efficient in receiving and integrating information resources, adapt to changes in the policy environment relatively quickly, and can integrate a variety of policy resources to significantly improve their technological innovation performance. Through digital transformation, enterprises can improve their adaptability to changes in the policy environment in many ways, including shortening the response time to changes in the external policy environment, speeding up the decision-making process, improving the organizational learning efficiency, promoting organizational structure reform, reducing transaction costs, and promoting resource sharing among organizations [57]. On the other hand, enterprises with a low degree of digital transformation are less able to improve their technological innovation performance in time with the support of demand-side policy due to the low efficiency of knowledge absorption and transformation. However, with the support of the supply-side policy, it is possible to significantly improve the performance of technological innovation, indicating that the improvement in the supply of innovation resources has a greater impact on the technological innovation output of such enterprises.

6.2. Limitations

This paper has the following limitations. First, considering the availability of data, this paper only discusses the role of digital transformation in the mechanism of industrial policies' impact on technological innovation performance based on the sample of listed enterprises. Second, in order to select industry-specific demand-side policies and supply-side policies, this paper only selects industrial policies and enterprises related to wind power as the analysis sample. There are still limitations from the industrial perspective. Third, this paper only selects China's industrial policies for research, and fails to fully consider the role of international policy spillovers. Due to the spillover effect, the supply-side policies adopted by other countries may affect the development process of domestic enterprises' technological capabilities. At the same time, the environmental policies implemented by other countries will also affect the access standards of enterprises' exports, thus creating conditions for the generation and diffusion of new technologies. Fourth, this paper only conducts tests based on annual observations, without further analyzing the long-term effects of digital transformation on the relationship between industrial policy and technological innovation performance.

6.3. Practical Implications and Future Research

Based on the above research results, this paper puts forward the following suggestions in policy design and enterprise management. First, government departments should pay attention to the coordination between demand-side policy and supply-side policy in policy design, optimize the synergistic effect between policies, and thus more effectively promote the improvement in enterprise technological innovation performance. Second, digital transformation plays an important role in the technological innovation activities of enterprises. Enterprises should pay attention to the positive significance of digital transformation for long-term competitiveness from the perspective of innovation. At the same time, the government should formulate relevant policies that encourage and support enterprises when they carry out digital transformation and ensure the sustainability of the national innovation-driven development strategy. Third, digital transformation has a significant positive impact on the relationship between industrial policies and enterprise technological innovation performance. The design of policy differentiation should focus on matching the differences of enterprise digital transformation, optimize the industrial policy portfolio from the perspective of enterprise digital transformation heterogeneity, and improve the corresponding policy support for enterprise innovation activities with different degrees of digital transformation. Finally, demand-side policies play an important role in promoting technological innovation performance. In the design of demand-side policies related to wind power, a unilateral, excessive reduction in wind power feed-in tariffs may be detrimental to the output of wind power technological innovation. In the process of gradually reducing the on-grid price of wind power, and in order to maintain the attractiveness of renewable energy sources such as wind power compared with traditional fossil energy in terms of research and development investment, conditions can be created on the demand side to increase the relative consumption of wind power. This would attract relevant investments, promote the sustainable transformation of energy, and improve China's energy technology advantages.

Although the empirical data of this paper mainly comprise the relevant information of wind power enterprises and policy documents, the findings of the study can bring more universal contributions to emerging technologies. On the one hand, emerging technologies have similar characteristics, such as the initial high-tech uncertainty and lack of cost competitiveness [41]. At the same time, emerging technologies such as renewable energy technologies face various market or institutional failures at the initial stage, and new technologies embedded in existing systems may need more protection, cultivation, and authorization in policy design [11]. Therefore, the research results of this paper are helpful for other research related to emerging green technology innovation. Additionally, this study focuses on the impact of digital transformation on the relationship between industrial policies and technological innovation performance, which is helpful for supplementing the existing research focusing on the impact of the organization and social culture [52].

In addition, we provide the following suggestions for future research. First, future research can enrich the existing relevant research by conducting questionnaires and interviews with non-listed enterprises. Second, further research can include more industries in the sample for a comprehensive and in-depth investigation. In addition, similar research can be designed to explore corporate activities in other sectors. Third, the complementarity and coordination of different national and international policies can be further analyzed. Finally, future research can attempt to further explore the differences between the short-term and long-term impacts of digital transformation on the relationship between industrial policy and technological innovation performance.

Author Contributions: X.C.: conceptualization, methodology, data curation, formal analysis, validation, resources, writing—review and editing, supervision, project administration, funding acquisition. T.C.: conceptualization, methodology, data curation, formal analysis, validation, writing—original draft, writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding: Major Program, National Social Science Fund of China (serial number: 21ZDA033); General Program, National Natural Science Foundation of China (serial number: 72071104); General Program, National Social Science Fund of China (serial number: 21BGL223); Key Program, Social Science Foundation of Jiangsu Province (serial number: 20GLA007).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: Thanks for the support of funding and NJU.

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

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