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Corporate ESG Performance Analysis Based on Benchmark Regression Models

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Abstract: This study aims to analyze the impact of digital transformation and green innovation technology on the environmental, social and governance (ESG) performance of new energy companies based on a benchmark regression model. Based on the data of 552 new energy listed firms in China's Shanghai and Shenzhen markets between 2013 and 2023, this paper uses a benchmark regression model to conduct an empirical analysis to explore how digital transformation promotes firms' ESG performance and to examine the mediating role of green technology innovation in it. By examining whether new energy firms undergoing digital transformation can promote corporate ESG performance, the results show that digital transformation significantly enhances the ESG performance of new energy firms, a finding that still holds after the robustness test. In addition, digital transformation further enhances firms' ESG performance by accelerating green technology innovation.

1. Introduction

The purpose of this paper is to explore how digital transformation [1] can enhance the ESG performance [2] of new energy companies [3] through green innovation technology [4]. To this end, we comprehensively applied a benchmark regression model [5] to empirically analyze the data of 552 new energy listed companies in China's Shanghai and Shenzhen cities between 2013 and 2023. The study shows that digital transformation significantly improves firms' ESG performance and further enhances this performance by accelerating green technology innovation. In the research process, this paper adopts the robustness test [6] to ensure the reliability and validity of the results. Digital transformation not only optimizes the operation mode of enterprises and improves production efficiency, but also promotes the green transformation of product functions and industrial chain, which in turn effectively enhances the ESG performance of enterprises. Through the in-depth analysis of the relationship between digital transformation and ESG performance, this paper provides important theoretical support and practical guidance for new energy enterprises in the process of achieving sustainable development goals. In summary, the research in this paper not only fills the research gap between digital transformation and ESG performance of new energy enterprises, but also provides new perspectives and methods for promoting green transformation and sustainable

development of enterprises.

2. Theoretical Analysis

Digital transformation, as an important means to improve the operational efficiency of enterprises, optimize resource allocation and promote business innovation, has a profound impact on the ESG performance of new energy enterprises.

First, from the environmental dimension, digital transformation can significantly improve the resource utilization efficiency and environmental management capability of new energy enterprises. By introducing advanced technologies such as IoT, big data analysis and artificial intelligence, new energy enterprises can achieve real-time monitoring and precise control of the production process, thereby optimizing energy allocation and reducing energy waste and pollutant emissions. In addition, digital transformation can also promote new energy enterprises to carry out green technological innovation, such as the development of more efficient and environmentally friendly energy conversion and storage technology, thus further reducing the impact of enterprises on the environment.

Second, from the social dimension, digital transformation can help new energy companies improve their sense of social responsibility and employee well-being. Through digital means, new energy companies can communicate and interact more efficiently with suppliers, customers, communities and other stakeholders, and understand their needs and expectations, so as to better fulfill their social responsibilities.

Finally, from the governance dimension, digital transformation can improve the transparency and governance of new energy enterprises. Through digital means, new energy enterprises can realize real-time monitoring and data analysis of internal business processes and financial status, so as to identify and solve potential management problems in a timely manner. At the same time, digital transformation can also promote communication and interaction between enterprises and external stakeholders such as investors and regulators, and improve the transparency and accuracy of information disclosure.

3. Research Hypotheses

Based on the theoretical analysis in the previous section, the following hypotheses are conducted in this section.

3.1 New energy enterprises carry out digital transformation to promote corporate ESG performance

Digital transformation is a key force for new energy enterprises to promote green technological innovation, improve industrial structure and lead them towards greener environment. This transformation not only optimizes their production and business models, but also significantly improves their ESG performance.

On the one hand, digital transformation enhances the transparency of information by strengthening the flow of information within and outside the enterprise, effectively alleviating the problem of information asymmetry. This change not only provides the necessary financial support for green technological innovation, but also promotes the integration of cross-field technological knowledge, which lays a solid technological foundation for green technological R&D and innovation.

On the other hand, green technology innovation plays a crucial role in enhancing the ESG performance of new energy enterprises. It optimizes the enterprise's allocation of resources, improves resource utilization efficiency and reduces resource waste, thus improving the industrial structure. At the same time, green technology innovation also reduces the energy consumption of enterprises in

the process of product development and production, optimizes the function of products, and enables enterprises to launch greener and more environmentally friendly products, which in turn improves their ESG performance.

3.2 Digital transformation can improve the ESG performance of new energy enterprises by promoting green technology innovation

3.2.1 Model Construction Based on Research Design and Data Sources

(1) Constructing a benchmark regression model of digital transformation affecting corporate ESG performance

Based on the existing literature, a benchmark regression model is constructed for the impact of digital transformation on the ESG performance of new energy enterprises:

$$\mathrm{ESG}_{it} = \mu_1 \mathrm{Digi}_{it} + \mu' A_{it} + \alpha_0 + \rho_i + \gamma_t + \theta_{it} \tag{1}$$

Where ESG_{it} represents the ESG performance of new energy enterprises; Digi_{it} represents digital transformation; A_{it} represents the ensemble of control variables μ_1 ; and μ' represent the estimated coefficients of explanatory variables and control variables, respectively; α_0 and θ_{it} are constant terms and random error terms, respectively; ρ_i and γ_t represent individual fixed effects and time fixed effects, respectively; subscript i denotes an enterprise, and t denotes a year.

(2) Mediation effect model of digital transformation

According to the previous analysis, the mediation effect model is constructed as follows:

$$\mathrm{tech}_{it} = \Pi_1 \mathrm{Digi}_{it} + \Pi' A_{it} + \alpha_0 + \rho_i + \gamma_t + \theta_{it} \tag{2}$$

$$\mathrm{ESG}_{it} = \omega_1 \mathrm{Digi}_{it} + \omega_2 \mathrm{Digi}_{it} + \omega' A_{it} + \alpha_0 + \rho_i + \gamma_t + \theta_{it} \tag{3}$$

Where tech_{it} represents the mediating variable green technology innovation, and the meaning of the rest of the variables is the same as formula (1).

3.2.2 Variable Measurement

(1) Explanatory variables: digital transformation (Digi)

In this paper, we use text analysis technology to identify the keywords related to digital transformation in the annual reports of listed companies and count the frequency of these keywords, so as to measure the “text expression intensity” of the digital transformation of new energy enterprises and use this as a proxy variable.

(2) Explanatory variables: corporate performance (ESG)

In this paper, the ESG performance of enterprises is measured by their comprehensive disclosure scores in the three aspects of environment, social responsibility and corporate governance.

(3) Control variables

Referring to existing studies, this paper first analyzes the factors affecting ESG performance from the enterprise level, which mainly include: enterprise gearing ratio (Ratio), measured by the ratio of total liabilities to total assets of the enterprise; enterprise profitability (Profit), expressed as the ratio of the current profit of the enterprise to the total output value; and age of the enterprise, which is reflected by calculating the difference between the observed year and the year of the enterprise's

establishment, plus 1 of the logarithmic value is represented. Further, macro-level control variables are also introduced, specifically: the level of scientific research (Scien), using personal computer ownership as an indicator; and human capital (Hum), which is assessed by using the ratio of employees with bachelor's degree and above to the total number of employees.

3.2.3 Data Source

The research data in this paper is the data of A-share new energy listed companies in China's Shanghai and Shenzhen cities from 2013-2023. Specifically, data related to digital transformation are obtained from the China Fixed Assets Statistical Yearbook and annual reports released by listed companies in previous years; data on corporate ESG performance are taken from ESG disclosure scores provided by Bloomberg Information and from the Wind database; basic information and financial data of listed companies are obtained from Oriental Fortune; data at the corporate level are obtained from the Flush website, while data at the provincial level are are sourced from the China Statistical Yearbook. In order to ensure the rationality and scientificity of the data, during the sample screening process, this paper takes the following measures: (1) financial and insurance enterprises are excluded; (2) samples of companies with seriously missing data during this period. After rigorous screening, several valid observations are finally obtained.

4. Empirical Analysis

4.1 Benchmark Regression Results

According to the benchmark regression results of the impact of digital transformation on the ESG performance of new energy enterprises. By analyzing the regression results of the data, it can be found that the regression coefficients of digital transformation on the ESG performance of new energy enterprises are significantly positive regardless of whether the control variables are included or not, and all of them have passed the test of 1% significance level. This result indicates that digital transformation has a significant positive impact on the ESG performance of new energy enterprises, thus verifying the correctness of hypothesis 1.

As far as the control variables are concerned, the regression coefficient of corporate gearing is significantly negative, indicating that it has a negative impact on the ESG performance of new energy enterprises. The main reason may be that the higher the corporate gearing ratio means the weaker its solvency, which may adversely affect the operation and management of the enterprise, and then affect the ESG performance of the enterprise. The macro-level control variables all have a positive effect on enterprise ESG performance, indicating that the level of scientific research and the level of human resources can promote the development of the enterprise, thus enhancing the enterprise ESG performance.

4.2 Robustness Test

4.2.1 Replacement of explanatory and interpreted variables

To further validate the robustness of the research findings, this paper adopts another method to measure the digital transformation intensity (DigiA) of enterprises, i.e., the proportion of the digital transformation-related portion of the year-end intangible asset details disclosed in the annual reports of listed enterprises is utilized. The ESG scores provided by the Runling database were also used as a proxy variable for ESG performance (Perfor2), and regression analyses were re-run. Among them, the coefficient of the core explanatory variable DigiA is 1.606 and passes the test at the 1% significance level; the regression coefficient of the explanatory variable Digi on the explanatory

variable Perfor2 is also significantly positive at the 1% level. No significant change was found from the previous regression results.

4.2.2 Instrumental Variables

In this paper, the number of data arithmetic facilities constructed (Dicfc) is chosen as an instrumental variable to measure digital transformation. Data arithmetic facilities, as a key support for enterprise digital transformation, are built in a way that does not directly affect current ESG performance, and thus meet the conditions of relevance and exogeneity required for instrumental variables. Based on this, this paper adopts a two-stage instrumental variable approach for regression analysis. The results of the analysis show that the regression coefficient of the number of data arithmetic infrastructures built is positive at the 1% significance level and passes the pseudo-identification test, the weak instrumental variable test, and the endogeneity test, which proves that there is a certain degree of rationality in using it as an instrumental variable for digital transformation. Further observation reveals that digital transformation has a positive driving effect on firms' ESG performance, which again validates the robustness of the benchmark regression results.

4.3 Mediation Effect Test

The mediating effect of green technology innovation was tested using equations (2) and (3). Specifically, the regression results show that the regression coefficient of digital transformation on green technological innovation is significantly positive ($P < 0.01$), which proves that digital transformation has a significant promotion effect on green technological innovation; the other regression results show that the regression coefficients of digital transformation and green technological innovation are 1.136 and 1.132, respectively, and both of them have passed the test of the 1% significance level, which further indicates that digital transformation can enhance the ESG performance of enterprises by promoting green technology innovation, thus verifying the correctness of hypothesis 2.

5. Conclusion

This paper analyzes the impact of digital transformation and green technology innovation on the performance of new energy enterprises (ESG) through a benchmark regression model. Based on the data of 552 new energy-listed companies in China's Shanghai and Shenzhen markets between 2013 and 2023, this paper empirically investigates using a double fixed-effects model to validate the positive role of digital transformation in enhancing corporate ESG performance. The results of the study show that digital transformation significantly contributes to firms' ESG performance and remains valid after the robustness test. More importantly, the study also reveals the mediating role of green technology innovation in this process, i.e., digital transformation can further enhance firms' ESG performance by accelerating the development and application of green technologies. This finding emphasizes the close connection between digital transformation and green technology innovation, which provides an important theoretical basis and practical guidance for new energy enterprises in achieving sustainable development goals.

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