

Will enterprise technological innovation enhance the value of energy-based enterprises? ——Analysis of the Moderating Effect Based on ESG Information Disclosure

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Abstract. Facing the stage of high-quality economic development, energy-based enterprises not only need to improve their energy development technological innovation capabilities, but also actively face the transition to green, low-carbon and sustainable development. Technological innovation realizes the continuous accumulation of corporate value by innovating production technology and improving production efficiency. The ESG concept focuses on the three dimensions of environmental protection, fulfillment of social responsibilities and corporate governance, and helps companies cultivate green and sustainable development capabilities. Based on the two new development concepts of "innovation" and "green" as the research starting point, the article selects 208 listed energy-based companies in A-shares from 2015 to 2019 as the research sample, and uses empirical research to test the impact of corporate technological innovation and ESG information disclosure on energy. The impact of the value of the type of enterprise. The empirical results show that both corporate technological innovation and good ESG information disclosure have positive value creation effects; at the same time, good ESG information disclosure by energy-based companies can further enhance the value creation of technological innovation. At the end of the article, it also puts forward relevant suggestions for energy-based enterprises to improve their technological innovation capabilities and enhance environmental protection awareness.

Keywords: Enterprise technological innovation; ESG information disclosure; energy-based enterprise; enterprise value.

1. Introduction

At present, China has become the world's largest energy consumer. The healthy development of the energy industry is of great significance to my country's economic development and social energy supply. The energy industry is characterized by high resource consumption and serious environmental pollution, which will undoubtedly have a negative impact on economic development in the new era. On the other hand, as a pillar industry of the national economy, the energy industry plays an important role in serving economic development and ensuring people's lives[1]. Therefore, in the context of green, low-carbon and high-quality development, it is particularly important for energy-based enterprises to achieve the triple balance of technological innovation, environmental protection, and self-value enhancement. As an effective means for modern enterprises to enhance their core competitiveness, technological innovation is being valued by more enterprises. The "14th Five-Year Plan Outline" mentioned that in the new era, my country should adhere to the innovation-driven development strategy and comprehensively shape new development advantages; the enterprise level also needs to actively improve technological innovation capabilities and cultivate core competitive advantages. Therefore, it is a very meaningful topic to explore whether technological innovation can help energy-based enterprises face high-quality development.

In recent years, China has successively put forward the "green" new development concept, "carbon peak" and "carbon neutral" overall goals, and strive to promote green development and build a modernization in which man and nature live in harmony. Energy-based enterprises in the new era need not only to achieve high-quality development, but also to actively implement the concept of green and low-carbon development. The ESG concept focuses on the three factors of environmental protection (Environment), social responsibility (Society) and the company (Governance), and promotes the green and sustainable development of enterprises, which is in line

with the development goals of energy-based enterprises. At the same time, relevant studies have shown that companies based on ESG concepts can effectively enhance their corporate value through good ESG information disclosure performance[2]. Therefore, this article takes the two concepts of "innovation" and "green" in the new development concept as the research starting point, trying to explore the impact of corporate technological innovation and ESG information disclosure on the value of energy-based companies.

2. Literature review and research hypothesis

2.1 Literature review

Reviewing the research on enterprise technological innovation and enterprise value, we can find that a large number of scholars have studied that enterprises can improve their own enterprise value through technological innovation (Su Yuzhu et al. 2019; Chen Xu et al. 2021; Kingsley olibe2010; Kur2019;), and also found that there are Related theories are supported, but there are few literatures focusing on energy companies. In addition, compared with corporate social responsibility (CSR), the ESG evaluation system has a broader focus on companies, and it also highlights the investigation of the company's sustainable development capabilities. Therefore, in recent years, the ESG concept has also attracted the attention of many scholars, and many of them have investigated its economic consequences. Existing research shows that companies with good ESG information disclosure can attract more institutional investors (Zhou Fangzhao et al. 2020), increase corporate value (Zhang Lin et al. 2019), obtain higher investment returns (Alda 2019), and reduce financing costs (Qiu Muyuan et al. 2019). However, at this stage, there is no document that joint investigations on enterprise technological innovation and ESG information disclosure, and there is no investigation specifically focusing on energy-based enterprises as the research object. Therefore, this article attempts to use the two new development concepts of "innovation" and "green" as the starting point for research to explore the impact of corporate technological innovation and ESG information disclosure on the value of energy-based companies.

2.2 Enterprise technological innovation and enterprise value

The well-known economist Schumpeter believes that enterprise innovation is the process of reorganizing its own inputs and providing new production functions to achieve residual profits. Based on the theory of technological innovation, enterprises can effectively increase productivity and reduce costs through technological innovation[3]; at the same time, the output of new knowledge and new technologies can also bring continuous growth in enterprise value. According to the value chain theory, enterprise technological innovation will have an impact on all aspects of enterprise value creation, and the improvement of production process and production efficiency brought by technological innovation can bring value accumulation to the enterprise. In addition, the technological innovation investment of enterprises is also a form of enterprise resource allocation. According to the resource-based theory, technological innovation output is a unique and highly competitive resource of an enterprise, and it can create income for the enterprise. At present, China's energy-based enterprises generally have the problem of low resource utilization, which has led to their lack of competitiveness in the international market. Therefore, technological innovation can help energy-based enterprises innovate production processes to improve resource utilization efficiency and cultivate core competitive advantages, thereby realizing value creation. Based on this, this article proposes the following hypotheses:

H1: Enterprise technological innovation has a role in enhancing the value of energy-based enterprises.

2.3 ESG information disclosure and corporate value

Enterprise value will be affected by the comprehensive influence of the internal and external environment of the enterprise. The ESG concept is based on the stakeholder theory and advocates

that companies should pay attention to environmental protection and social responsibility performance, and actively maintain relationships with corporate stakeholders, so as to gain trust from the outside world, so that companies can gain competitive advantages. On the other hand, the ESG philosophy rooted in the theory of sustainable development also requires companies to pay attention to environmental protection and good social governance, and create an internal and external environment conducive to the sustainable development of the company, thereby enhancing the company's green and sustainable development capabilities and improving itself Corporation value[4]. However, the energy industry is a typical industry with high energy resource consumption, and the operation and development of energy-based enterprises will also cause tremendous pressure on the environment. Therefore, good ESG information disclosure can not only effectively alleviate the contradiction between environmental protection and resource development faced by energy-based companies, but also enhance the company's sustainable development capabilities, thereby enhancing its corporate value. Based on this, this article proposes the following hypotheses:

H2: ESG information disclosure has a positive effect on the value of resource-based companies.

2.4 Enterprise technological innovation, ESG information disclosure and enterprise value

Technological innovation has given companies an inexhaustible driving force for sustainable value growth internally; and ESG information disclosure takes into account the three major factors of the company's internal and external operating environment, which helps companies enhance their own sustainable development capabilities and thus obtain corporate value continued accumulation. Therefore, enterprises also need to fully consider external factors when carrying out technological innovation[5], and effectively interact with the public, suppliers and other stakeholders. Therefore, good ESG information disclosure can more effectively promote the improvement of technological innovation capabilities. This also means that under different ESG information disclosure quality, the value creation effect of enterprise technological innovation may also be different. Based on this, the article takes ESG information disclosure as a moderating variable to further investigate the value creation effect of enterprise technological innovation under different ESG information disclosure qualities. Therefore, the following hypotheses are proposed:

H3: Good ESG information disclosure by energy-based companies can further enhance the value creation effect of technological innovation.

3. Research and design

3.1 Sample selection and data sources

This article selects the Bloomberg database (Bloomberg) 2015-2019 energy-based companies that disclosed ESG scores as the initial sample, and performs the following processing: remove ST, *ST companies and samples with missing data; after screening, the final sample involves 208 Companies, 1040 pieces of data. The patent application data in this article comes from the CNRDS database, and the financial data comes from the CSMAR database; further, in order to avoid the interference of outliers on the empirical analysis results, this article has carried out the upper and lower 1% Winsorize processing on all continuous variables.

3.2 Model setting and variable definition

This paper studies the impact of corporate technological innovation and ESG information disclosure on the value of energy-based companies. In order to verify H1 and H2, the following empirical models (1) and (2) are constructed; in addition, the article is to investigate the moderating effect of ESG information disclosure and construct an empirical study. Model (3):

$$\text{TobinQ} = \alpha_0 + \alpha_1 \times \text{patent} + \text{year_d} + \alpha_i \times \text{Controls} + \varepsilon \quad (1)$$

$$\text{TobinQ} = \beta_0 + \beta_1 \times \text{ESG} + \text{year_d} + \beta_i \times \text{Controls} + \varepsilon \quad (2)$$

$$\text{TobinQ} = \gamma_0 + \gamma_1 \times \text{patent} + \gamma_2 \times \text{ESG} + \gamma_3 \times \ln(\text{patent} \times \text{ESG}) + \text{year_d} + \gamma_i \times \text{Controls} + \varepsilon \quad (3)$$

In this paper, the explanatory variable enterprise value is measured by the widely used metric TobinQ value[6]; the explanatory variable enterprise technology innovation is measured by the patent application volume of the enterprise, and the article uses enterprise R&D investment as a substitute variable for robustness test[7]; the moderating variable ESG information disclosure adopts the ESG scores in the Bloomberg Information database. This article draws on relevant research to select the debt-to-asset ratio (Lev), return on total assets (ROA), shareholding ratio of the largest shareholder (TOP1), shareholding ratio of the top 10 shareholders (TOP10), cash Ratio (Cash_r), growth (Growth), enterprise size (SIZE), enterprise age (age), and property rights (SOE) are used as control variables.

4. Empirical analysis

4.1 Descriptive results analysis

The article uses Stata16.0 software to perform descriptive analysis of sample data. As shown in Table 1, the average value of the sample enterprise value index TobinQ is 1.74, which is greater than the median value of 1.395, indicating that the overall value of the sample energy-based enterprises is relatively high. This may be related to the nature of their property rights, which are mostly state-owned enterprises. Conditions such as performance and policy subsidies are relatively good; but from the point of view of its maximum value, there is still a big difference in the value level between enterprises. The standard deviation of the technical innovation patent of the sample enterprises reached 157, indicating that there is a big difference in the level of technical innovation among enterprises. The average ESG score of the sample companies is 23.49 slightly higher than the median of 21.90, but the maximum value is still quite different, which also reflects the current differences in the degree of ESG practice of energy-based companies.

Table 1. Descriptive statistical results of main variables

variable	N	mean	p50	sd	min	max
TobinQ	1040	1.740	1.395	1.015	0.851	6.358
patent	1040	83.27	29	157.0	1	979
ESG	1040	23.49	21.90	6.834	11.98	47.52
lnpatentESG	1040	6.213	6.493	1.962	2.582	10.35
lnR&D	1040	17.837	18.126	2.222	4.102	22.905
ROA	1040	0.0400	0.0280	0.0680	-0.159	0.309
Lev	1040	0.415	0.441	0.215	0.00400	0.878
TOP1	1040	39.99	39.59	16.35	9.080	81.10
Top10	1040	61.24	60.78	15.20	24.34	92.07
Cash r	1040	0.734	0.193	2.301	0.00100	18.73
Growth	1040	0.459	0.0500	2.821	-0.992	25.95
SOE	1040	0.674	1	0.469	0	1
SIZE	1040	23.47	23.47	1.195	20.91	26.41
age	1040	15.31	16	6.012	0	26

4.2 Analysis of basic regression results

Before the empirical analysis, the article uses Hausman test on the regression model. The p-value of the regression result is significantly 0. Therefore, it is believed that the fixed-effect model should be used, so this paper uses the time-fixed-effect model for relevant empirical analysis. The article first uses the empirical model (1) to test the value creation effect of enterprise technological innovation. As shown in the regression result table 2 column (1), enterprise technological innovation has a positive effect on the value of energy-based enterprises, and the regression coefficient is significantly at a significance level of 1%; similarly, the results in column (2) show that the regression coefficient of corporate ESG information disclosure on the value of energy-based companies is positive and significant at the significance level of 1%. Therefore, it

verifies H1 And the establishment of H2. When testing the moderating effect of ESG information disclosure, the article introduces patent×ESG, which is the crossover term of technological innovation and ESG score, into the empirical model, and performs logarithmic processing on this. The regression coefficient is 0.0679, and it is significant at the 1% significance level, indicating that the good ESG information disclosure of energy-based companies can further enhance the value creation of technological innovation, so, H3 proved to be established.

	(1)	(2)	(3)	(4)
	TobinQ	TobinQ	TobinQ	TobinQ
patent	0.0010*** (0.0001)		0.0005** (0.0002)	0.0005*** (0.0002)
ESG		0.0129*** (0.0044)	0.0081* (0.0044)	0.0084** (0.0042)
InpatentESG			0.0679*** (0.0177)	0.0509*** (0.0182)
ROA	1.6317*** (0.4400)	1.6966*** (0.4403)	1.5805*** (0.4321)	1.3552*** (0.5143)
Lev	-0.1292 (0.1440)	-0.1283 (0.1466)	-0.1346 (0.1427)	-0.1311 (0.1396)
Cash_r	0.0309 (0.0229)	0.0339 (0.0231)	0.0340 (0.0230)	0.0410 (0.0293)
TOP1	-0.0093*** (0.0020)	-0.0082*** (0.0021)	-0.0102*** (0.0020)	-0.0100*** (0.0022)
Top10	0.0052** (0.0024)	0.0056** (0.0024)	0.0067*** (0.0025)	0.0079*** (0.0027)
Growth	0.0142 (0.0123)	0.0156 (0.0121)	0.0162 (0.0121)	0.0156 (0.0146)
SIZE	-0.4845*** (0.0322)	-0.4670*** (0.0323)	-0.5407*** (0.0347)	-0.4935*** (0.0389)
SOE	-0.1147* (0.0612)	-0.1266** (0.0631)	-0.0968 (0.0613)	-0.0751 (0.0662)
age	-0.0073 (0.0046)	-0.0068 (0.0046)	-0.0052 (0.0046)	-0.0090* (0.0047)
cons	13.5159*** (0.6941)	12.7962*** (0.6734)	14.1721*** (0.7192)	12.7699*** (0.7863)
N	1040	1040	1040	832
r2	0.4476	0.4368	0.4602	0.3981
year	Yes	Yes	Yes	NO

Table 2. Enterprise technological innovation, ESG information disclosure and enterprise value
 Note: *, **, *** indicate statistical significance of 10%, 5%, and 1% respectively.

4.3 Robustness test

The article uses patent lagging one-period regression to solve the problem of the lagging effect of corporate technological innovation on corporate value. The regression results are shown in Table 3 (4). The regression coefficient is also significant at the 1% significance level, which still supports H1,H2 and H3. The article also uses the substitution variable method to test the robustness, and uses the company's R&D investment lnR&D as a substitute variable to measure the company's technological innovation. The regression analysis results are basically consistent with the above analysis.

5. Conclusions and recommendations

Facing the stage of high-quality development, energy-based enterprises need to be guided by green development, and while achieving value creation, they also need to further enhance their own sustainable development capabilities. Today, technological innovation has become an effective means for companies to gain long-term competitive advantages. Therefore, this article takes the two concepts of "innovation" and "green" in the new development concept as the research starting point, and selects 208 listed energy-based companies with A-shares from 2015 to 2019 as the research samples to empirically test the impact of corporate technological innovation and ESG information disclosure on the value of energy-based companies. The empirical results show that both corporate technological innovation and good ESG information disclosure have positive value creation effects; at the same time, good ESG information disclosure by energy-based companies can further enhance the value creation effects of technological innovation. Based on the research conclusions, this article puts forward the following suggestions:

First, increase investment in technological innovation and research and development. In the era of "mass entrepreneurship and innovation", energy-based enterprises should increase investment in technological innovation, increase innovation output, and use technological innovation as a continuous driving force for the accumulation of corporate value. In addition, energy-based enterprises also need to make good use of relevant national policy subsidies, strengthen technological innovation cooperation with relevant scientific research departments, and implement the latest scientific research results.

Second, actively implement the ESG business philosophy and enhance the company's green and sustainable development capabilities. Energy-based companies are typical resource-consuming companies. Actively practicing ESG business philosophy can enable companies to effectively alleviate the contradiction between resource development and utilization and environmental protection. In addition, environmental protection, fulfillment of social responsibilities, and good corporate governance can enhance corporate risk resilience, and achieve sustainable growth in value.

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