sustainability

MDPI

Article

Green Technology Innovation, Energy Consumption Structure and Sustainable Improvement of Enterprise Performance

Chenggang Wang

School of Economics and Business Administration, Heilongjiang University, Harbin 150080, China; wangchenggang@hlju.edu.cn

Abstract: In order to promote the coordinated development of social and economic development and the natural environment, high-end equipment manufacturing (HEM) enterprises should promote the sustainable development of the green economy. In this process, HEM enterprises need to strengthen the green technology innovation ability and optimize the energy consumption structure. In this way, it will be beneficial to the sustainable improvement of HEM enterprise performance. On the basis of sorting out relevant research literature, this study uses structural equation modeling and hierarchical regression analysis to systematically study the impact of green technology innovation on the continuous improvement of HEM enterprise performance. Currently, there are many difficulties in the research of this paper, such as variable selection, index measurement, empirical testing process and so on. However, based on the success of previous academic research, this paper overcame the difficulties and completed this research. In this study, the energy consumption structure is an intermediary variable, and the government policy support is a moderator variable. A relationship model of the impact of green technology innovation on the continuous improvement of HEM enterprises' performance is constructed. In addition, the author conducts a confirmatory analysis of the relationship between multiple variables. The conclusions of this study are as follows: (1) Green technology innovation has a significant positive impact on the performance improvement of HEM enterprises. (2) Energy consumption structure plays a partial mediating role between green technology innovation and enterprise performance improvement. (3) Government policy support regulates the relationship between green technology innovation and HEM enterprise performance improvement. That is to say that the stronger the government's policy support for green technology innovation, the stronger the green technology innovation impetus of HEM enterprises, and the better the effect of HEM enterprise performance improvement.

Keywords: green technology innovation; green production capacity; HEM enterprises; structural equation

check for updates

Citation: Wang, C. Green Technology Innovation, Energy Consumption Structure and Sustainable Improvement of Enterprise Performance. *Sustainability* **2022**, *14*, 10168. https://doi.org/10.3390/su141610168

Academic Editor: Wen-Hsien Tsai

Received: 29 July 2022
Accepted: 15 August 2022
Published: 16 August 2022

1. Introduction

With the continuous enhancement of social awareness of environmental protection, the competition among enterprises has emerged in a new development direction under the background of green economy [1]. With the continuous transformation of traditional industries and the rise of emerging industries, green production, green operation, and environmental protection have become new components of the global economy. As an important main body of a key industry, HEM enterprises have made great contributions to China's economic development in recent years, while consuming a lot of energy and resources, causing major environmental pollution. Therefore, under the background of carbon peaking and carbon neutrality proposed by the Chinese government, in order to sustainably promote the harmonious interaction between economic development and natural environment, HEM enterprises must change their original products, production process and energy consumption structure. Furthermore, it will promote the commercialization and diffusion of green technology innovation to meet the needs of green economy and market development, thereby effectively improving operational performance. Technological innovation is the core force for a country to achieve innovation-driven growth. In addition, it is also an important determinant of economic development [2]. When the level of green technology innovation reaches a certain height, relevant entities can effectively predict the consumption structure of production factors such as energy [3]. This will help enterprises to formulate efficient management measures and promote the improvement of enterprise performance [4,5]. At the same time, manufacturing is the main body of China's industrial economic development. The energy consumption of manufacturing enterprises accounts for nearly 95% of China's total industrial energy consumption. Among them, compared with the terminal consumer goods manufacturing industry, HEM enterprises are responsible for providing technical high-end equipment for simple reproduction and expanded reproduction of the national economy. They consume the most fossil energy such as coal, and the energy accounts for the highest proportion of operating costs. Furthermore, the type of resource consumption determines the choice of innovation form. Carrying out green technology innovation can reduce environmental pollution and continuously improve corporate performance. At the same time, energy efficiency can be improved by developing the commercialization of green technology innovations. This helps to achieve carbon emission reduction goals. Therefore, green technology innovation by HEM enterprises is in line with the trend of global economic development. However, in previous studies by scholars, few scholars have studied the impact of HEM enterprise green technology innovation and energy consumption structure on the performance improvement of enterprises. Therefore, in order to extend the relevant research content, this paper will conduct in-depth systematic research on this issue. It is hoped that the research of this paper can scientifically reveal the role process of green technology innovation on enterprise performance improvement. Based on previous research, this paper attempts to use energy consumption structure as an intermediary variable and government policy support as a moderator variable to analyze the impact process of green technology innovation in HEM enterprises on enterprise performance improvement. This study can theoretically lay an important research foundation for future related scholars' research. At the same time, the conclusions of this paper will also provide important references for enterprises or governments to make relevant decisions. This research will demonstrate important theoretical and practical implications.

The rest of this research is structured as follows: (1) Relevant literature will be sorted out, such as green technology innovation, the relationship between green technology innovation and the performance of HEM enterprises, etc. (2) This paper will put forward the content of the research hypothesis, and scientifically construct the theoretical model of this research. (3) The research methods part includes the data, and test the reliability and validity of the data. (4) The part of testing the relevant research results involving the test of the mediating effect of green production capacity and the adjustment effect of positive policy. (5) The final research conclusions and suggestions are proposed.

2. Literature Review

2.1. Research on Green Technology Innovation

After the concept of "innovation" was put forward by the famous economist Schumpeter, related innovation theories continued to appear. Breakthrough innovation and incremental innovation are the two main forms of organizational technological innovation, but the contribution of breakthrough innovation to organizational performance is far greater than the contribution of incremental innovation to organizational performance. Moreover, technological innovation has developed into an important measure for enterprises to improve total factor productivity, and achieve intensive development of economic growth by promoting technological progress [5]. At the same time, the technological innovation model forms a "double hump" model due to the different push-pull factors of technology and demand [6]. In addition, with the development of technological innovation theory, the theory of green technology innovation came into being. Green technology innovation is a breakthrough innovation for traditional energy technology based on renewable resource technology [7]. The innovation of energy technology stems from the fact that some companies want to control costs in the face of rising energy prices. They will also increase the research and development of energy-saving technologies, thereby improving energy efficiency [8]. Among them, developing countries need at least six elements if they want to introduce green technology from abroad, such as capital, technology, talents, information, management concepts, and culture. The relative impact of green energy technologies on the scientific niche of technological excellence is greater. With the gradual weakening of fossil energy development momentum, green energy technology is conducive to promoting the development of emerging economies [9]. From the research of many scholars in the world, it is not difficult to find that green technology innovation, as an innovation-driven model, has realized energy saving, environmental protection and harmonious development between man and nature in the process of manufacturing development.

2.2. Research on the Relationship between Green Technology Innovation and the Performance of HEM Enterprises

Research on the impact of green technology innovation on the performance of HEM enterprises. Green technology innovation of industries and enterprises has been an important booster for economic and social development. Green technology innovation could also continue to promote the continuous expansion of economic scale [10]. Green technology innovation is the biggest driving force for promoting sustainable economic development in the future. Continuous green technology innovation and the popularization of innovative outputs are conducive to improving enterprise performance [11]. At the same time, the green innovation of HEM enterprises, on the one hand, can broaden the original way of obtaining environmental benefits only through waste recycling by forming new development ideas. On the other hand, the green innovation can also form a "technical compensation" effect. It could help to promote the realization of high technology and reduce energy consumption in the production process of HEM enterprises. Furthermore, it also helps to improve the performance of HEM enterprises and the transformation of green innovation achievements [12]. In addition, in the context of environmental degradation and resource crisis, the HEM industry improves industrial performance through green technology innovation and realizes a green operation mode with low energy consumption and emissions [13]. However, from the perspective of endogenous economy, enterprises can improve energy efficiency by strengthening "hard" technological innovation and progress. They also improve their innovation performance with high efficiency and low energy consumption. At the same time, green technology innovation controls the carbon emission process of HEM industry and improves the utilization efficiency, and from the perspective of innovation process, it is pointed out that the performance of green technology innovation is expressed as green research and development performance, green manufacturing performance and green marketing performance [14].

Research on the role of government policies in the process of enterprise green technology innovation. Under the background of the transitional economy, most HEM enterprises are faced with adapting to the new environment based on technological innovation, and have a lot of interactions about government policy, institutional changes and the evolution of their own behavior, so as to improve the performance of HEM enterprises [15]. China's HEM enterprises have many obstacles to green technology innovation. They are inseparable from the government's policy support and guidance. Scholars generally believe that under the institutional environment, the government's preferential tax policies can help encourage enterprises to increase investment in R&D innovation, thereby improving the performance of green technology innovation [16]. Moreover, the power source for HEM enterprises to carry out green technology innovation has several major characteristics. The fundamental is to pursue economic interests and competitive advantages. The product economy of green technology application can be better achieved in a green background. In terms of the impact of government policy regulation on green technology innovation of

HEM enterprises, the government's strict environmental control pressure and advocacy of green environmental behavior help HEM enterprises to adopt environmental innovation behaviors. It also effectively improves environmental and economic benefit [17]. In addition, China's HEM industry has taken green innovation technology into its own strategic management. In addition, China is accepting green technology transferred from developed countries, which will help to improve enterprise performance [18]. In the existing empirical studies that affect performance, most scholars focus on more specific green technologies such as carbon capture and sequestration. Therefore, HEM enterprises are the research objects to study whether green technology innovation can affect enterprises if there is an impact on performance, and how it affects it, the results of this research have a great contribution to the improvement of the relevant theories of green technology innovation. Furthermore, it also plays an important reference role in promoting the green technology innovation of HEM enterprises.

2.3. Literature Review Summary

This study sorts out previous scholars' research on green technology innovation and its impact on HEM corporate performance. At the same time, this paper also sorts out the research on enterprise energy efficiency, enterprise environmental benefit, enterprise performance, and green technology innovation performance of high-end equipment manufacturing enterprises. The related research results are abundant. However, with the dynamic changes in the internal and external environment of HEM enterprises, it is difficult to significantly improve enterprise performance by carrying out green technology innovation alone. Therefore, some scholars have begun to explore the marginal influencing factors of green technology innovation and HEM enterprise performance. The specific research gap is as follows:

(1) In terms of research perspective, scholars' research on technological innovation and enterprise performance has been relatively mature, but there is little research on the green level. The only current research literature on green technology innovation is also limited to manufacturing enterprises specializing in green products. There is little research literature on how some HEM enterprises with high pollution, high energy consumption, and high carbon emissions carry out green technology innovation to achieve enterprise performance improvement.

(2) In terms of research focus, the results of green technology innovation were mainly studied from the perspective of economic growth of HEM enterprises in the early stage. Later, green technology innovation was studied in the form of breakthrough innovation and incremental innovation. Nowadays, the research on green technology innovation of HEM enterprises has begun to conduct international comprehensive research, and try to conduct systematic and comprehensive research. However, current scholars' research in this area still lacks sufficient comprehensiveness.

(3) In terms of research methods, much existing literature uses econometric methods such as stage model and PVAR model, and select Chinese provincial panel data to empirically study the relationship between energy efficiency and operational performance of HEM enterprises. It focuses on the efficiency evaluation of green technology innovation performance, but does not test the exogenous factors that affect green technology and enterprise performance.

(4) In terms of research elements, the research scope of existing scholars is mostly limited to single-level factors, such as energy prices, environmental benefits, environmental regulation, competitive environment, technological progress of enterprises, energy efficiency, product characteristics, logistics outsourcing and so on. However, few scholars have integrated all levels of factors into one mechanism for research.

Therefore, in order to make up for the shortcomings of previous scholars' research, this paper has carried out related research. Based on the research foundation of relevant scholars, this paper further studies the impact of green technology innovation of HEM enterprises on enterprise performance improvement with rigorous scientific thinking and innovative research ideas.

The innovation and marginal contribution of this paper are as follows: (1) This paper takes the green technology innovation theory as the starting point, takes China's economic transformation as the research background, and selects HEM enterprises that pursue low-energy consumption, high-efficiency production and green operation as the main research objects are discussed. In addition, the impact of green technology innovation on enterprise performance improvement is also discussed. This research enriches the content of green technology innovation. (2) In the previous related research, few scholars can simultaneously unify the 3 variables of green technology, government policy, and energy consumption into a research system to analyze their impact on the performance of HEM enterprises. The research of this paper further expands and deepens the multi-layered mechanism of the impact of green technology innovation on enterprise performance improvement. (3) Based on China's current economic situation, institutional environment and characteristics of manufacturing enterprises, this study constructs a mediated moderating model with energy consumption structure as the mediating variable and government policy support as the moderating variable. The establishment of this model has laid an important theoretical foundation for the related research of scholars in the future. (4) Using structural equation model and hierarchical regression analysis method to verify relevant theories and hypotheses, we analyze the impact of green technology innovation on enterprise performance improvement from different dimensions. According to the research results, relevant suggestions for improving the performance of HEM enterprises in the context of green economy are put forward.

3. Research Hypotheses and Theoretical Models

3.1. Assumptions about the Impact of Green Technology Innovation on Enterprise Performance

As a strategic orientation of enterprises, green technology innovation is the key to green production and operation [19]. Enterprise managers are also actively advocating green products and regard green indicators as another new criterion for enterprise performance evaluation [20]. For HEM firms to break through the relevant bottlenecks, it must improve green technology policies, strengthen green innovation teams, cultivate green technology talents, introduce external advanced green technologies, and explore the development path of green technology innovation [21]. In addition, enterprise performance is considered to be a multi-dimensional concept. Different studies use different measurement methods. Performance measurement indicators can be divided into financial indicators and non-financial indicators. The performance of HEM enterprises includes not only economic performance such as sales growth rate, profit margin, and return on assets, but also social performance such as providing jobs and stabilizing social order [22]. At the same time, there is a certain lag in the impact of enterprises' R&D investment in green technology on business performance. Green technology innovation has a certain effect on environmental performance, and green process innovation can improve the competitiveness of enterprises by changing environmental performance [23]. Moreover, the participation of suppliers and customers in HEM enterprise green technology innovation has a significant positive impact on the continuous improvement of enterprise innovation performance [24].

In the current market economy environment that pays attention to greening, green technology innovation not only reduces the cost of environmental governance of enterprises in a sense, but also improves the quality of original products [25]. The stimulus brought by new technology and new use value to the consumer market will be reflected in the rapid expansion of the consumer market's demand for products. The development of green economy affects the green consumption in the end consumer market. The green economy will also help HEM enterprises to continuously expand their green technology innovation advantages. At the same time, green technology innovation can also promote the continuous improvement of HEM enterprise performance [26]. Therefore, the author proposes the following hypothesis:

Hypothesis 1 (H1). *There is a positive correlation between green technology innovation and enterprise performance improvement.*

3.2. Assumptions about the Impact of Green Technology Innovation on Green Production Capacity

Coal energy has become the main energy consumption resource that HEM enterprises rely on because of its low price, but coal cannot be converted into clean energy from a scientific point of view [27]. Therefore, with the reduction of fossil energy and non-renewable, the production cost of manufacturing will be higher and higher. Furthermore, most of China's HEM enterprises use traditional production equipment, and their energy consumption is mainly based on coal and oil. Moreover, developing countries such as China play a key role in promoting green technology innovation, while manufacturing enterprises in developing countries are the main body to promote green and green technology innovation [28]. Changes in the energy mix can directly affect carbon dioxide emissions. If the energy consumption structure of the manufacturing industry is not optimized and reformed, it will directly lead to an increase in the proportion of coal-based fossil energy consumption and an increase in carbon dioxide emissions. Only by optimizing the energy consumption structure can carbon dioxide emissions be reduced [29]. In addition, the coal-dominated energy consumption structure of enterprises can only achieve substantial transformation through technological innovation. In turn, the transformation of energy consumption supply and demand structure further stimulates the sustainable development of green technology innovation [30]. Therefore, the author proposes the following hypothesis:

Hypothesis 2 (H2). *There is a positive correlation between green technology innovation and changing energy consumption structure.*

3.3. Assumptions of the Impact of Green Production Capacity on Enterprise Performance

The carbon emission standards of manufacturing enterprises formulated by the government will bring a great burden to the production methods and costs of enterprises [31]. Quickly adapt to development needs in the early stage of market transformation, and adjust strategic countermeasures as quickly as possible. With the development of green economy, if HEM enterprises want to change the original fossil energy consumption structure and occupy a place in the new green manufacturing field, the most effective way is to develop clean energy and green technology applied innovation, and fundamentally change the energy consumption structure of HEM firms can achieve the purpose of reducing the cost of energy consumption. It would ultimately improve the performance of enterprises [32]. In addition, there is a significant one-way causal relationship from GDP to energy consumption. At the same time, most of the enterprises in the developed countries achieve the improvement of enterprise performance by adjusting the energy consumption structure and improving energy efficiency. A country's green industry is weak, and the low fiscal power ratio of fossil fuels will restrict the actual green industry performance of domestic enterprises [33]. Manufacturing enterprises can continuously improve energy efficiency and operational performance by adjusting energy consumption structure, improving energy efficiency, and establishing energy management standards [34]. Therefore, the author proposes the following hypothesis:

Hypothesis 3 (H3). *There is a positive correlation between changing energy consumption structure and improving enterprise performance.*

3.4. Assumptions about the Moderating Effect of a Positive Policy Environment

The pollution resistance measures of stakeholders promote the diffusion of green technology innovation to a certain extent. HEM enterprises actively develop environmentally friendly products under the government's appropriate innovation incentive compensation measures, and take the road of lower energy consumption [35]. At the same time, compared with developed countries, China's leadership in promoting enterprise green technology innovation is not strong enough. The investment in projects with high energy consumption and low production efficiency should be more strictly reviewed and controlled [36]. In order to vigorously promote the development of green technology in China, the government should take the lead, give full play to its guiding role and introduce private capital to form the main driving force for China's green technology R&D [37]. In addition, in the process of promoting green technology innovation, government policies are irreplaceable roles [38]. Through preferential policies such as tax reduction and exemption, the government's policy support can accelerate enterprise green technology innovation, and urge the establishment and formation of enterprise green-related systems, awareness and culture. Moreover, government policy guidance support has a significant positive impact on the green competitiveness of enterprises [39]. Based on economic, legal, environmental and other policy support, the government increases subsidies for green technology innovation enterprises, vigorously supports the development of clean energy projects, and provides support in project cooperation, technology development and financial support. Therefore, the desire of enterprises to transform from high-carbon energy consumption structure to clean energy consumption through green technology innovation will become stronger and stronger, and they are more willing to invest more R&D personnel and funds to enhance the output of green technology innovation, thereby affecting enterprise performance [40]. Based on the above analysis, the author proposes the following hypothesis:

Hypothesis 4 (H4). *Government policy support has a positive moderating effect on the relationship between green technology innovation and enterprise performance improvement.*

Hypothesis 5 (H5). *Government policy support has a positive moderating effect on the relationship between green technology innovation and energy consumption structure.*

3.5. Theoretical Model

The theoretical model of this study is shown in Figure 1. Green technology innovation has a direct impact on the performance improvement of HEM enterprises. At the same time, the green technology innovation behavior will also have a certain impact on the improvement of enterprise performance based on the intermediary variable of energy consumption structure. However, the important moderating variable of government policy support is also a vital variable worth considering. Government policy support will regulate the impact process of green technology innovation on enterprise performance improvement, and also regulate the impact process of green technology innovation on energy consumption structure. This theoretical model also puts forward the research hypothesis based on the conclusions of relevant research literature.

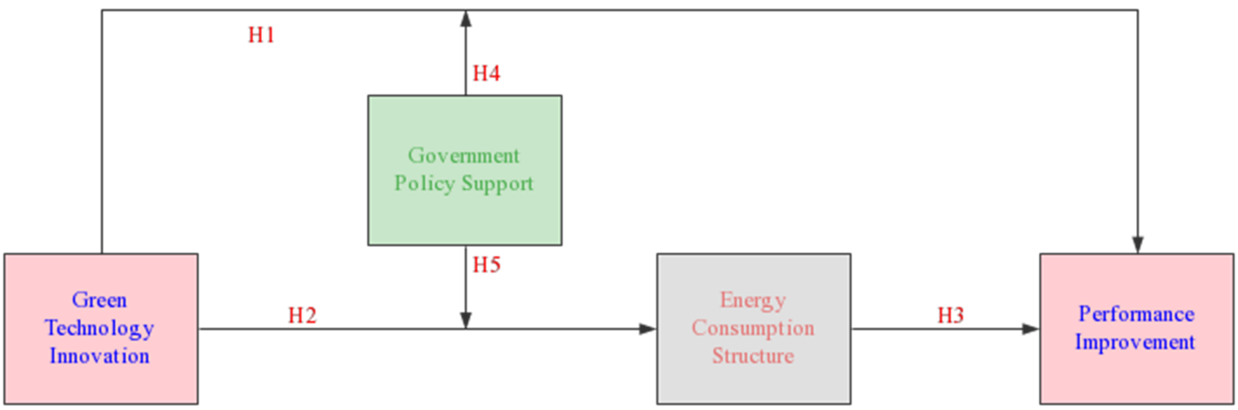

Figure 1. The theoretical model of this study.

The specific research hypotheses are shown in Table 1.

Table 1. The research hypothesis of this study.

Serial Number	Hypothetical Content
H1	There is a positive correlation between green technology innovation and enterprise performance improvement.
H2	There is a positive correlation between green technology innovation and changing energy consumption structure.
H3	There is a positive correlation between changing energy consumption structure and improving enterprise performance.
H4	Government policy support has a positive moderating effect on the relationship between green technology innovation and enterprise performance improvement.
H5	Government policy support has a positive moderating effect on the relationship between green technology innovation and energy consumption structure.

4. Research Methods and Data

4.1. Research Method Design

The research purpose of this paper is to observe the impact of green technology innovation on HEM enterprise performance improvement. This study obtains the data with subjective evaluation characteristics provided by the respondents by designing a questionnaire. In addition, there are many scholars who use the subjective evaluation method in the empirical research on enterprise performance. Some scholars have confirmed its significant correlation with objective data [41–43]. Therefore, this research, similar to the scholars who use subjective evaluation methods, adopts the method of subjective evaluation of enterprise performance by middle and senior managers and related technical researchers to evaluate the enterprise performance level in this study.

The author collects data by means of a questionnaire survey. The survey respondents are set as middle-level and above managers and technicians in HEM enterprises who have a better understanding of the green technology innovation, energy consumption structure, government policy support and enterprise performance of the enterprise. In order to highlight the representation of the sample, the companies that the author chooses to investigate are mainly from the manufacturing industry of core high-end equipment products. These enterprises mainly manufacture aviation equipment, satellite equipment, rail transit equipment, marine engineering equipment, and intelligent manufacturing equipment. 410 copies of the questionnaire were distributed to HEM enterprises in Shanghai, Tianjin, Heilongjiang and other places in two forms: direct and indirect distribution. A total of 172 paper questionnaires were distributed directly to middle-level and above managers and technical personnel of the enterprises, and 161 copies were recovered. A total of 238 copies were sent to the mailboxes of enterprise managers and technicians by e-mail, and 205 copies were recovered. The recovery rate of the questionnaire reached 89.27%. After excluding invalid questionnaires, there were still 324 valid questionnaires. The effective rate of the recovered questionnaires was 88.5%. Questionnaire recovery is good. The nature and size distribution of the HEM enterprises involved are shown in Figures 2 and 3. There are 81 state-owned enterprises, accounting for 25.0%, 85 private enterprises, accounting for 26.2%, 54 wholly foreign-owned enterprises, accounting for 16.7%, 58 joint ventures, accounting for 17.9%, and 46 other enterprises accounted for 14.2%. Among the personnel surveyed, 58 were enterprise executives, accounting for 17.9%, 59 were project managers, accounting for 18.2%, 83 were R&D personnel, accounting for 25.6%, 69 were technical management personnel, accounting for 21.3%, and 55 were other personnel accounted for 17.0%. In addition, in terms of the scale of HEM enterprises involved in this questionnaire, there are 143 large enterprises, accounting for 44.1%, 114 medium-sized enterprises, accounting for 35.2%, and 67 small enterprises, accounting for 20.7%.

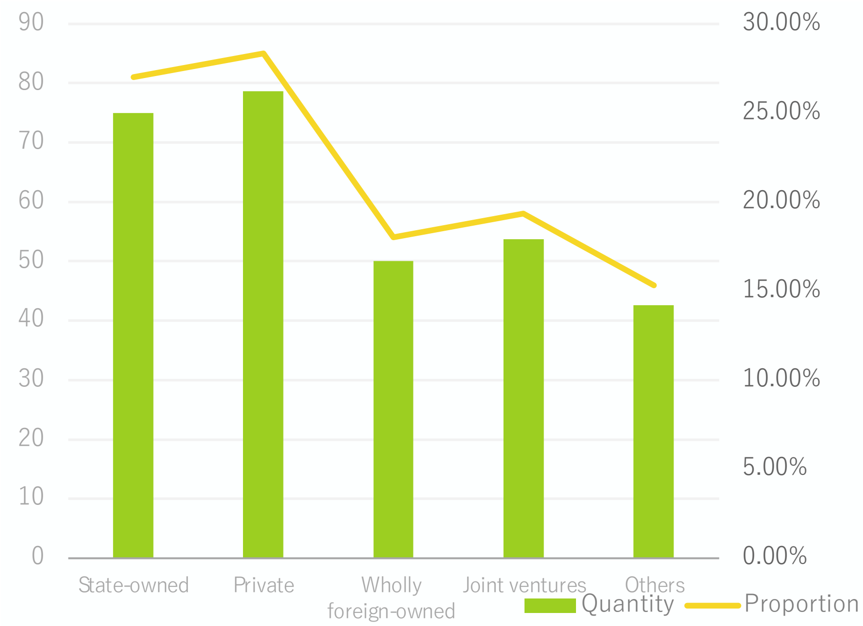

Figure 2. The nature of the surveyed enterprises.

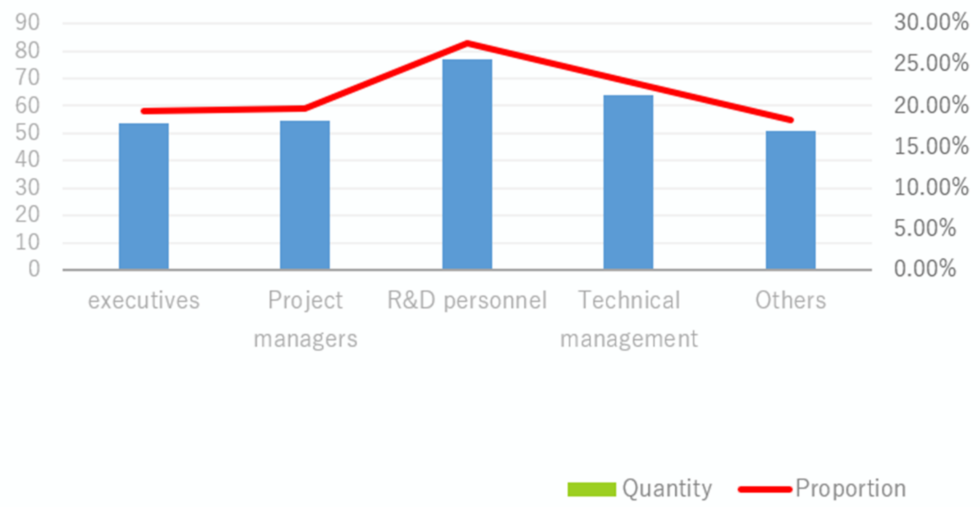

Figure 3. The personnel of the surveyed enterprises.

The author adopts the method of issuing questionnaires to the middle and senior managers and technicians of HEM enterprises. This study makes self-evaluation on the operation of HEM enterprises based on the subjective perception of the subjects. The variable indicators are measured using the Likert 7-level scale to compare the company's green technology innovation, energy consumption structure, enjoyment of government policy support and enterprise performance with major competitors in the same industry, ranging from 1 to 7. Furthermore, the scores range from completely disagree to completely agree. This research method is generally effective on the relationship between related variables. The scale design is shown in Table 2.

4.2. Data

Based on the previous theoretical and empirical research, the author uses SPSS22.0 and AMOS21.0 software to verify the theoretical model. The 4 latent variables in the model are green technology innovation, energy consumption structure, government policy support and enterprise performance. During the testing process, the fitness of the data and the normalization path were observed to measure the validity of the model. Based on a large number of mathematical statistics literature, the author determines the reliability and validity test index criteria and fitting index criteria, as shown in Tables 3 and 4, respectively.

Table 2. Variable dimensions and indicators.

Dimension	Item	References
Green technology innovation	A1 The proportion of enterprise-to-green technology innovators in the total R&D personnel is increasing	Sun (2022) [41], Xu (2021) [42]
	A2 The proportion of enterprises' investment in green technology innovation equipment in the total investment in equipment assets is becoming higher and higher	
	A3 The proportion of enterprise green technology innovation investment in total enterprise R&D investment is gradually increasing	
	A5 The sales of products developed by enterprises' green technology account for an increasing proportion of total sales	
	A6 Enterprises are increasingly replacing the original production model due to green technology innovation	
Energy consumption structure	B1 Fossil energy is gradually being replaced by clean energy and renewable energy in the production activities of enterprises	Brodny (2022) [43]
	B2 The proportion of fossil energy consumed in the value of a single product is gradually decreasing	
Government policy support	C1 The company's energy conservation, emission reduction and clean development projects are supported by government policies	Bullock (1992) [44], Shoag (2014) [45]
	C2 Green products produced by enterprises can enjoy the reduction and exemption policy	
	C3 The green technology innovation activities of enterprises have enjoyed national low-interest preferential loans or government subsidies	
	C4 The development and utilization of clean new energy by enterprises enjoy government subsidies and financial support	
	C5 The government formulates energy conservation and emission reduction targets to assess the green development level of enterprises	
Business performance improvement	D1 The growth rate of enterprise sales is higher than that of major competitors in the same industry	Brynjolfsson (2000) [46]
	D2 The company's return on equity has increased year by year	
	D3 The company's market share growth rate is increasing year by year	
	D4 The overall market competitiveness of the product is higher than that of the main competitors in the same industry	
Innovation performance improvement	D5 The proportion of product innovation is gradually increasing	Calderini (2005) [47], Kesidousupa (2012) [48]
	D6 The proportion of process innovation is gradually increasing	
	D7 The proportion of new product output value in total sales has gradually increased	
	D8 The development speed of new products is faster than that of the main competitors in the same industry	
	D9 Innovative products have a higher success rate	

Table 3. Reliability test indicators and evaluation criteria.

Reliability Test Index	Range	Acceptable Level	Source Basis	The Standard Adopted in This Study
Cronbach's α	>0.7	High reliability	Otchere (2022) [49], Tirgil (2022) [50], Fakhimi (2022) [51]	>0.8
	0.65–0.70	Acceptable		
	0.7–0.8	High reliability		
	>0.8	Higher reliability		
CITC	>0.5	Acceptable		>0.5
CR	>0.6	High reliability		>0.6
AVE	>0.5	Good convergent validity		>0.5

Table 4. Structural equation model structure fitting index index and evaluation criteria.

<table>
<tr><th>Indicator Type</th><th>Fit Metrics</th><th>Judgement Standard</th><th>Acceptable</th><th>Source Basis</th><th>The Standard Adopted in This Study</th></tr>
<tr><td rowspan="5">Absolute index</td><td>Chi-square statistic (X^2)</td><td>$p > 0.05$</td><td>Acceptable</td><td rowspan="5">Keller (1998) [52], Maccallum (2000) [53], Boker (2011) [54]</td><td>$p > 0.05$</td></tr>
<tr><td>Adjusted chi-square (X^2/df, df is the degrees of freedom)</td><td>≤ 5</td><td>Acceptable</td><td>$X^2/\text{df} \leq 5$
RMSEA < 0.05</td></tr>
<tr><td>RMS residuals (RMSEA)</td><td><0.1</td><td>Acceptable</td><td rowspan="3">0.85–1</td></tr>
<tr><td>Goodness of fit index (GFI)</td><td rowspan="2">0.85–1</td><td rowspan="2">The closer to 1, the better the fit</td></tr>
<tr><td>Modified goodness-of-fit index (AGFI)</td></tr>
</table>

4.2.1. Reliability Test

The reliability test is to test the internal consistency of each variable in the model. The questionnaire used is the Likert 7-point scale. Therefore, Cronbach's α value can be used as the reference value for reliability test for reliability analysis. The questionnaire scale includes 4 latent variables and 21 observed variables. First of all, the evaluation of the observation variables of the questionnaire is based on the CITC purification coefficient value to check whether the measurement items are reasonable. The author considers 0.4 to be an acceptable standard for purification measurement items. The reliability coefficients of 21 observed variables in the 4 latent variables were analyzed, respectively. It was found that the coefficients of the A4 item in the green technology innovation scale and the C6 item in the government policy support scale were lower than CITC > 0.4. Therefore, after deleting the 2 items A4 and C6, the spss22.0 software (IBM, Armonk, NY, USA) was used for calculation again. The test results are shown in Table 5. The Cronbach's α coefficients of the 4 latent variables are finally between 0.830 and 0.999, all greater than 0.8. At the same time, the combined reliability CR values of the variables were between 0.79 and 0.82, all greater than 0.7. From the above test results, we can see that the questionnaire scale used in this paper has good reliability.

Table 5. Cronbach's α coefficient.

Latent Variable	Number of Observed Variables	CR	Cronbach's α Coefficient
Green technology innovation	5	0.82	0.883
Energy consumption structure	2	0.79	0.902
Government policy support	5	0.80	0.955
Enterprise Performance improvement	9	0.79	0.830

4.2.2. Validity Test

The validity test results are shown in Table 6. As can be seen from the table, the observed variable factor loading levels of each latent variable all exceed 0.6 and all reach a significant level, indicating that the latent variables all have good convergent validity. The correlation coefficients of other latent variables in Table 7 are all smaller than the square root of AVE in Table 6, indicating that each latent variable has good discriminant validity. The scales of each latent variable have passed the test of reliability and validity. Thus, the next step to test the hypothesis of the model can be carried out.

Based on the above analysis, it can be seen that the reliability and validity of the sample data have passed the test, which is in line with the conditions for the next empirical research.

Table 6. Validity test of the scale.

Dimension	Item	Factor Loading	AVE
Green technology innovation	A1 The proportion of enterprise-to-green technology innovators in the total R&D personnel is increasing	0.671	0.78
	A2 The proportion of enterprises' investment in green technology innovation equipment in the total investment in equipment assets is becoming higher and higher	0.680	
	A3 The proportion of enterprise green technology innovation investment in total enterprise R&D investment is gradually increasing	0.624	
	A5 The sales of products developed by enterprises' green technology account for an increasing proportion of total sales	0.783	
	A6 Enterprises are increasingly replacing the original production model due to green technology innovation	0.804	
Energy consumption structure	B1 Fossil energy is gradually being replaced by clean energy and renewable energy in the production activities of enterprises	0.791	0.86
	B2 The proportion of fossil energy consumed in the value of a single product is gradually decreasing	0.793	
Government policy support	C1 The company's energy conservation, emission reduction and clean development projects are supported by government policies	0.784	0.80
	C2 Green products produced by enterprises can enjoy the reduction and exemption policy	0.699	
	C3 The green technology innovation activities of enterprises have enjoyed national low-interest preferential loans or government subsidies	0.890	
	C4 The development and utilization of clean new energy by enterprises enjoy government subsidies and financial support	0.822	
	C5 The government formulates energy conservation and emission reduction targets to assess the green development level of enterprises	0.753	
Business performance improvement	D1 The growth rate of enterprise sales is higher than that of major competitors in the same industry	0.884	0.81
	D2 The company's return on equity has increased year by year	0.742	
	D3 The company's market share growth rate is increasing year by year	0.639	
	D4 The overall market competitiveness of the product is higher than that of the main competitors in the same industry	0.843	
Innovation performance improvement	D5 The proportion of product innovation is gradually increasing	0.711	0.83
	D6 The proportion of process innovation is gradually increasing	0.764	
	D7 The proportion of new product output value in total sales has gradually increased	0.804	
	D8 The development speed of new products is faster than that of the main competitors in the same industry	0.782	
	D9 Innovative products have a higher success rate	0.763	

Table 7. Latent variable correlation coefficient matrix.

Latent Variable	Green Technology Innovation	Energy Consumption Structure	Government Policy Support	Enterprise Performance Improvement
Green technology innovation	1.00	0.613	0.488	0.529
Energy consumption structure	0.613	1.00	0.582	0.571
Government policy support	0.488	0.582	1.00	0.506
Enterprise performance improvement	0.529	0.571	0.506	1.00

5. Testing the Results of the Study

5.1. The Mediation Test of Green Production Capacity

In the first step, the energy consumption structure of the intermediary variable is not considered. Only the path coefficient of the explanatory variable green technology innovation and the explained variable enterprise performance is tested. The analysis results are shown in Figure 4.

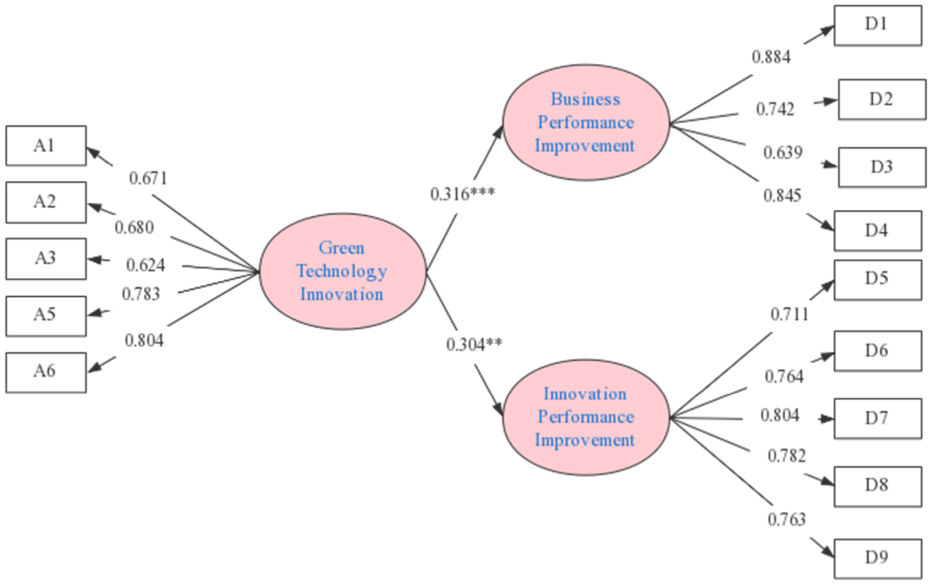

Figure 4. The relationship model of the impact of green technology innovation on enterprise performance improvement. Note: ** represents $p < 0.01$, *** represents $p < 0.001$.

As can be seen from Figure 4, χ^2/df is 3.719 < 5; the values of GFI, CFI, IFI, and NFI are, respectively, 0.93, 0.92, 0.97, and 0.99, which are all greater than 0.9; RMSEA value 0.072 < 0.08, the results show that the model fitting degree is good. The model test results show that the standardized path coefficient between green technology innovation and business performance improvement is 0.316, which is significant at the 0.001 level. This means that there is a significant positive correlation between green technology innovation and the improvement of business performance. The path coefficient between green technology innovation and enterprise innovation performance improvement is 0.304, which is significant at the 0.01 level. This means that there is a significant positive correlation between green technology innovation and the improvement of enterprise innovation performance. Therefore, the hypothesis H1 is validated.

The second step is to test the standardized path coefficients of the independent variable green technology innovation and the intermediary variable energy consumption structure. The results are shown in Figure 5. χ^2/df is 3.285 < 5; GFI, CFI, IFI, and NFI are, respectively, 0.95, 0.91, 0.92, and 0.95, which are all greater than 0.9; RMSEA value is 0.073 < 0.08. These results show that the model fitting degree is good. The model test results show that the standardized path coefficient between green technology innovation and energy consumption structure is 0.519, which is significant at the 0.001 level. Therefore, the hypothesis H2 is verified.

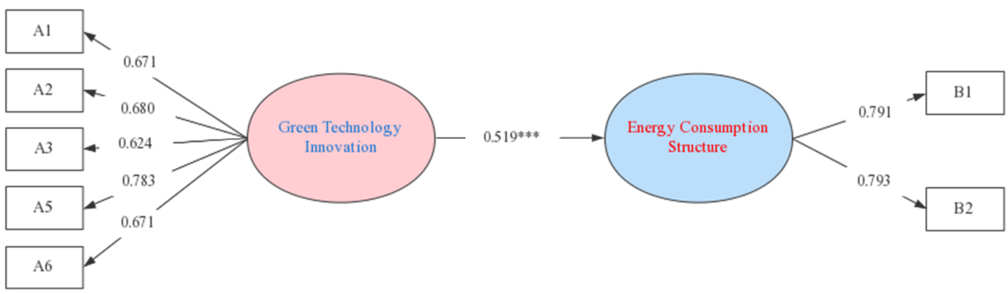

Figure 5. Relationship model of the impact of green technology innovation on energy consumption structure. Note: *** represents $p < 0.001$.

The third step is to test the standardized path coefficient of the intermediary variable energy consumption structure and the dependent variable enterprise performance improvement. The results are shown in Figure 6. χ^2/df was 3.172 < 5; the index values of GFI, CFI, IFI, and NFI were 0.93, 0.92, 0.91, and 0.95, all exceeding 0.9. The RMSEA value was 0.062 < 0.08, which indicated that the model fit well. The model test results show that the standardized path coefficient between energy consumption structure and business performance improvement is 0.429, which is significant at the 0.001 level. The standardized path coefficient between energy consumption structure and enterprise innovation performance improvement is 0.417, which is significant at the 0.01 level. It shows that there is a positive correlation between energy consumption structure and enterprise performance improvement. Thus, the hypothesis H3 is verified.

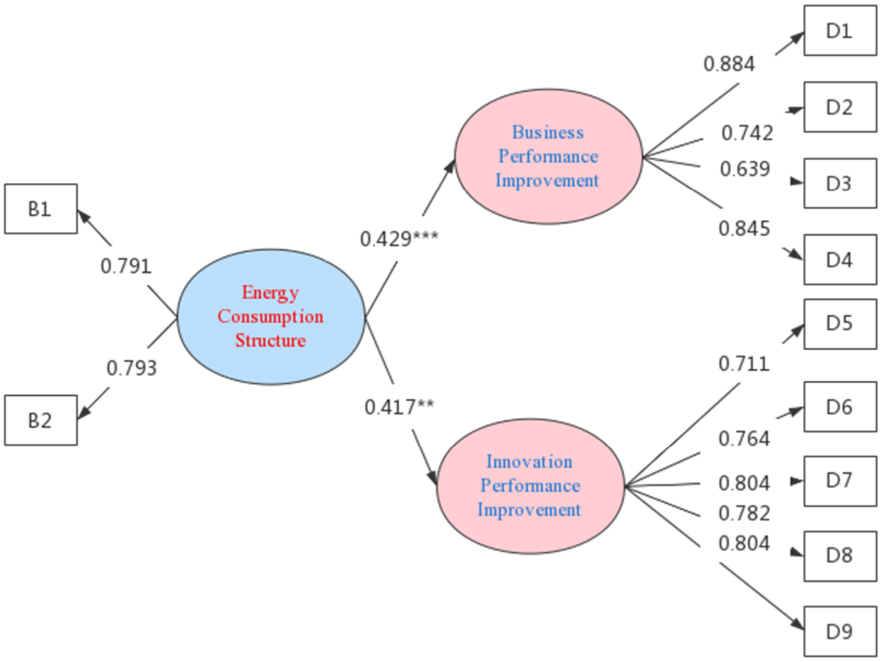

Figure 6. The relationship model of the impact of energy consumption structure on enterprise performance improvement. Note: ** represents $p < 0.01$, *** represents $p < 0.001$.

Finally, the structural equation model is used to conduct a complete mediation test on the energy consumption structure of the mediating variable. The results are shown in Figure 7. χ^2/df is 3.152 < 5. The index values of GFI, CFI, IFI, and NFI are 0.92, 0.91, 0.95, and 0.98, respectively. All are greater than 0.9, which is close to the ideal value of 1. The RMSEA value was 0.075 < 0.08, which indicated that the model fit was good. The test results show that the regression standardization path coefficient of business performance improvement to green technology innovation is 0.302 < 0.316, which is significant at the 0.001 level, and the regression standardization path coefficient of enterprise performance improvement to green technology innovation is 0.296 < 0.304, which is significant at the 0.01 level. It can be seen that the impact of green technology innovation on the improvement of enterprise innovation performance is greater than the impact on business performance. As an intermediary variable, energy consumption structure plays a partial mediating role in the relationship between green technology innovation and enterprise performance improvement. It also can be seen that the indirect impact of green technology innovation on business performance improvement through the mediating role of energy consumption structure is greater than the direct impact (0.513 × 0.427 = 0.219 > 0.204). It means that energy consumption structure plays a partial mediating role in the relationship between green technology innovation and the improvement of business performance. The indirect impact of green technology innovation on the improvement of enterprise performance through the mediating role of energy consumption structure is greater than the direct impact (0.513 × 0.412 = 0.211 > 0.193), indicating that energy consumption structure plays an intermediary role in the relationship between green technology innovation and enterprise performance improvement.

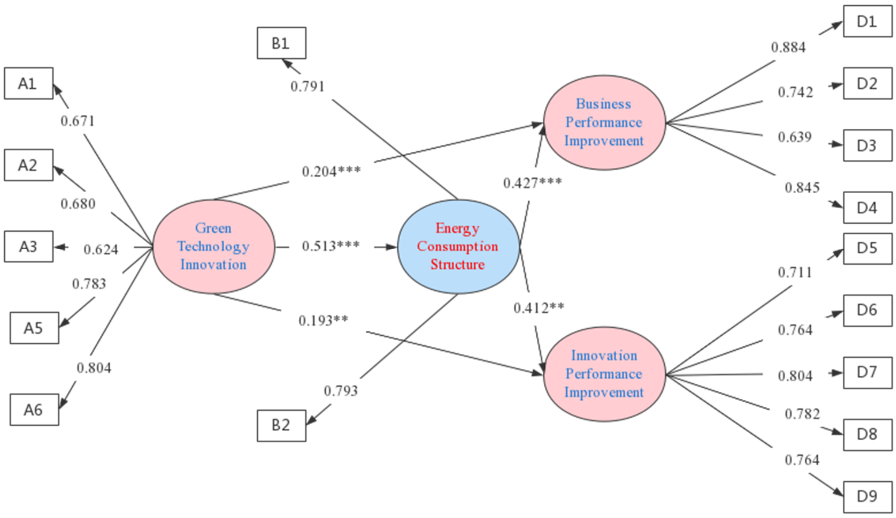

Figure 7. Structural equation model and path analysis results. Note: ** represents $p < 0.01$, *** represents $p < 0.001$.

5.2. Test of the Moderating Effect of Positive Policy Environment

(1) Hierarchical regression analysis of the moderating effect of government policy support in the relationship between green technology innovation and enterprise performance improvement. First, as shown in Table 8, model 1 takes the improvement of business performance as the dependent variable. It introduces the independent variable green technology innovation. In the regression results, we can see that green technology innovation has a significant positive impact on business performance at the level of $p < 0.001$. The hypothesis H1 is further verified to some extent.

Table 8. Hierarchical regression analysis results of the moderating effect of government policy support on enterprise performance improvement.

	Business Performance Improvement			Innovation Performance Improvement		
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Green technology innovation	0.204 ***	0.238 ***	0.205 **	0.338 **	0.242 *	0.226 **
Moderator						
Government policy support		0.481 **	0.516 **		0.729 **	0.597 **
Moderating effect						
Green technology innovation × government policy support			0.232 ***			0.244 ***
R^2	0.390	0.538	0.472	0.483	0.590	0.591
ΔR^2	-	0.032	0.059	-	0.071	0.094
F	8.204 ***	15.39 ***	22.76 ***	19.45 ***	20.04 ***	56.31 ***

Note: * represents $p < 0.05$, ** represents $p < 0.01$, *** represents $p < 0.001$.

Secondly, on the basis of Model 1, the government policy support is introduced as a moderator to construct Model 2. The regression results show that the regression coefficient of the moderator variable government policy support is 0.481, which is significant at the $p < 0.01$ level. Then, the product term of green technology innovation and government policy support is introduced into Model 3. The regression coefficient of the interaction term for the enterprise performance improvement is 0.232, which is significant at the

$p < 0.001$ level. At the same time, R2 increased from 0.390 to 0.472, and the overall explanatory power of the model gradually increased. It shows that government policy support has played a positive moderating role in the relationship between green technology innovation and the business performance improvement. Hypothesis H4 has been verified to a certain extent. In the same way, model 4 takes enterprise innovation performance as the dependent variable and introduces the independent variable green technology innovation. In the regression results, green technology innovation has a significant positive impact on enterprise performance at the level of $p < 0.05$. The hypothesis H1 is verified again.

Finally, on the basis of Model 4, the moderator variable government policy support is introduced to construct Model 5. The regression results show that the regression coefficient of the moderator variable government policy support is 0.729, which is significant at the level of $p < 0.01$. Then, green technology innovation is introduced into Model 6. The product term of the product term and government policy support, the regression coefficient of the interaction term for the enterprise performance improvement is 0.244, which is significant at the level of $p < 0.001$. At the same time, R2 increases from 0.483 to 0.591. The overall interpretation of the model is gradually strengthened, indicating that government policy support is in green technology. The relationship between innovation and the enterprise innovation performance improvement has played a positive moderating role. Thus, the hypothesis H4 is validated.

(2) Hierarchical regression results analysis of the moderating effect of government policy support in the impact of green technology innovation on energy consumption structure. The regression results are shown in Table 9. Model 7 takes the energy consumption structure as the dependent variable and introduces the independent variable green technology innovation for regression analysis. The regression coefficient was 0.417, which was significant at the $p < 0.05$ level, further validating the hypothesis H2. Then, on the basis of the first step, the moderator variable government policy support is introduced to construct Model 8. The regression results show that the regression coefficient of the moderating variable government policy support is 0.690, which is significant at the $p < 0.001$ level. It shows that the government policy support as the moderator variable also has a significant positive impact on the energy consumption structure. Then, the product term of green technology innovation and government policy support is introduced into Model 9, The regression coefficient of the interaction term on the energy consumption structure is 0.203, which is significant at the $p < 0.01$ level. At the same time, R2 increased from 0.479 to 0.733, and the overall explanatory power of the model gradually increased. It shows that government policy support plays a positive moderating role in the relationship between green technology innovation and energy consumption structure. Thus, the hypothesis H5 is verified.

Table 9. Hierarchical regression analysis results of government policy support on the adjustment effect of energy consumption structure.

	Energy Consumption Structure		
Independent variable	Model 7	Model 8	Model 9
Green technology innovation	0.417 *	0.299 ***	0.173 ***
Moderator			
Government policy support		0.690 ***	0.591 **
Moderating effect			
Green technology innovation × government policy support			0.203 **
R^2	0.479	0.492	0.733
ΔR^2	-	0.052	0.074
F	6.026 ***	9.748 ***	25.093 ***

Note: * represents $p < 0.05$, ** represents $p < 0.01$, *** represents $p < 0.001$.

6. Conclusions, Recommendations and Future Research Directions

6.1. Conclusions

HEM enterprises are distinguished from other manufacturing enterprises by the characteristics of high energy consumption, high pollution and contribution. Therefore, improvement measures must be implemented to reduce energy consumption and pollution, improve efficiency and sustainable development. In addition, green technology innovation has been unanimously recognized by the academic and business circles as one of the most feasible and effective ways to continuously improve the HEM enterprises performance. In this study, the author takes middle and senior managers and technical R&D personnel from HEM enterprises in many regions of China as the research objects. By systematically collecting and sorting data, quantitatively verified the relationship between green technology innovation, energy consumption structure, government policy support and enterprise performance improvement. The specific conclusions are as follows:

(1) Green technology innovation has a significant positive impact on the continuous improvement of the performance of HEM enterprises. This is because the Chinese government has clearly put forward the advocacy of green economic life in the future. Climate and environmental changes have brought more and more serious troubles to people's lives. Green life under the background of green economy is no longer an empty talk. Once the green products and processes brought by green technology innovation flood into the market, it will soon affect or even change the market demand and change people's consumption habits, which will realize the creation of a new market proposed by Schumpeter under the background of green economy idea. HEM enterprises continue to promote technological innovation in the application of green technology to products, processes and other production links. With the help of major improvements in performance and use of new products, they respond in a timely manner to create market demand and win the market pricing initiative for products. Finally, stable and sustained growth in enterprise performance can be achieved.

(2) The positive improvement of green technology innovation on the performance of HEM enterprises needs to be mediated by the energy consumption structure. It means that green technology innovation has a direct effect on the performance improvement of HEM enterprises. There is also an indirect effect of "green technology innovation, energy consumption structure and enterprise performance". It also shows that there may be other mediating variables between green technology innovation and the performance improvement of HEM enterprises, which provides new research ideas for future research. Therefore, HEM enterprises should gradually change their dependence on the original fossil energy consumption and turn to clean energy and renewable energy. In the context of reducing carbon emissions per unit of product, combined with the government's low-carbon policy, HEM companies can reduce operating costs. At the same time, technological advantages will increase the core competitiveness of enterprises and promote the continuous improvement of HEM enterprise performance.

(3) Government policy support has a positive regulating effect on green technology innovation and the continuous improvement of HEM enterprise performance. That is to say, the stronger the government's policy support for green technology innovation, the stronger the green technology innovation impetus of HEM enterprises, and the better the performance will be. In recent years, the Chinese government has advocated that all people pursue green life. Green technology can cover almost all pillar industries of national economic development. Therefore, establishing a green economic development model and a green social consumption model is an important development goal of the Chinese government in the future. To develop a green economy, scientific decision-making is the premise. Technological innovation is the key. Capital investment is the guarantee. Full participation is the core. The government should integrate various social resources, encourage and mobilize the enthusiasm of all parties with policies, establish incentives and clarify policies. At

the same time, the promotion of green technology also needs to be fully mobilized. The government should encourage the whole people to participate in scientific and technological innovation and promote the transformation of economic and social development to a green direction.

The implications of this study are as follows: (1) This study further extends the research scope of issues related to green technology innovation. At the same time, this study also enriches the relevant research methods on the relationship between green technology innovation and enterprise performance. These research contents and research methods, to a large extent, have laid an important research foundation for future scholars' research in this field. (2) This paper makes managers clearer about the impact degree and mechanism of green technology innovation on enterprise performance. The research conclusions of this paper can optimize the inherent innovative thinking of managers of HEM enterprises, win the market position in the context of green economy, and give inspiration to enterprises in the process of green industry market operation and development in the future, so as to help sustainable improve business performance. (3) The research provides an important reference for the government to formulate relevant management policies. By discussing the impact of government policy support on the green technology innovation and enterprise performance improvement of HEM enterprises, it can provide an important reference for the government to formulate policies such as carbon tax incentives and green technology innovation subsidies to ensure the green technology innovation of manufacturing enterprises.

6.2. Recommendations

The relevant research conclusions of this paper can provide some thoughts for the formulation of green technology operation strategies of related enterprises. The author therefore makes the following recommendations:

(1) When making management decisions, enterprise managers should fully consider the comprehensive effect of various factors. The impact of green technology innovation on the improvement of corporate performance is not only directly affected by itself, but also affected by factors such as energy consumption structure and government management policies. Therefore, enterprise managers should clearly understand the process of green technology innovation affecting enterprise performance improvement. In the management process, enterprise managers should not only simply improve the level of green technology innovation, but also fully adjust the energy consumption structure. At the same time, enterprises must actively adapt to the government's management policies. Enterprises should make full use of government support policies that are beneficial to their own development. Therefore, in a high-quality innovative development environment, enterprises can help to continuously improve their performance.

(2) Enterprises need to formulate various measures in the development of green technology innovation. The development of enterprise green technology innovation requires the cooperation of internal and external resources. Therefore, enterprises should strengthen the introduction, digestion, absorption and self-development of green technologies. Enterprises should gradually realize the use of green technology in key areas such as workshop production. The enterprise should also strengthen the systematic training of green technology R&D personnel. At the same time, enterprises can also send senior R&D personnel to high-level enterprises to learn new green technologies. By improving the enterprise's own green technology innovation ability, it will ultimately help to promote the continuous improvement of the comprehensive performance of the enterprise.

(3) Government agencies should formulate effective carbon tax management measures. The government policy environment will play a key role in the green technology innovation and performance improvement of enterprises. Therefore, relevant governments should formulate scientific and reasonable carbon tax management policies

based on the development needs of enterprises. In particular, in terms of enterprises' ability to improve green technology innovation, the government should strengthen the guaranteed ability of relevant policies. The government can reduce or exempt some taxes for companies with strong green technology innovation capabilities. The government can also provide certain innovation subsidies for green technology innovation enterprises. The implementation of these management measures will also promote the continuous improvement of corporate performance to a large extent.

6.3. Future Research Directions

(1) This study only considers the energy consumption structure and government policy support when designing the model and measurement scale. Although both reliability and validity tests meet the research standards, these two indicators cannot comprehensively cover all aspects of the problem. Therefore, in the theoretical and empirical models of future research, more relevant indicators can be added, such as external economic environment, changes in production factors, production efficiency, enterprise dynamic capabilities, enterprise organizational innovation, and enterprise atmosphere. After enriching the content of relevant research indicators, relevant research conclusions will be more scientific and accurate.
(2) The effective sample data collected by this survey and research needs to be increased. Due to the limitation of time and author's energy, the sample size of this study needs to be increased. Therefore, future research needs to conduct investigations on a larger scale, expand the coverage of the survey samples, and ensure the reliability of the research conclusions.
(3) The entry point of this study needs to be further increased. Under the new economic normal, Made in China 2025 covers five major projects. This paper only takes the green manufacturing engineering of high-end equipment manufacturing enterprises as the starting point for research, and does not deeply explore the relevant content of other equipment manufacturing fields. The results of this study also lack sufficient scientific. Therefore, this study suggests that future scholars can conduct related research in other equipment manufacturing fields to enrich the relevant research content.

Funding: This research was funded by Basic Research Business Expenses Research Project of Provincial Colleges and Universities in the Heilongjiang Province (No. 2021-KYYWF-0102, 2021-KYYWF-0106, 2021-KYYWF-0082).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available in the article.

Acknowledgments: The author greatly appreciated the comments of reviewers to this paper.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Jezierska-Thle, A.; Gwiadzińska-Goraj, M.; Dudzińska, M. Environmental, Social, and Economic Aspects of the Green Economy in Polish Rural Areas—A Spatial Analysis. *Energies* **2022**, *15*, 3332. [CrossRef]
2. Xie, J.M.; Tang, X.W.; Shao, Y.F. Research on Stratified Cluster Evaluation of Enterprise Green Technology Innovation Based on the Rough Set. *Technol. Invest.* **2012**, *3*, 68–73. [CrossRef]
3. Ahmed, H.A.; Nor, Z.M.; Rohaizat, B. Neuromarketing: The popularity of the brain-imaging and physiological tools. *Neurosci. Res. Notes* **2021**, *3*, 13–22.
4. Eun-Ju, L.; Gusang, K.; Hyun, J.; Seungeun, Y.; Sukhan, L.; Minah, S. The spell of green: Can frontal EEG activations indentify green consumers? *J. Bus. Ethics* **2014**, *122*, 511–521.
5. Ahmed, H.A.; Nor, Z.M.; Wan, A.; Ahmad, K. Biomedical technology in studying consumers' subconscions behavior. *Int. J. Online Biomed. Eng.* **2022**, *8*, 98–114. [CrossRef]
6. Rahman, H.Z.; Matin, I.; Banks, N. Finding out fast about the impact of covid-19: The need for policy-relevant methodological innovation. *World Dev.* **2021**, *140*, 105380. [CrossRef]

7. Ebrary, I. Innovation in information technology. *Perm. J.* **2009**, *33*, 709–734.
8. Hienuki, S.; Hirayama, Y.; Shibutani, T. How Knowledge about or Experience with Hydrogen Fueling Stations Improves Their Public Acceptance. *Sustainability* **2019**, *11*, 6339. [CrossRef]
9. Suzuki, M. Identifying roles of international institutions in clean energy technology innovation and diffusion in the developing countries: Matching barriers with roles of the institutions. *J. Clean. Prod.* **2015**, *98*, 229–240. [CrossRef]
10. Groba, F.; Jing, C. Chinese Renewable Energy Technology Exports: The Role of Policy, Innovation and Markets. *Environ. Resour. Econ.* **2015**, *60*, 243–283. [CrossRef]
11. Wang, W.; Xiao, W.; Bai, C. Can renewable energy technology innovation alleviate energy poverty? Perspective from the marketization level. *Technol. Soc.* **2022**, *68*, 101933. [CrossRef]
12. Ma, S.; Zhu, M.; Yang, Y. Status Analysis, Path Exploration and Policy Enlightenment of Zhejiang Province's Manufacturing Green Technology Innovation. *J. Phys. Conf. Ser.* **2020**, *1549*, 022054. [CrossRef]
13. Jiang, T.; Ji, P.; Shi, Y. Efficiency assessment of green technology innovation of renewable energy enterprises in China: A dynamic data envelopment analysis considering undesirable output. *Clean Technol. Environ. Policy* **2021**, *3*, 1509–1519. [CrossRef]
14. Razzaq, A.; Wang, Y.; Chupradit, S. Asymmetric inter-linkages between green technology innovation and consumption-based carbon emissions in BRICS countries using quantile-on-quantile framework. *Technol. Soc.* **2021**, *66*, 101656. [CrossRef]
15. Xiao, Z.; Shi, J.; Tan, R. Prediction Algorithm of Collaborative Innovation Capability of High-End Equipment Manufacturing Enterprises Based on Random Forest. *Mob. Inf. Syst.* **2021**, *2021*, 8378274. [CrossRef]
16. Xu, X.; Yang, K.; Dou, Y. High-end equipment development task decomposition and scheme selection method. *J. Syst. Eng. Electron.* **2021**, *32*, 118–135.
17. Lin, M.; Fu, L.; Zeng, F. Design of Distributed Substation High Voltage Electrical Equipment Online Monitoring System Based on Image Segmentation Technology. *J. Phys. Conf. Ser.* **2021**, *2143*, 012001. [CrossRef]
18. Xue, M.; Fu, C.; Yang, S.L. Dynamic Expert Reliability Based Feedback Mechanism in Consensus Reaching Process with Distributed Preference Relations. *Group Decis. Negot.* **2021**, *30*, 341–375. [CrossRef]
19. Zhang, X.; Sun, H.; Liu, F. The impact of green technology innovation on the investment efficiency of new energy enterprises. *Coal Econ. Res.* **2021**, *41*, 74–82.
20. Wan, H.L.; Ke, B.I.; Sun, B. Research on the Effect of Environmental Regulation Intensity on Green Technological Innovation of Pollution Intensive Industries—Empirical Test Based on Panel Data of 2003–2010. *RD Manag.* **2013**, *6*, 72–81.
21. Wang, J. Discussion on the Relationship between Green Technological Innovation and System Innovation Science Direct. *Energy Procedia* **2011**, *5*, 2352–2357.
22. Fernando, Y.; Wah, W.X. The impact of eco-innovation drivers on environmental performance: Empirical results from the green technology sector in Malaysia. *Sustain. Prod. Consum.* **2017**, *12*, 27–43. [CrossRef]
23. Miao, C.; Fang, D.; Sun, L. Natural resources utilization efficiency under the influence of green technological innovation. *Resour. Conserv. Recycl.* **2017**, *126*, 153–161. [CrossRef]
24. Zhang, J. A review of research on innovation efficiency of green technology in China. *Future Dev.* **2022**, *46*, 22–30.
25. Shen, F.; Tao, Q.; Zhang, Y. Research on the influence of directors' overseas background on corporate green technology innovation-based on the perspective of corporate reputation. *J. Shanghai Univ. Financ. Econ.* **2022**, *24*, 108–122.
26. Marra, A.; Antonelli, P.; Pozzi, C. Emerging green-tech specializations and clusters–A network analysis on technological innovation at the metropolitan level. *Renew. Sustain. Energy Rev.* **2017**, *67*, 1037–1046. [CrossRef]
27. Shao, Y.; Chen, Z.; Wilson, C. Can government subsidies promote the green technology innovation transformation? Evidence from Chinese listed companies. *Econ. Anal. Policy* **2022**, *74*, 716–727. [CrossRef]
28. Hou, J.C. External Knowledge Sourcing and Green Innovation Growth with Environmental and Energy Regulations: Evidence from Manufacturing in China. *Sustainability* **2017**, *9*, 342. [CrossRef]
29. Sun, K.; Cao, X.; Xing, Z. Can the Diffusion Modes of Green Technology Affect the Enterprise's Technology Diffusion Network towards Sustainable Development of Hospitality and Tourism Industry in China? *Sustainability* **2021**, *13*, 9266. [CrossRef]
30. Yan, Z. Analysis on Spatio-Temporal Characteristics and Influencing Factors of Industrial Green Innovation Efficiency—From the Perspective of Innovation Value Chain. *Sustainability* **2021**, *14*, 342.
31. Hall, B.H.; Helmers, C. Innovation and Diffusion of Clean/Green Technology: Can Patent Commons Help? *NBER Work. Pap.* **2011**, *66*, 33–51.
32. Lestari, E.R.; Dania, W.; Indriani, C. The impact of customer pressure and the environmental regulation on green innovation performance. *Earth Environ. Sci.* **2021**, *733*, 012048. [CrossRef]
33. Wang, B.; Zheng, X. The Research of the Relationship between Low Carbon-Based Marketing Innovation and Organizational Performance. *Technol. Invest.* **2013**, *4*, 164–167. [CrossRef]
34. Albort-Morant, G.; Leal-Millán, A.; Cepeda-Carrion, G.; Henseler, J. Developing green innovation performance by fostering of organizational knowledge and coopetitive relations. *Rev. Manag. Sci.* **2018**, *12*, 499–517. [CrossRef]
35. Chaston, I. Environment and Planning C: Government and Policy. *Milbank Meml. Fund Q. Health Soc.* **2000**, *59*, 224–255.
36. Yan, J.; Yang, J.; Zhu, F. Green city and government ecological environment management based on ZigBee technology. *Environ. Technol. Innov.* **2021**, *1*, 101711. [CrossRef]
37. Mackay, S.; Gerritsen, S.; Sing, F. Implementing healthy food environment policies in New Zealand: Nine years of inaction. *Health Res. Policy Syst.* **2022**, *20*, 8. [CrossRef]

38. Seehoe, N.; Heather, Y.; Bridget, K. Identifying barriers and facilitators in the development and implementation of government-led food environment policies: A systematic review. *Nutr. Rev.* **2022**, *80*, 1896–1918.
39. Bertelli, L. What kind of global city? Circulating policies for 'slum' upgrading in the making of world-class Buenos Aires. *Environ. Plan. A* **2021**, *53*, 1293–1313. [CrossRef]
40. Long, R. Analysis on the System of Compensation for Eco-environmental Damage. *Asian Agric. Res.* **2022**, *14*, 52–56.
41. Sun, H.; Zhang, Z.; Liu, Z. Does air pollution collaborative governance promote green technology innovation? Evidence from China. *Environ. Sci. Pollut. Res.* **2022**, *29*, 51609–51622. [CrossRef] [PubMed]
42. Xu, H.; Qiu, L.; Liu, B. Does regional planning policy of Yangtze River Delta improve green technology innovation? Evidence from a quasi-natural experiment in China. *Environ. Sci. Pollut. Res.* **2022**, *28*, 62321–62337. [CrossRef] [PubMed]
43. Brodny, J.; Tutak, M. Analysis of the efficiency and structure of energy consumption in the industrial sector in the European Union countries between 1995 and 2019. *Sci. Total Environ.* **2022**, *808*, 152052. [CrossRef] [PubMed]
44. Bullock, D.S. Objectives and Constraints of Government Policy: The Countercyclicity of Transfers to Agriculture. *Am. J. Agric. Econ.* **1992**, *74*, 617–629. [CrossRef]
45. Shoag, D.; Veuger, S. Shops and the City: Evidence on Local Externalities and Local Government Policy from Big Box Bankruptcies. *Work. Pap.* **2014**, *100*, 440–453. [CrossRef]
46. Brynjolfsson, E.; Hitt, L.M. Beyond Computation: Information Technology, Organizational Transformation and Business Performance. *J. Econ. Perspect.* **2000**, *14*, 23–48. [CrossRef]
47. Calderini, M.; Scellato, G. Academic research, technological specialization and the innovation performance in European regions: An empirical analysis in the wireless sector. *Soc. Exp. Biol. Med. Soc. Exp. Biol. Med.* **2005**, *197*, 471–476. [CrossRef]
48. Kesidousupa, E.; Snijderssupb, C. External Knowledge and Innovation Performance in Clusters: Empirical Evidence from the Uruguay Software Cluster. *Ind. Innov.* **2012**, *19*, 437–457. [CrossRef]
49. Otchere, S.K.; Nyamewaa, E.B.; Hammond, F. Big Data Characteristics and Innovation Performance in Ghanaian Manufacturing Firms: The Role of the Big Data Team? *Open Access Libr. J.* **2022**, *9*, 1–13. [CrossRef]
50. Tirgil, A.; Fndk, D. How Does Awareness toward the Industry 4.0 Applications Affect Firms' Financial and Innovation Performance? *J. Knowl. Econ.* **2022**, *14*, 1–23. [CrossRef]
51. Fakhimi, M.A.; Miremadi, I. The impact of technological and social capabilities on innovation performance: A technological catch-up perspective. *Technol. Soc.* **2022**, *68*, 101890. [CrossRef]
52. Keller, S.D.; Ware, J.E., Jr.; Bentler, P.M.; Aaronson, N.K.; Alonso, J.; Apolone, G.; Bjorner, J.B.; Brazier, J.; Bullinger, M.; Kaasa, S.; et al. Use of Structural Equation Modeling to Test the Construct Validity of the SF-36 Health Survey in Ten Countries. *J. Clin. Epidemiol.* **1998**, *51*, 1179–1188. [CrossRef]
53. Maccallum, R.C.; Austin, J.T. Applications of structural equation modeling in psychological research. *Annu. Rev. Psychol.* **2000**, *51*, 201–226. [CrossRef] [PubMed]
54. Boker, S.; Neale, M.; Maes, H. OpenMx: An Open Source Extended Structural Equation Modeling Framework. *Psychometrika* **2011**, *76*, 306–317. [CrossRef] [PubMed]