GREEN INNOVATION STRATEGY ON FIRM PERFORMANCE: THE EVIDENCE FROM MANUFACTURING INDUSTRY IN CHINA

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ABSTRACT
The objective of this research is to examine the impact of green innovation strategy on firm performance in the manufacturing industry in China. The study used a sample group of 623 managers and executives from companies in the manufacturing industry in China. The sample was collected using a convenience sampling method and data was gathered through a questionnaire survey. The data was analyzed using frequency, percentage, mean, standard deviation, and hypothesis testing was conducted using partial least squares structural equation modeling (PLS-SEM). The research findings reveal that green innovation strategies, including green product innovation, green process innovation, and green services, have a statistically significant positive impact on firm performance at a 0.05 level of significance with a predictive power of 92.7%.
Keywords: Green Innovation Strategy, Green Product Innovation, Green Process Innovation, Green Service Innovation, Firm Performance

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INTRODUCTION

Since the industrial revolution, industrialization has promoted economic and social development, but also resulted in endless environmental problems. The wanton destruction of the environment and the disorderly collection of resources by the expansion of industrialization have not only brought the development of society and economy into a bottleneck, but also the ecological footprint of mankind has exceeded the carrying capacity of the earth (Guan, 2017). In the 1960s, the rapid economic development in the western developed countries led to serious environmental pollution, which aroused strong protests from the international community. People began to attach importance to the issue of economic development and environmental pollution (Li, 2014). This issue also caused many scholars' thinking and received high attention from researchers (Liyin, Hong & Griffith, 2006； Tse, 2001； Tam et al., 2006). The severe ecological crisis wakes up the alarm for mankind and has caused a heat of attention to resources and environmental issues in the world. In order to strengthen the protection of the ecological environment and solve the irreversible negative externalities of human industrial activities on the natural environment, 193 countries reached an agreement on the post-2015 development agenda at the United Nations Summit on Sustainable Development, and the road of "sustainable development" became a consensus, which marked that the human development model was heading for a new era.

The legally binding Paris Climate Agreement was adopted at the 2015 Paris Climate Change Conference (Weir, Oda, Ott & Schmidt, 2022). According to the agreement, all parties will participate in the global response to climate change in the form of independent contribution and control the increase of global average temperature within 2 degrees Celsius compared with the pre-industrial level. This agreement is a new starting point for international cooperation in response to climate change and is of milestone significance. The game between economic development and environmental protection will exist for a long time, and it is not easy to break through the global consensus reached by many obstacles (Xie, 2016). Therefore, how to transform from traditional economy to green economy and realize the win-win pattern of environment-economy-society has become an important issue for the development of all countries in the world.

Manufacturing is the general term for the industry that transforms available manufacturing resources into new products usable by people by processing or reprocessing them in accordance with market requirements. A manufacturing enterprise is the subject of human manufacturing activities and market exchange, an economic organization that engages in manufacturing production and operation activities or provides industrial labour services in order to meet market demand and make a profit and is an independent production unit that operates independently and is self-financing (Guan, 2017). Manufacturing is the main source of human material wealth, the main force of industrialization, and plays a pivotal role in the national economy of all countries. In many developed countries, the scientific and technological personnel and scientific research funds in the manufacturing industry account for about 70% of the total (Guan, 2017). It can be seen that the manufacturing industry is also the medium for the transformation of scientific and technological achievements and the driving force for technological development. For a long time, the extensive economic growth and manufacturing development mode realized by relying solely on the massive input and scale expansion of production factors has not only brought economic benefits, but also caused a huge negative impact on the environment. Compared with other industries, the manufacturing industry is characterized by high energy consumption and carbon emissions, high emissions, strong government constraints and strong linkages with upstream and downstream enterprises, and the green transformation of manufacturing enterprises has an important impact on whether the whole society can achieve energy saving and emission reduction. As manufacturing is typically a technology and innovation-driven industry (Bi, Wang & Yang,2014), it is imperative to

enhance the green innovation capability of manufacturing enterprises to develop a new circular, green and low-carbon manufacturing industry. Therefore, the research on green innovation in this paper will be carried out with manufacturing enterprises as the object.

The green innovation strategy can promote the realization of the harmonious development of economy, environment, and society (Guan, 2017). With the continuous growth of world energy consumption, it has also become the focus of competition among governments. Compared with traditional technological innovation, which overemphasizes economic benefits, green innovation focuses on achieving the economic development of the whole society, emphasizing the introduction of new products, processes and services, reduce the environmental burden of enterprises, and bring economic value and competitive advantages to enterprises. While obtaining economic performance, they will also obtain social performance, which is equally important for enterprises (Li, 2018).

Through literature review and analysis, we find that many scholars have verified the positive impact of green innovation strategy on firm performance (Sharma and Vredenbrug, 1998; Chan, 2005; Bansal and Gao, 2006, Sprinkle and Maines, 2010; Yang, 2013; Zhang and Zhang, 2013 et al.). Judge and Douglas (1998) found through research that there was a positive correlation between the environmental strategy adopted by enterprises and their financial performance. Kemp (2004) not only proved the promotion effect of corporate green innovation strategy on corporate economic performance, but also pointed out four ways for environmental strategy to increase profitability, namely, improving resource utilization efficiency, reducing environmental protection cost, innovating products and processes, and improving corporate image.

Based on the above point of view, this paper is interested in studying the impact of green innovation strategy on firm performance, further in-depth analysis of the various components of green innovation strategy, and explore its role in firm performance, providing a certain guiding significance for the performance improvement of manufacturing enterprises.

LITERATURE REVIEWS

Concept and Theories of Green Innovation Strategy

The academic research on green innovation strategy originates from people's concern about environmental issues. In the 21st century, the appeal for environmental protection from all walks of life has become increasingly strong, and the activities of enterprises that cause negative impacts on the environment have been restricted. Therefore, enterprises have to take corresponding measures to meet increasingly stringent environmental requirements. Green innovation strategy is an integral part of enterprise development strategy. However, scholars found that in actual enterprise operation, different enterprises have different ways to deal with environmental problems, which led to further thinking. Later, scholars classified and defined the environmental strategies adopted by enterprises. With the continuous development of research, the concept of green innovation strategy has been proposed by scholars. It is regarded as a positive environmental strategy and a strategic choice made by enterprises to achieve sustainable development through green innovation (Nunes & Bennett, 2020; Xie & Du, 2021). Green innovation has always been considered as one of the most important components of economic progress, environmental sustainability and improving living standards (Moshood Taofeeq et al., 2022). Industrialization development and traditional economic growth mode make the environment unbearable. The consequences of various environmental pollution are gradually perceived and experienced by human society. The impacts of environmental degradation range from atmospheric destruction and severe extreme weather to various impacts on personal health. Therefore, as a new development model, sustainable development and green innovation have become the consensus of the whole society. Clean production, energy conservation and environmental protection technology, green science and technology, green

equipment manufacturing and other vigorous sustainable development practice activities further promote the development of green innovation. Schiederiget et al. (2012) reviewed the literature related to green innovation. The review found that the research on green innovation and its similar concepts, such as "environmental innovation" and "sustainable innovation", is increasing, and has become a research hotspot in the field of enterprise management (de Jesus Pacheco et al., 2017). Nevertheless, the overall research on green innovation is still at an early stage, and scholars still need to make continuous efforts (Andersen, 2008).

Concept and Theories of Firm Performance

For a long time, scholars in various countries have studied firm performance extensively. However, due to the multidimensional nature of firm performance, research from different perspectives has different priorities (Gupta and Kohli, 2021). Therefore, the academic community has not yet formed a unified standard for understanding firm performance (Yilmaz and Kabadayi, 2010). Because enterprises can test the strategic achievements of this stage through firm performance, it is the influencing factor of enterprise strategic management. Relevant researchers believe that firm performance is not a simple concept and cannot be directly defined operationally. It needs to be evaluated by building indicators through relevant models (Moussa et al., 2017). Bottani and Rizzi (2018) believe that corporate performance can be measured from financial, non-financial and marketing perspectives. The dimensions of corporate performance can vary according to different backgrounds and purposes, but usually include indicators of finance, markets, customers, internal processes and learning and growth (Sila et al., 2019).

Balanced Scorecard (BSC), which includes four dimensions: financial dimension, customer dimension, internal operation dimension and learning and growth dimension, is a supplement and improvement to the traditional single financial indicator (Kaplan & Norton, 1992). It is more comprehensive and applicable to the need of this paper to study the impact of green innovation on firm performance. Lee (2000) believes that the BSC is a more structured method for measuring firm performance, rather than simply relying on intuition for performance evaluation. Niven (2014) believes that the BSC is a tool for performance evaluation and strategic management to help companies and organizations effectively implement their strategies and improve their competitive advantages. Dincer (2017) believes that the BSC evaluates the performance of enterprises from a dynamic perspective, linking performance indicators and behaviors. Therefore, according to the research needs, this paper selects the BSC method as the evaluation method of firm performance.

Relationship between Green Innovation Strategy and Firm Performance

Green innovation was all "new" measures taken by environmental participants under the premise of reducing the burden of the ecological environment and taking sustainable development as the goal, including the creation, introduction and transformation of new concepts, new products and new processes related to the ecological environment. In the 21st century, the European Union (EU) and the Organization for Economic Cooperation and Development (OECD) are the driving actors in defining the efficiency of green innovation is analyzed from the perspective of objectives, mechanisms and impacts, and the classification of green innovation is guided. Therefore, green innovation is based on different levels of product innovation, process innovation and service innovation, and has the universality of the general innovation process.

Serrano-García et al. (2022) explored which green innovation capabilities (GICs) and organizational dimensions (ODs). The empirical results show that the application of the relevance of these constructs has contributed to the Resource Based Theory (RBT) and its extension in geographical indication products and pointed out that they need to be linked with ODs to achieve GPI to meet the challenges of sustainable development. Wu et al. (2022) believed that green process innovation itself is a complex process, which involves inter

organizational collaboration across disciplines, industries, and university industry boundaries, and provides many opportunities for online action learning. And Adu Yeboah et al. (2022) found that provide support for the view of enterprise competitive advantage based on natural resources and use ecological innovation to achieve sustainable market and operational performance. From the collection of various literature, the following hypotheses can be formulated.

H1: Green product innovation has a positive impact on firm performance.
H2: Green process innovation has a positive impact on firm performance.
H3: Green service innovation has a positive impact on firm performance.
From the literature review, the conceptual framework can be drawn as shown in Figure 1.

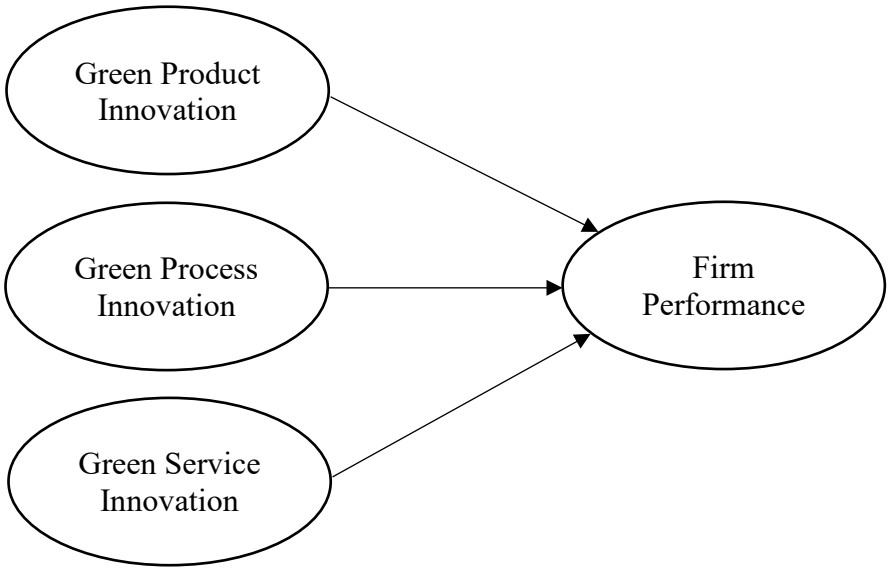

Figure 1 Conceptual Framework

RESEARCH METHODOLOGY

The population in this study is the working adults in China's manufacturing industry. The sample group used is the working adults in China's manufacturing industry. The sampling method used is intentional sampling. This study uses the standard of Hair et al. (2010), that is, the proportion between the number of parameters and the observed variables is not less than 20%. In order to obtain more complete data, 623 samples were set in this study. A sampling method focused on using convenience sampling techniques. The questionnaire of this study includes three parts, the first part of the site for the enterprise, industry, enterprise nature, enterprise scale and the fixed number of years, a total of 5 questions, this part is mainly to collect the basic information of the enterprise. The second part measure of green innovation strategy, a total of 17 items. Including four questions for green product innovation (GPT), eight questions for green process innovation (GPS), and five questions for green service innovation (GSI). The third part is enterprise performance, which is divided into 4 dimensions and 12 questions in total. In the process of questionnaire design, the item colloquial as far as possible, in order to get real and effective information. After the completion of the questionnaire design, the issuance of a small scale, according to the feedback of the corresponding change, to form the final questionnaire, refer to appendix for more details. All the items in part two and part three are measured using a five-point Likert scale (1= Strongly Disagree, 2= Disagree，3= Neutral，4=Agree，5= Strongly Agree). Each respondent is required to click the option indicating the extent of agreement or disagreement with each statement.

Before the instrument was applied for data collection, the item-objective congruence (IOC) and reliability test of the questionnaire through Cronbach’s alpha were systematically conducted.

From the investigation, the result revealed that the IOC was equal to 0.66 and Cronbach's alpha was obtained at 0.74, illustrating the sufficient quality of the research tool. Regarding data analysis, the descriptive statistics, including frequency, percentage, mean, standard deviation. And hypothesis testing use partial least squares structural equation modelling (PLS-SEM) with ADANCO program.

RESEARCH RESULTS

Data Analysis Results

Most of businesses are located in Guangzhou (11.72%), number of employees is more than 300 employees (36.28%) and finally, the company has been operating for more than 10 years (26.32%). the results of the green innovation strategy data analysis and draw conclusions. Interviewees have opinions on both the overall and the report. Agreement: Considering the average level, most respondents have the highest opinion on green service innovation, followed by green product innovation and green process innovation. And interviewees are at the agreed level on firm performance. As shown in Table 1.

Table 1 Mean, Standard Deviation and Agreeable Level

Variables	Mean	SD	Agreeable Level
Green innovation strategy			
- Green product innovation	4.04	0.93	Agree
- Green process innovation	4.04	0.93	Agree
- Green service innovation	4.05	0.93	Agree
Firm performance			
- Financial perspective	4.03	0.96	Agree
- Customer perspective	4.01	0.94	Agree
- Internal business process perspective	4.00	0.93	Agree
Y4 Learning and growth perspective	4.04	0.94	Agree

Results of Hypothesis Testing

Table 2 Shows the Test Results for Structural Integrity and Factor Loadings

Factors	Loading	AVE	Dijkstra-Henseler's rho (ρA)	Jöreskog's rho (ρc)	Cronbach's alpha(α)
Green product innovation		0.750	0.889	0.923	0.889
- X11	0.872				
- X12	0.861				
- X13	0.864				
- X14	0.867				
Green process innovation		0.721	0.945	0.954	0.945
- X21	0.851				
- X22	0.839				
- X23	0.853				
- X24	0.850				
- X25	0.853				
- X26	0.840				
- X27	0.865				
- X28	0.842				
		0.741	0.913	0.935	0.913

Factors	Loading	AVE	Dijkstra-Henseler's rho (ρA)	Jöreskog's rho (ρc)	Cronbach's alpha(α)
Green service innovation					
- X31	0.856				
- X32	0.854				
- X33	0.873				
- X34	0.861				
- X35	0.860				
Firms Performance		0.899	0.963	0.973	0.963
- Y1	0.948				
- Y2	0.950				
- Y3	0.945				
- Y4	0.951				

According to Table 2, the component weights of all observation parameters in the model are greater than 0.5 or higher, ranging from 0.839 to 0.951. Rho of Dijkstra Henseler ρ A) The value is between 0.889-0.963, Rho of J ö reskog ρ C) This value is between 0.923-0.973, the alpha of Kroenbach α) The value is between 0.889-0.963, with all values greater than 0.7. In addition, based on the average value, hidden variables have classification accuracy. Above 0.5 between 0.721-0.899 (Hensler, Hubner, and Ray, 2016).

Table 3 Shows Discriminant Validity According to the Fornell-larcker Criterion

Construct	Green product innovation	Green process innovation	Green service innovation	Firm performance
Green product innovation	**0.750**			
Green process innovation	0.705	**0.721**		
Green service innovation	0.707	0.716	**0.741**	
Firm performance	0.743	0.702	0.737	**0.900**

According to Table 3, the classification fidelity comes from the average extraction variance (AVE). This value is higher than the relative value of other potential variables, as observed in the diagonal (Fornell & Larcker, 1981).

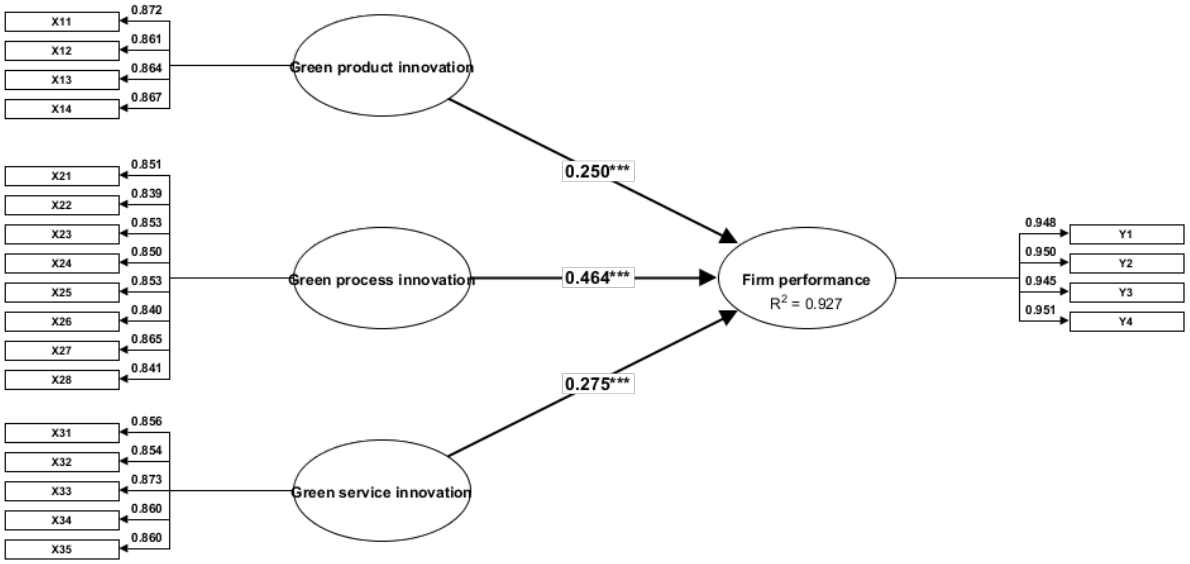

Figure 2 Shows the Results of Hypothesis Testing

Table 4 Show Effects between Green Innovation Strategy and Firm Performance

Effects	Beta	t-test	p-value	Cohen's F2
Green product innovation > Firm performance	0.250	8.176	0.000***	0.122
Green process innovation > Firm performance	0.464	13.048	0.000***	0.291
Green service innovation > Firm performance	0.275	8.204	0.000***	0.127

*** Statistical significance at .001 level

According to Table 4, green innovation strategies include green product innovation, green process innovation, and green services. Innovation has a statistically significant impact on farm performance at a level of 0.000. The path coefficient for green product innovation is 0.25. (t=8.176, P value=0.000) Green process innovation equals 0.464 (t=13.048, P value=0.000) and green services The innovation value was 0.275 (t=8.204, P=0.000). The predicted value for all three variables was 92.7% (R^2=0.927).

DISCUSSION & CONCLUSION

In this research, it was found that three components of green innovation strategies, namely green product innovation, green process innovation, and green service innovation, affected firm performance, which can be summarized as follows:

Green product innovation has a positive direct effect on firm performance because it is related to developing products and services by an organization that does not affect the environment and follows sustainable practices. For example, products that use renewable energy sources or reduce waste in the production process. Using innovative and environmentally friendly products can also positively affect the company's financial performance by increasing sales, reducing costs, and increasing its reputation. Many customers are looking for products with policies promoting social and environmental sustainability. Therefore, if companies can offer these products ahead of their competitors, they will have a competitive advantage. This is consistent with the research of Chen and Chiu (2018), who studied "Green product innovation and firm performance: Evidence from the electronics industry in Taiwan." The research found that firms that engage in green product innovation are more likely to have higher financial

performance than those that do not. This is consistent with Su, Chuang, and Lin's (2018) research, which studied “The effects of green innovation on environmental and corporate performance: A stakeholder perspective.” The research found that green product innovation affects firm performance.

Green process innovation has a positive direct effect on firm performance because green process innovation is related to corporate, social, and environmental sustainability practices. Each company's production must strive to reduce pollution that affects the environment and waste in the production process by using clean energy sources, including sourcing organic raw materials. These processes are, therefore, important for executives and customers to consider. To build the image and reputation of the company. It also helps reduce costs. Increase the customer's positive view of the company. Therefore, these guidelines are indispensable to any sustainability strategy. This is consistent with the research of Jiang and Bansal (2020), who conducted a study on “Does green process innovation pay off for firms? An empirical examination.” The results showed that firms that engage in green process innovation are more likely to have higher financial performance than those that do not. And research by Bocken, Short, Rana, and Evans (2016) on “A literature and practice review to develop sustainable business model archetypes.” The results showed that green process innovation can lead to improved resource efficiency, which can result in cost savings and improved financial performance.

Green service innovation has a positive direct effect on firm performance, as it involves the development of new, environmentally friendly, and sustainable service models for companies. For example, services that promote sustainable behavior or reduce environmental impact can reduce wasteful use of natural resources for services, use environmentally friendly products, care for the environment around the company and throughout the company community, etc. These service models tell employees and customers that the company operates with the highest quality service and does not affect the environment or people's livelihoods. This makes it possible to improve customer satisfaction and effectively build loyalty with the company. Consistent with the research of Lin and Wu's (2014) study, “The impact of green innovation on environmental and corporate performance: A view from service firms.” The results showed that green service innovation positively impacts customer satisfaction and loyalty, which can lead to improved financial performance. And in accordance with the research of Vila-López, Revilla-Camacho, and Castro-González (2018), they studied “Green service innovation and its impact on business competitiveness: An empirical analysis in the hotel industry.” The results showed that green service innovation can lead to improved efficiency and cost savings, which can result in improved financial performance.

The study on green innovation strategies and enterprise performance has expanded the understanding of the impact of green innovation on enterprise performance under the balanced scorecard evaluation framework. It has also enriched the research on green innovation and enterprise performance evaluation. The findings provide valuable insights for enterprises seeking to improve their green innovation strategies and enterprise performance. Specifically, through the research on green product, process, and service innovation, the study suggests guidelines for executives and managers to prioritize developing environmentally friendly products, identifying processes with the greatest environmental impact, and creating innovative service solutions that reduce environmental impact and increase sustainability for the company, society, and customers. Ultimately, the study highlights the importance of considering the entire life cycle of products, collaborating with suppliers and stakeholders, adopting effective practices, and continuously monitoring the results of green innovation strategies to achieve optimal enterprise performance.

To further expand the understanding of green innovation strategies and firm performance, future research can be directed towards qualitative research methods to gain insights from the

perspectives of executives, society, and customers. Exploring intermediate variables that influence firm performance, such as organizational culture, leadership, and employee commitment, can also be a potential area of investigation to identify additional factors that affect the relationship between green innovation strategy and firm performance. Additionally, extending the findings to other industries beyond manufacturing can help identify similarities and differences in the impact of green innovation on enterprise performance, which can lead to more effective strategies for achieving optimal enterprise performance. Ultimately, these future research directions can contribute to a more comprehensive understanding of green innovation strategies and firm performance and provide valuable insights for enterprises seeking to improve their green innovation strategies and enterprise performance.

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