

# The Path of Green Innovation Driving the Transformation and Development of Manufacturing Industry

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**Abstract:** Since industrialization, manufacturing has been an important pillar of national economic development. However, with the rising costs of labor, resources and environment, the development of manufacturing industry is increasingly facing a severe test. Green innovation is the product of meeting the development needs of the times, and it is the focus of current academic research. By studying the mechanism of green innovation driving the transformation and development of the manufacturing industry, this paper puts forward the path of green innovation driving the transformation and development of the manufacturing industry from three aspects: technology promotion, market pull and government regulation, to provide a reference for perfecting and optimizing the green innovation transformation of the manufacturing industry.

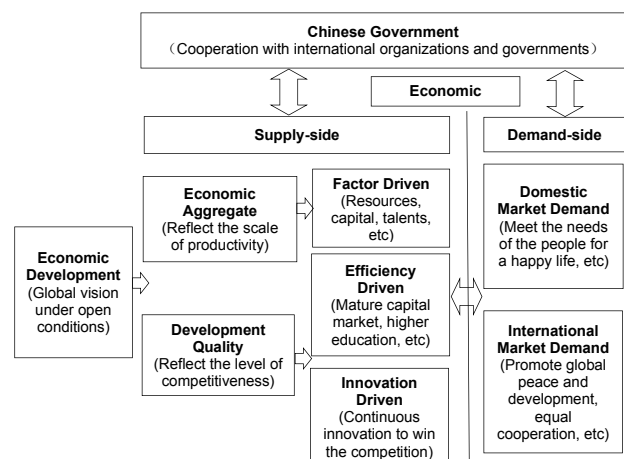
**Keywords:** green innovation; innovation driven; manufacturing transformation

## 1. Introduction

After years of reform and development, China has gradually formed a "world factory" with manufacturing as important support. However, there are still some problems in developing China's manufacturing industry. Some industries are becoming more and more frothy. With the continuous increase of labor, resource and environmental costs, the traditional competitive advantage of China's manufacturing industry is seriously weakened, and the space of the old development model relying solely on scale expansion is becoming smaller and smaller. In the future, China's traditional manufacturing industry will be the priority among priorities in building a resource-saving and environment-friendly society by removing industrial bubbles and resolving excess capacity<sup>[1,2]</sup>. Driving the transformation of China's manufacturing industry with innovation is the only way to reshape the competitive advantage of China's manufacturing industry and consolidate and enhance the international status of China's manufacturing industry in line with the requirements of China's future national development strategy.

Over the years of reform and opening-up, China's economy has maintained a rapid growth trend. However, the high growth of China's economy is largely driven by

investment. The imbalance of domestic demand structure has become a major challenge for China's economy. Similarly, as the pillar of China's economy, the manufacturing industry has long relied on the advantages of factors such as labor force and raw materials to obtain a certain competitive advantage. Its development belongs to a typical "factor-driven" type. This development model often limits a country's manufacturing industry to the lowest end of the industrial chain and makes its economic transformation in trouble<sup>[3]</sup>. From a long-term point of view, a country's traditional factor-driven development will lose its advantages and eventually stagnate its manufacturing industry. Therefore, Chinese enterprises need to time change the mode of economic growth, change the traditional "factor-driven" into "innovation driven", and rely on "soft power" such as technological innovation and institutional change to promote the transformation and sustainable development of the manufacturing industry. (As shown in Figure 1)



**Figure 1.** Macroeconomic analysis framework model

Reviewing previous studies, most scholars discussed the driving factors of green transformation from two aspects: internal factors and external factors. The internal factors are mostly analyzed from the concept of enterprise management, and the external factors are mostly analyzed and studied from the aspects of government, market, science and technology, laws and regulations. In terms of

internal driving factors, the institutional pressure of managers and the profitability of enterprises will promote enterprises to carry out green product innovation [4]. The company's human resource quality and customer pressure will significantly positively impact Green Innovation [5,6]. Song and Yu (2018) pointed out that enterprises have stronger green creativity and sustainable development ability in organizations with a strong green identity [7]. In terms of external drivers, green policies can significantly improve the level of green innovation, and strict environmental supervision can improve the efficiency of regional green innovation [8-10]. Zhang et al. (2019) believe that green innovation is mainly driven by green patented technology in state-owned enterprises [11]. In addition, the uncertainty of the external environment and the market's attention will also drive green innovation [12,13].

With the intensification of competition in the global market economy, resources and environmental problems have become the bottleneck that seriously restricts economic and social development [14,15]. Coordinating environmental protection and economic development has become a major issue to be solved urgently. It is also a direct problem for China to accelerate the transformation of economic development mode at this stage. In 2013, the Third Plenary Session of the Chinese government proposed to deepen the reform of the ecological civilization system and promote the construction of ecological civilization around the goal of building a "beautiful China". In this context, the development of a green economy based on an environmental perspective is becoming the resonance of economic development worldwide. As the main body of micro-economy, the "green" and green innovation of innovation is the inevitable choice for enterprises to adapt to the development of green economy and meet the needs of their sustainable development. It is also the internal requirement and realization path to promote the construction of ecological civilization and strengthen the protection of the ecological environment.

## 2. Mechanism of Green Innovation Driving the Transformation and Development of Manufacturing Industry

### 2.1. Figures and Tables

Green innovation puts ecological protection in the first place. It pursues the maximization of the comprehensive benefits of economy, society and ecology. The purpose is to realize the sustainable development of enterprises, industries, and even society or region. From the perspective of current global development, countries worldwide have actively won the competitive advantage of green development in the economic crisis and a new round of industrial and technological change. This broad demand provides sufficient impetus for accelerating green innovation [16].

With the increasing role of green innovation in practice, the research on the details and regularity of the green innovation process has become the object of attention. Green innovation can not be studied only as an overall variable but as a green innovation system. A green

innovation system is a network composed of government, enterprises, universities, scientific research institutions, intermediary service institutions, and other subjects in a country or region. These subjects interact and contact each other. The system consists of three subsystems: green knowledge production, green knowledge dissemination and green knowledge application.

The green innovation system adopts green technology innovation, including green product innovation and green process innovation, as well as green non-technical innovation in system, market, management and concept, in which technology and various innovation-related activities are included in the whole process innovation. By combing and analyzing the relevant literature, we divide the mechanism of green innovation in the manufacturing industry into three aspects: technology promoting green innovation, market driving green innovation and government regulation promoting green innovation (as shown in Figure 2).

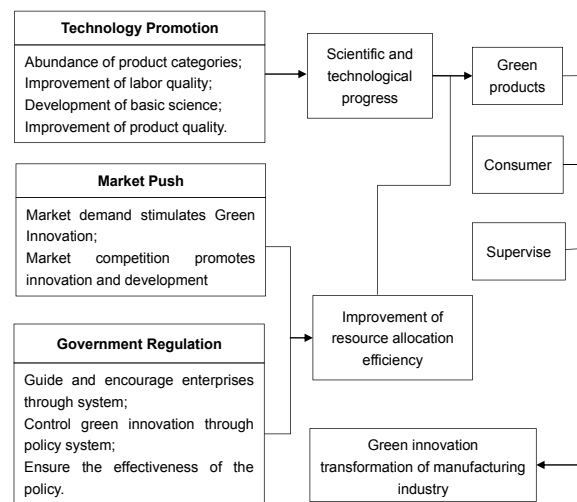


Figure 2. Mechanism of green innovation drive

## 3. The Specific Path of Green Innovation Driving the Transformation and Development of the Manufacturing Industry

### 3.1. Technology Promotes Green Innovation

The development of science and technology promotes green innovation. Due to the rapid development of technology, the continuous progress of technology can provide new ideas and technological opportunities so that there are more and more technological opportunities. Therefore, enterprises have greater motivation to carry out technological innovation activities. In this case, technology can continuously promote green innovation. Moreover, technology can be widely used. Through commercial application, technology will produce economic benefits and even excess profits in the short term [17]. Therefore, one of the main driving factors leading to green innovation is technology. The development and change of technology play an important role in promoting green innovation.

#### 3.1.1. Improve productivity

Technological progress is an important source of transforming the way manufacturing output grows, and it improves development efficiency in the course of transforming manufacturing development. The improvement of production equipment and processes is an important form of technological progress. As the main symbol of the technical level, the production process level plays the most critical and direct role in raw material cost, product quality and product consumption. In addition, through the "growth of knowledge and technology" of workers, we can improve production efficiency and manufacturing technology.

The relationship between science and technology and economic development is an important factor and force to promote scientific and technological progress and even the development of modern productive forces. In the productivity system, the key and leading factor in promoting the development of productivity is undoubtedly science and technology. Science and technology play a decisive role in the nature, direction, structure and level of advanced productive forces. Therefore, science and technology mark the level of advanced productive forces. The progress of science and technology provides technological opportunities for green innovation, which promotes green innovation activities.

### *3.1.2. Optimize the industrial structure*

Technological progress can improve the internal structure of the manufacturing industry, promote the reconstruction and upgrading of the internal sub-industry structure, and improve the industrial structure and resource allocation efficiency of the manufacturing industry as a whole. Fundamentally speaking, the birth, development and decline of industry are closely related to the emergence, development and decline of a technology. When technological progress accumulates to a certain extent, the industry can promote the qualitative change of productivity, promote the fundamental change of production mode, and even cause great changes in the whole social technology system. The impact of technological progress on the industrial structure of the manufacturing industry is multidimensional. Technological progress generates and forms new output growth points by stimulating demand structure, affecting employment structure and promoting the formation and development of new industries.

With China vigorously advocating and supporting the green economy, China's manufacturing industry is facing a low-carbon green revolution. It is necessary to gradually integrate the concepts of intelligence, green, energy conservation and environmental protection, take green technology as the support for enterprise and industrial development, and improve the overall industrial level of the manufacturing industry. Under the condition that China's resources and environment bear a strong load, it is imperative to take the development path of technological innovation. China's manufacturing industry should fundamentally change the mode of economic growth, make technological innovation become the internal driving force of economic and social development, widely carry

out and spread in the whole society, and realize the sustainable and coordinated development of economy and society; fully rely on the power of institutional innovation and technological innovation. Only by paying attention to talents, scientific and technological progress and management, the research and development of Applied Technology and the digestion, absorption and innovation of introduced technology can we promote the upgrading of industrial structure and promote the rapid development of the economy.

### *3.1.3. Form new industrial competitiveness*

In the process of global green transformation, China's green transformation is the requirement of China's sustainable development and the need to form new industrial competitiveness. The new industrial competitiveness maybe green or low-carbon in the future, which may become an important embodiment of manufacturing competitiveness in the next step. With the promulgation of the 14th five-year plan, China has higher and higher requirements for environmental protection and cleaner production. Among them, it is required to transform and upgrade the manufacturing industry, which will be a huge opportunity and challenge for the current production model of the manufacturing industry.

The progress of green technology will improve the technology and equipment to improve production efficiency, reduce pollutant emission, and meet the requirements of green production while improving competitiveness. Green technology brings the appearance of green products, which meets people's demand for environmental protection products and green products, effectively expands market share and brings long-term profits to enterprises. Manufacturing enterprises should pay more attention to the sustainability of development, combine their development strategy with green technology, and make the progress of green technology play the greatest role in improving the competitiveness of the manufacturing industry.

## *3.2. Market-driven Green Innovation*

There is a direct relationship between user satisfaction and market sales share in the market because the economic benefits obtained by meeting user needs can achieve the goal of green innovation. At the same time, the driving effect of market demand on green innovation is also inseparable from market competition, mainly because only under a certain market competition intensity of fairness and justice can market demand play a driving role in green innovation.

### *3.2.1. Market demand stimulates Green Innovation*

The final place where the market plays a role in the market. The driving force of green innovation activities comes from customers' demand for the market, so the original starting point is market demand. The economic level and society are constantly developing and changing. At the same time, the market demand is also changing accordingly. When this change has a certain scale, it will directly impact manufacturing enterprises' product sales

and income levels. In this case, enterprises will encounter new market opportunities and generate new ideas for the market. At this time, this change has given a certain degree of guidance to manufacturing enterprises to realize further the development of green technology innovation activities, which will further encourage manufacturing enterprises to carry out green innovation activities.

3.2.2. Market competition promotes innovation and development

The market competition also promotes green innovation, as shown in Figure 3 below. This kind of market competition can be reflected by the difficulty of green product differentiation in the manufacturing industry. The difference of green products in the manufacturing industry mainly comes from consumer preferences in the market for the products of other enterprises in the long-term process. This preference advantage has a certain long-term accumulation effect. Therefore, the manufacturing enterprises that enter the market first enjoy a certain consumer preference advantage. While for the new manufacturing enterprises, it needs to be recognized by consumers so that consumers have a special preference for their green products, which must cost a certain cost. Of course, only under the fair and just market competition mechanism can promote green innovation [18,19]. In the absence of a fair and just market competition mechanism, advanced enterprises will rely on their special advantages and monopoly position to take unfair means of competition in order to obtain market profits and maintain their monopoly position, to occupy market space, which is not conducive to the smooth development of green innovation activities.

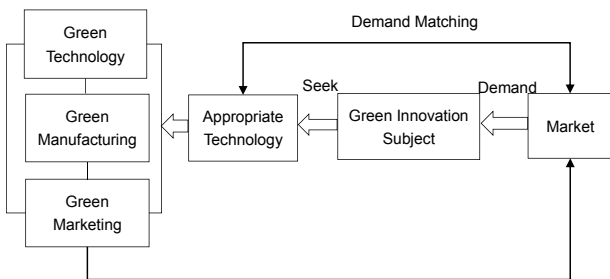


Figure 3. Structure of market-driven green innovation model

3.3. Government Regulation Promotes Green Innovation

Government policies also have a certain incentive and guiding effect on the green innovation of manufacturing enterprises and have a certain promoting effect [9,20]. Government policies play a more prominent role in promoting some special industries. In 2013, the Chinese government proposed the Fifth Plenary the Chinese government proposed that to achieve the development goals during the 13th Five Year Plan period, solve development problems and plant development advantages, and we must firmly establish and effectively implement the development concept of innovation, coordination, green, openness and sharing. Under the current political background, macro industrial policy, scientific and technological innovation policy and fiscal and tax policy

will stimulate and guide the technological innovation activities of enterprises to varying degrees.

3.3.1. Guide and encourage enterprises through the system

The institution is the endogenous condition for the economic development of a country or region. Its essence is a contractual relationship between social people and behavior norms that restrict people. Any innovation activity depends on a certain institutional environment and rules. Enterprises can reduce transaction costs with the help of good institutional design and give full play to the role of institutional innovation in the growth of manufacturing output. The system works mainly by changing the incentive conditions for enterprises, which can be embodied as institutional arrangements such as property rights and legal design, which affect economic growth. Specifically, the role of institutional innovation in the development of the manufacturing industry can be summarized into three points: first, the institution can reduce the transaction cost of economic system operation and provide effective support for the development of the manufacturing industry. For example, the property rights system can reduce the externality of market operation, reduce the uncertainty of market activities, control moral hazard and immoral behavior, and improve the efficiency of market operation. Secondly, the system can create conditions for cooperation and ensure the smooth progress of cooperation among industry subjects. The system can provide people with sufficient behavior constraint information, standardize the behavior of economic subjects, and reduce information cost and market uncertainty. Finally, the system can influence and guide the behavior of economic subjects through an incentive mechanism. Effective organization and institutional arrangement can stimulate and guide individual economic behavior, link economic subjects' behavior cost and income, effectively solve the free-riding behavior in practice, and minimize the externality.

3.3.2 Control green innovation through policy system

In order to make government regulation play a better role in promoting green innovation, in addition to formulating a series of perfect government regulation systems, we also need to establish a complete set of government regulation policy systems. Environmental policy is a series of measures the state takes to protect the environment. These measures play the role of management, regulation and control, including laws, regulations and government directives. Policies and regulations take legal enforcement as a tool to regulate and restrict the activities of manufacturing enterprises to reduce the negative impact on the environment as much as possible. The government can promote green innovation through economic incentives of tax preference. For manufacturing enterprises that adopt green technology or environmental protection equipment, policies such as tax reduction or subsidy shall be given. In addition, the government can promote green innovation through funding and give subsidies and tax incentives to projects in line with industrial policy development. In order to encourage green

innovation activities, the government should actively use various incentives to create a good development environment for green innovation to promote green innovation of enterprises. R&D is the power source of green innovation activities and must consume much money. For green technology innovation activities, the government needs to support green innovation through direct funding; At the same time, in order to reduce environmental pollution, economic means such as sewage charges and fines need to be adopted appropriately, and manufacturing enterprises with high energy consumption, large waste of resources and serious pollution need to be warned, notified or even shut down, and replaced by new energy enterprises and green enterprises.

### 3.3.3. *The government should ensure the effectiveness of the policy*

The effectiveness of government regulation is an important guarantee of policy driving factors. Suppose the implementation effect of government regulation is not ideal and lacks sufficient implementation. In that case, it will frustrate the enthusiasm of manufacturing enterprises to carry out green innovation activities to weaken the driving force of green innovation of manufacturing enterprises. Therefore, the government should establish and improve the existing regulatory and policy systems and ensure effectiveness. If policies and systems are not strictly implemented, they will be vain. The government's supervision plays a decisive role in whether manufacturing enterprises fully comply with government regulations. When the government's supervision is strong enough, enterprises will have fewer false reports; On the contrary, when the supervision is not strong, enterprises may have the phenomenon of false reporting. Whether an enterprise falsely reports pollution and the amount of pollution falsely has nothing to do with the enterprise's green innovation ability, but it is related to the severity of government regulation and supervision. Therefore, the government needs to improve the severity of environmental regulation to expand the incentive effect of green innovation of manufacturing enterprises. In addition, the government also needs to continuously strengthen supervision and further promote enterprises to reduce emissions without making false reports. For government regulation, only by ensuring high implementation effectiveness, high feasibility, and operability can government regulation fully effect. At the same time, the government should ensure the quality level of regulators and the rationality and effectiveness of regulation implementation methods and effectively regulate regulators. To sum up, the government should ensure the effectiveness of supporting regulations for green innovation in the manufacturing industry to play a better role in promoting green innovation in the manufacturing industry.

## 4. Conclusion

By studying the mechanism of green innovation driving the transformation and development of the manufacturing industry, this paper puts forward the specific path of green

innovation driving the transformation and development of the manufacturing industry from three aspects: technology promotion, market pull and government regulation.

Firstly, enterprises' transformation and innovation mode should make full use of labor force and technology and fully save resources to protect the environment. In this way, we resolve the resource factor bottleneck of economic development and the pressure of green transformation of world economic development. Secondly, for enterprises to carry out green transformation efficiently, funds need to be mainly invested in technology investment such as technology upgrading and talent attraction. Manufacturing enterprises should implement the corresponding reform of management systems and business models to realize the overall upgrading of the industry. In addition, the current manufacturing industry needs to graft the green transformation into a complete industrial chain to drive the collective transformation of raw materials, sales and other markets. This new virtuous cycle can reduce costs, improve efficiency objectives, help the overall stable transformation of the industrial chain, and drive national economic development. Finally, on the one hand, the ecological turn of the innovation system of the manufacturing industry depends on the action mechanism of the government, the guiding mechanism of the market, the service mechanism of intermediary organizations and the catalytic mechanism of scientific research organizations; On the other hand, we should also pay attention to the compatibility between the enterprise's innovation system and the environment, and select the ecological innovation model suitable for the enterprise technology cluster according to the characteristics and development stage of the enterprise.

The manufacturing industry is the foundation of the country and the pillar of the national economy. The green transformation of the manufacturing industry is the responsibility of enterprises and the whole society. Under the current social background of "supply-side reform", the green transformation of the manufacturing industry is urgent, which will affect the realization plan of the "Chinese dream" in the long run and promote the great rejuvenation of the Chinese nation.

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