Study on the Driving Mechanism of Green Economic Development

Xiaoyun Zhang[1, 2]

[1] School of Economics and Finance, Xi'an International Studies University, Xi'an, 710128, China;

[2] Research center of resources, environment and industrial economics, Xi'an International Studies University, Xi'an 710128, China

Keywords: Environmental regulation; Technological innovation; Green development

Abstract. This paper integrates environmental regulation, technological innovation, and green development into a unified research framework, and analyzes the inner logical relationship between the three through normative research, in order to understand the driving process and mechanism of green economic development. It is concluded that environmental regulation, technological innovation are the external and internal drivers of green economic development, and that both directly drive green economic development. It also summarized that environmental regulation indirectly drives green economic development through driving technological innovation, in which technological innovation plays an intermediary role. The conclusion provides theoretical support for the government to promote green economic development.

1. Introduction

Environmental regulation, technological innovation and green development are the hot spots of domestic and international research all the time. Scholars have carried out many theoretical and empirical types of research on environmental regulation and technological innovation to promote green development from different perspectives [1]. However, these studies didn't offer a systematic analysis of the mechanism among environmental regulation, technological innovation and green development[2]. This study integrates environmental regulation, technological innovation and green development into a unified research framework, and systematically analyzes the mechanism among them. This actually answers three questions: How does environmental regulation affect green development? How does environmental regulation affect technological innovation? How does technological innovation affect green development?

2. The Mechanism of Environmental Regulation on Green Development

The mechanism of environmental regulation on green development essentially refers to how environmental regulation affects the enterprises' production cost, then affects the environmental efficiency and production efficiency, and ultimately affects green development (Figure 1).

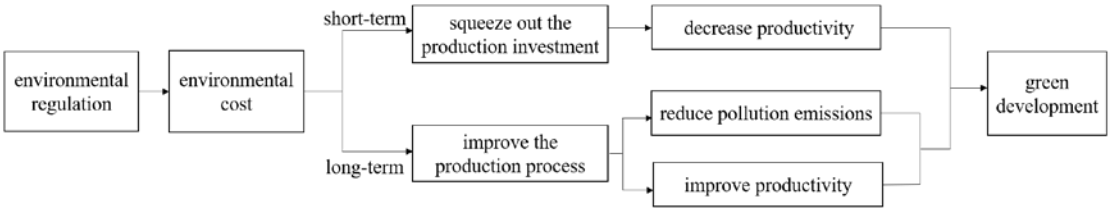

Figure 1. The transmission mechanism of environmental regulation on green development by affecting the environmental cost

Enterprises production processes will produce waste gas, wastewater and solid waste which will cause environmental pollution. Due to the strong negative externality of environmental pollution, it is difficult to solve the problem only by the market mechanism. It is necessary for the government to regulate the environmental problem.

The purpose of government intervention in enterprises' economic activities is to internalize the external cost of environmental pollution [3]. With the constraints of government environmental

  DOI: 10.25236/ic3er.2019.044

regulation, enterprises have to invest certain manpower, material and financial resources for environmental governance, resulting in increased environmental costs.

2. 1. The negative impact of the rising environmental cost on green development

When enterprises are constrained by environmental regulation, the rising environmental cost will squeeze enterprises' production investment to a certain extent if the original technology remains unchanged. In the short term, it will lead to a decrease in green total factor productivity which in turn hinders green development.

2. 2. The active impact of the rising environmental cost on green development

In the long run, as environmental regulations become stringent, enterprises gradually realize that the increase in environmental costs is continuous [5]. For enterprises aiming at maximizing profits, they have two ways to maintaining the original pollution emissions, that is, passively paying environmental costs and actively reducing pollution. Obviously, reducing environmental costs is much more important. When enterprises find that it is more advantageous to reduce pollution, they will consciously improve the production process and improve the utilization efficiency of resources, thus promoting the economic and environmental benefits so as to achieve green development.

To sum up, environmental regulation will increase enterprises' environmental cost, which in the short term, squeezes enterprises' production investment, reduce productivity, and hinder green development. However, in the long run, environmental regulation will force enterprises to change their production methods, strengthen the recycling of resources, reduce pollution emissions, improve productivity, and ultimately promote green development.

3. The Mechanism of Environmental Regulation on Technological Innovation

Technological innovation is characterized by high investment, slow return and high risk, especially the technological innovation based on environmental protection which bears more uncertainty and spillovers. The internal motivation of enterprises to carry out this kind of technological innovation is not strong, so it is necessary to exert external pressure on technological innovation through environmental regulation. However, environmental regulation will increase environmental costs; enterprises comply with environmental regulations to pay the cost which is called "follow cost"[4]. If an enterprise adopts technological innovation, it may produce "innovation compensation effect", that is, innovation competitive advantage will increase profits, so that enterprises have more funds for production, then to compensate for "follow cost". At the same time, technological innovation activities need a lot of money. When enterprise funds are limited, "follow cost" may have a "crowding out effect" on technological innovation. Whether or not the "crowding out effect" is generated depends on the size of the "follow cost" and "innovation compensation effect"(Figure 2).

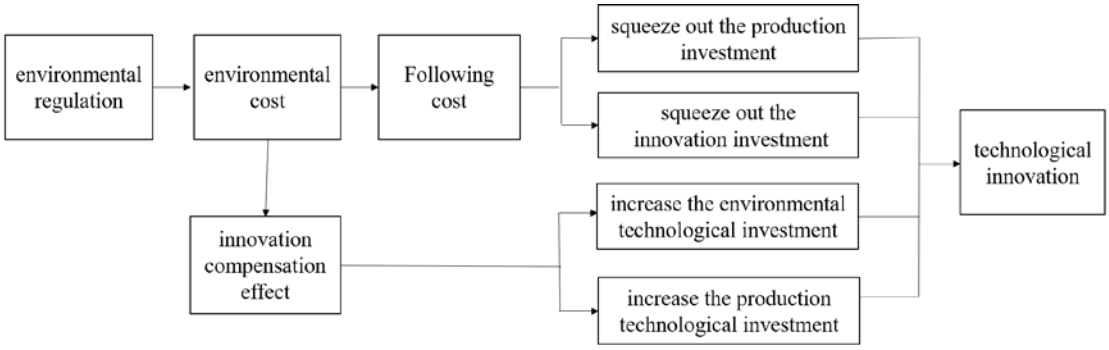

Figure 2. The transmission mechanism of environmental regulation on technological innovation by "follow cost" and "innovation compensation effect"

In general, environmental regulation is not overly strict in the initial stage of implementation, and the process from innovation investment to generate profit returns is time-stalling. In the initial stage of innovation investment, enterprises mainly pay the cost rather than pay off. Therefore, enterprises are unwilling to engage in technological innovation in the short term, and the

"innovation compensation effect" is smaller than the "follow cost", so the enterprise production process is mainly reflected in "follow cost", which directly squeezes out the enterprise's innovation input [6]. In addition, "follow cost" can hinder technological innovation by squeezing out the production investment, reducing profits, then indirectly squeezing out innovation investment. In short, environmental regulation has a negative impact on technological innovation from both direct and indirect aspects in the short term.

As environmental regulations become more stringent, "follow cost" of pollution control will be greatly increased, and long-term technological innovation will bring enterprises sustained high profits. When enterprises perceive that the "innovation compensation effect" is greater than "follow cost", they tend to meet the environmental regulation requirements through technological innovation and ultimately maximize their own profits. Specifically, enterprises have two ways of technological innovation [7]. The first way is to reduce pollution emissions and improve resource utilization through environmental technology innovation. The second is to reduce production costs and improve product quality, in order to increase enterprises' profit through production technology innovation, so that enterprises have more funds for environmental governance. Either way, environmental regulation is conducive to technological innovation.

To sum up, environmental regulation has both positive and negative effects on technological innovation, and its final impact depends on the relative size of "follow cost" and "innovation compensation effect". Usually, "innovation compensation effect" lags behind "follow cost", and environmental regulation may hinder technological innovation in the short term, but incent itin the long term.

4. The Mechanism of Technological Innovation on Green Development

Technological innovation is the intrinsic driving force of green development, which affects green development in the way the following transmission mechanism shows (Figure 3).

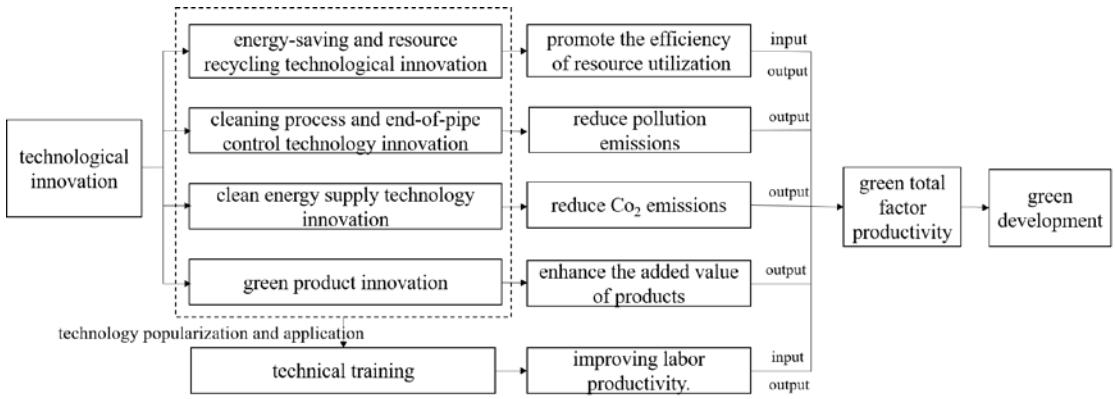

Figure 3. The transmission mechanism of technological innovation on green development

4.1. Energy-saving and resource recycling technological innovation

One of the important manifestations of green development is the conservation of resources and energy. A basic assumption of economics is the scarcity of resources. Technological innovation can improve the efficiency of resource utilization and save energy, which alleviates the scarcity of resources to a certain extent. At present, most enterprises in China didn't make the most of the raw materials, energy and other factors of production in the production process, and the waste of resources and energy is very serious. If enterprises can use advanced energy-saving technology or resource recycling technology to improve production tools, technologies and processes, and deepen the processing and development of existing resources, it will promote the efficiency of resource utilization. Thus, on the one hand, given the same total output, it can reduce the input of resources and energy in the production, and increase the green total factor productivity from the input point of view. On the other hand, as the total output is variable, productivity increase means that the equivalent resource and energy input can achieve more output, so as to increase green total factor

productivity from the output point of view. Either way, green development is reflected.

4.2. Cleaning process and end-of-pipe control technology innovation

Another important manifestation of green development is the reduction of pollution emissions. Technology innovations in cleaning processes and end-of-pipe control play an important role in reducing pollution emissions. On the one hand, through the cleaning technology innovation, enterprises can use advanced desulfurization technology, pollution control technology, and green basic manufacturing technology in the production process, which will effectively reduce waste generation and prevent pollution emissions from the source. On the other hand, through end-of-pipe control technology innovation, enterprises can use advanced purification technology to separate, dispose and incinerate waste, which can greatly reduce waste emissions to the atmosphere, land and water resources. Both innovative approaches promote green development by increasing green total factor productivity in terms of reducing non-expected output.

4.3. Clean energy supply technology innovation

For a long time, China's industrial development is heavily dependent on coal, oil and other traditional fossil energy, resulting in serious environmental pollution. Coal and oil are non-renewable energy sources, with years of overexploitation and use, energy constraints are tightening, and sustainable development is being seriously challenged. However, industrial development can’t be separated from energy supply. Energy supply technology innovation is the key way to meet industrial energy demand. It can expand the range of energy available, through refining and processing the clean energy such as solar, wind, nuclear energy, biomass energy, at last transforming into the form that the end user can use, so as to replace the coal, oil and other traditional fossil energy. In short, Energy supply technology innovation can not only save energy, but also greatly reduce pollution emissions, thus promote green total factor productivity from the view of input and output, which is conducive to green development.

4.4. Green product innovation

With the acceleration of the upgrading of consumption structure and the rapid growth of green consumption demand, the modes of enterprises’ production also accelerate the shift to “green” in order to seize the market share of green consumption. Through green product design, green materials research and development, and green packaging, enterprises can produce differentiated green products, which is conducive to improving market recognition and forming a brand effect, then enhancing the added value of products so as to bring higher profits. In particular, if enterprises’ technological innovation is original, that is, enterprises become the sole provider of new technology and new products, it can form a certain monopoly power and bring enterprises excess profits. When enterprises have high profits, they will invest more in environmental technology innovation and environmental governance, so as to achieve a beneficial cycle of economic benefits and environmental protection. Therefore, the differentiation advantage formed by green product innovation of enterprises that maximizing their own interests contributes to green development.

4.5. The popularization and application of new technology

The popularization and application of new technology put forward higher requirements for workers' skills. Enterprises need to carry out the necessary technical training for their workers while introducing advanced equipment to improve the production process. Technical training can improve the quality and skills of workers, thereby improving labor productivity. On the one hand, given the same total output, the improvement of labor productivity can greatly reduce the unit labor input, reduce the production cost and enhance the economic profits of enterprises from the input perspective. On the other hand, as the total output is variable, the improvement of labor productivity can produce more products by the same amount of output, and enhance the economic profits of enterprises from the output perspective. Either way, technological innovation can improve labor productivity and enhance the economic profits of enterprises, and then enterprises have more funds for green research and development and pollution control, so as to promote green development through the above-mentioned paths.

To sum up, regardless of the above-mentioned technological innovations, the result is either reducing pollution emissions from an input perspective, or increasing expected output or reducing

non-expected output from an output perspective, which will ultimately improve green total factor productivity and promote green development.

5. Conclusion

Through theoretical analysis, the study discusses how environmental regulation affects green development, how technological innovation affects green development, and how environmental regulation affects technological innovation. These three influence paths reveal the following meanings. First, environmental regulation, technological innovation can affect green development directly. Second, environmental regulation can influence green development indirectly by influencing technological innovation. Therefore, in order to promote enterprises' green development, the government should speed up the formulation of targeted environmental regulation policies and should strengthen the incentive of enterprise technology innovation, so as to achieve innovation-driven green development.

References

[1] Bréchet, Thierry, Meunier G. Are clean technology and environmental quality conflicting policy goals?[J]. Resource and Energy Economics, 2014, 38:61-83.

[2] Liu Wei etc. Environmental regulation policy and research on economic sustainable development [M]. Economic Science Press, 2017

[3] Li Yang etc. Heterogeneous effect of environmental regulation on the short-term impact of technological innovation—two-stage analysis based on a value chain perspective[J]. Studies in Science of Science, 2014, 32(06):937-949.

[4] Carmen E. Carrión-Flores, Innes R. Environmental innovation and environmental performance[J]. Journal of Environmental Economics & Management, 2010, 59(1):0-42.

[5] Rubashkina Y, Galeotti M, Verdolini E. Environmental regulation and competitiveness: Empirical evidence on the Porter Hypothesis from European manufacturing sectors[J]. Energy Policy, 2015, 83(35):288-300.

[6] Teng M J, Wu S Y, Chou J H. Environmental Commitment and Economic Performance-Short-Term Pain for Long-Term Gain[J]. Environmental Policy & Governance, 2014, 24(1):16-27.

[7] Chen Shiyi. Environmental problems under the new normal and China's economic transformation[J]. Journal of the Party School of the CPC Central Committee, 2016, 20(02):94-99.