

Research on the Effects of FDI, Fiscal Decentralization and Environmental Regulation on the Green Innovation Efficiency of Industrial Enterprises in Cities Along the Yangtze River

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Abstract: *As China continues to invest in innovation, the efficiency of innovation input and output of provinces and cities has also become an important indicator of the innovation capabilities, but the relationship between urban innovation efficiency and the intensity of environmental regulations and foreign direct investment from the perspective of all factors, the theoretical community has not given an exact answer. Based on previous studies, this article comprehensively discusses the mechanism of action between FDI, fiscal decentralization, environmental regulation and the efficiency of urban industrial enterprises' green innovation, hoping to inspire future researchers.*

Keywords: *Innovation Efficiency FDI*

1. Introduction

Over the past 40 years of reform and opening up, China's economy has achieved world-renowned development achievements, the industrial economy has achieved leapfrog development, the industrial system has been continuously improved, and the industrial competitiveness and technological level have been continuously improved in participating in international competition and cooperation. All these achievements have been achieved. It is inseparable from foreign direct investment. Over the years, China has ranked among the top three in the world in terms of attracting foreign direct investment. However, at the same time, China's industrial production is concentrated in the low value-added links of the global value chain, the resource and environmental constraints caused by the development of "high pollution", "high energy consumption" and "low technology" have intensified, and the urgency of ecologically efficient development has become increasingly urgent to increase. In recent years, affected by the adjustment of the international economic and trade structure and the new normal of the domestic economy, the problem of regional imbalances has become increasingly prominent, and a new trend of accelerated economic differentiation between the North and the South has emerged. The southeast coastal areas took the lead in opening-up and developing rapidly, gathering high-quality elements such as research and development, a sound industrial foundation, and relatively sufficient development potential. However, the relatively low degree of openness and development in the northern region has a relatively single industrial structure, weak technology-driven, and downward pressure on economic development. The gap between the northern provinces and the provinces with better open economy development such as Guangdong, Jiangsu and Zhejiang has been widening, and the southern region has taken the lead in the new wave of regional economic development, the Yangtze River Economic Belt and the Guangdong-Hong Kong-Macao Greater Bay Area Strategic planning will become an important driving force for regional economic growth.

The Yangtze River Economic Belt is the main battlefield for China's absorption and utilization of foreign capital. Foreign capital plays an important role in promoting the rapid development of the Yangtze River Economic Belt. The economic development levels of the provinces and cities in the Yangtze River Economic Belt are significantly different. Some provinces have strong economic growth momentum and may actively lower the environmental threshold for foreign investment access. Improving foreign investment policies and introducing green and high-quality foreign investment are important topics for China's opening up. Green development efficiency is a concentrated reflection of regional green production capacity. What impact will foreign investment have on the green development efficiency of cities in the Yangtze River Economic Belt? Does it promote or inhibit? Under the constraints of different environmental regulatory intensities and fiscal decentralization systems, does foreign

investment have a heterogeneous impact on the green development efficiency of the Yangtze River Economic Belt? Answering these questions has important practical significance for accelerating the green and high-quality development of the Yangtze River Economic Belt and promoting the modernization of the national ecological civilization governance system and governance capabilities.

2. Mechanism analysis

2.1 The mechanism of FDI

Foreign direct investment (FDI) has not only been considered to be an important economic engine to promote economic growth in China, but also has played a pivotal role in the ecological environment. Empirically, it may exhibit two conflicting effects, namely, pollution haven effect and pollution halo effect. Hence, it is of great significance to re-examine the effects of FDI on the ecological environment.

Wagner and Timmins analyzed FDI data from Germany in the manufacturing industries of 100 countries and found that the transfers of the polluting chemical industry led to environmental degradation in the host countries [13]. Jun applied a wavelet tool to examine the effect of FDI on pollution in China [9]. The findings showed that FDI increased pollution both in the short and long run. In contrast, FDI may also exhibit a positive impact on the environment. This is because firms in developed countries usually face higher environmental regulatory standards in their own countries. FDI can create positive externalities and thus improve the overall technological levels of developing countries, save various resources, and reduce pollution emissions through spillover effects, demonstration effects, and competition effects, which is referred to as “pollution halo” effect [3].

The “pollution haven” hypothesis was firstly proposed by Walter and Ugelow. Subsequently, a growing number of empirical studies have been conducted to verify the hypothesis. For example, Wagner and Timmins analyzed FDI data from Germany in the manufacturing industries of 100 countries and found that the transfers of the polluting chemical industry led to environmental degradation in the host countries. Besides, industries with lower environmental standards and pollution-intensive industries were more likely to invest in those developing countries with less strict environmental regulations [4]. Consequently, it made them “pollution sanctuaries”. Jun applied a wavelet tool to examine the effect of FDI on pollution in China. The findings showed that FDI increased pollution both in the short and long run.

In contrast, FDI may also exhibit a positive impact on the environment. This is because firms in developed countries usually face higher environmental regulatory standards in their own countries. These firms therefore generally adopt more advanced pollution treatment technology and have environmental managerial expertise. When these firms migrate to developing countries, they may introduce advanced equipment and technologies to developing countries [10]. FDI can create positive externalities and thus improve the overall technological levels of developing countries, save various resources, and reduce pollution emissions through spillover effects, demonstration effects, and competition effects, which is referred to as “pollution halo” effect.

To exactly measure the effect of FDI on the eco-efficiency of Chinese cities, we can apply a method of calculating capital stock, namely perpetual inventory method, to obtain FDI stock of each city. Besides, the depreciation rate is taken 6% [8].

Generally speaking, the overall intensity of environmental regulations in the Yangtze River Economic Belt is relatively strong, and the role of clean screening of foreign investment is obvious, which can ensure that entering enterprises have a strong overall green production capacity and foreign investment is a “polluting paradise”. The effect is weak. At the same time, there are significant regional differences in the Yangtze River Economic Zone. Although the downstream regions have established an efficient screening mechanism for foreign investment, the middle and upper regions are still in the stage of high-speed industrialization, which makes the Yangtze River Economic Belt as a certain degree of extensive development characteristics. The technical level of the introduced foreign-funded enterprises is not enough to fully digest the increase in production costs brought about by the improvement of environmental standards. To a certain extent, strengthening environmental regulations will weaken the driving effect of foreign investment on the green development efficiency of the Yangtze River Economic Belt, and the green quality of foreign investment needs to be improved.

2.2 The mechanism of Environmental Regulation Tools

There are mainly the following ways to measure environmental regulations: one is to find proxy variables, such as using GDP per capita as a proxy variable for environmental regulations, which means that as income rises, environmental regulation levels will also improve [1]. The second way is to measure the current pollution emission intensity. That is, the more pollution discharges, the weaker the current environmental regulations [5]. The third is to use the operating costs of pollution control facilities to measure, the higher the operating costs of pollution control facilities, the stronger the environmental regulations. The fourth is the use of the industrial solid waste comprehensive utilization rate, the industrial smoke removal rate, the industrial sulfur dioxide removal rate, the standard-achieving rate of waste water discharge, and the harmless treatment rate of domestic waste.

As far as the classification of environmental regulation tools is concerned, Tietenberg divides them into “control tools” and “incentive tools” [12]. The former has compulsory and prescriptive features, and generally includes environmental standards, market access, pollution control investment, etc.; the latter generally includes the issuance of pollution permits, collection of pollution fees, government’s environmental special subsidies, and deposit return systems.

Regarding the setting of “controlled” environmental regulation tools, Chen and Chen selected the frequency and proportion of environmental-related words in the provincial government work report as proxy variables for “controlled” environmental regulation tools. This indicator can better avoid reverse causality and meet the exogenous requirements of environmental regulations. On the one hand, local government work reports are usually released at the beginning of the year, and FDI runs throughout the year; on the other hand, this article selects the frequency and proportion of environment-related words in provincial-level’s government work reports. The research’s main object is prefectures and cities, which cannot influence higher-level government’s decisions.

For the setting of incentive environmental regulation tools, Feng use the weighted linear summation method of five indexes to calculate the intensity of incentive environmental regulation tools: the industrial solid waste comprehensive utilization rate, the industrial smoke removal rate, the industrial sulfur dioxide removal rate, the standard-achieving rate of waste water discharge, and the harmless treatment rate of domestic waste [6].

2.3 The mechanism of innovation capability

Currently, patents, new product sales revenue and new product projects are mostly used in the literature for measuring indicators of innovation capability. Since the sales revenue of new products is easily affected by external factors such as product promotion or promotion by the sales department, it cannot fully reflect the actual output value in the process of innovation activities. The number of new product items can only reflect the increase or decrease in the quantitative sense. Reflecting the specific scale of each project, there is a lack of comparability. As a direct manifestation of innovation output, patents have strict approval standards and horizontal comparability. Therefore, the number of patents has become the most frequently used index in the literature. The number of patents has always been the proxy index for most scholars to study urban innovation capabilities. However, the number of patent outputs cannot reflect the quality and value of different patents, and there may be large errors.

Many researchers use patent data from the National Statistical Yearbook, which greatly limits the reliability and precision of academic research. First of all, the yearbook data is relatively macro, and the lowest is only at the provincial level. In other words, based on such data, at most only some academic research at the provincial panel level can be done, which has great limitations in terms of mechanism analysis and causality identification. Second, the yearbook data does not provide patent update information. According to the patent law, a patent can only maintain its validity after the annual fee is paid. The longer the renewal time, the higher the patent value. This method is obviously inaccurate.

For the measurement of innovation capability, we know that innovation is an input-output process. Measuring innovation can be started from the perspective of input and output. As we all know, China’s R&D data is not only poorly available, but the quality of the data itself is also very unreliable. In contrast, China’s patent data is not only highly available, but also of high data quality. Therefore, using patent data to measure China’s innovation behavior has become a more feasible and reliable way.

2.4 The mechanism of fiscal decentralization

Environmental problems are characterized by high costs and insignificant economic benefits in a short period of time. The government plays an irreplaceable role in environmental governance, but there are obvious differences in the strength and effectiveness of local governments in the governance and protection of the local environment. At the same time, whether it is enterprise innovation or green innovation, it requires support and incentives from various aspects, such as industrial agglomeration, R&D resource endowment, and the formulation and implementation of environmental regulations and policies, which are inseparable from the behavioral decisions of local governments. Government behavior decision-making mainly depends on the size of local financial resources, so the financial power granted to local governments by the central government has a non-negligible impact on the local economy, innovation and green innovation.

The existing fiscal decentralization theory mainly has two conclusions: favorable view and unfavorable view. Oates proposed that local governments have advantages in terms of efficiency and information in supplying local public goods [11], while Dijkstra believes that fiscal decentralization will enable local governments to develop in order to attract more capital inflows and retention. Prospective companies take the initiative to lower environmental regulatory standards, which in turn leads to aggravation of environmental pollution problems, that is, "competition to the end". Since China implemented the tax-sharing system reform in 1994, the economic autonomy of local governments has increased. At the same time, the performance evaluation of local officials is often determined by the higher-level government. Under this circumstance, the criteria for performance evaluation are particularly critical. When performance indicators largely point to local economic construction and production development, local governments may ignore environmental issues or even sacrifice the environment in order to strive for the greatest possible economic development. Halkos and Paizanos conducted a research on the impact of fiscal decentralization on environmental factors, and believed that fiscal decentralization has a significant impact on environmental pollution in both the long-term and short-term perspectives [7]. Du Juntao and others pointed out that fiscal decentralization significantly affects the degree of local government's environmental governance investment. The level of local economic development and the central government's assessment mechanism determine the degree of local government's emphasis on the environment.

In terms of the relationship between fiscal decentralization and corporate innovation or green innovation, Atkeson proposed that, compared with other policies, direct government subsidies for corporate innovation activities are more conducive to promoting innovation [2]. The International Monetary Fund pointed out that increasing subsidies and tax incentives for corporate R&D expenditures can significantly increase productivity. However, research by others find that the impact of fiscal decentralization on corporate green technology innovation has obvious regional heterogeneity. It has a restraining effect on green technology innovation in the eastern and western regions, which has a promoting effect in the central region.

The perspective of fiscal decentralization has gradually entered the category of innovation research in recent years. Most of it focuses on the research on factors such as green economy and government subsidies. The research on the impact of corporate green innovation is due to the difficulty of data collection and the selection of variables. There are many problems such as doubts. The lack of a comprehensive discussion, and the lack of thinking about the interaction of fiscal decentralization and environmental regulation, which is one of the reasons why this paper chooses this research perspective. In terms of research methods, spatial measurement models have been applied in many empirical fields in recent years, but research in the field of green innovation still lacks systematic model verification and unified empirical conclusions.

3. Conclusions

Based on the above factors, in the future, the spatial agglomeration and spatial spillover characteristics of corporate green innovation efficiency will be verified through spatial measurement models, and the Yangtze River will be affected by different environmental regulatory tools, FDI levels, and innovation capabilities under different fiscal decentralization systems. The spatial effects and regional heterogeneity of green innovation efficiency of industrial enterprises in cities along the route are analyzed, and the development trend and impact effects of green innovation of enterprises are explored from the perspectives of time sequence and space. It is expected to be inspiring for future researchers.

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