

The Digital Economy, Environmental Regulation and Green Total Factor Productivity: A Theoretical Framework

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Abstract

Enhancing green total factor productivity has become an important measure for realizing green economic transformation and high-quality economic development. Different from the previous analytical paradigm of single-relationship chain, the article integrates environmental regulation into the research system of digital economy and green total factor productivity from a systemic perspective, and constructs the theoretical framework of "basic connotation - mechanism effect -- realization path". It constructs a theoretical framework of "basic connotation -- mechanism effect -- realization path" to analyze the impact of digital economy and environmental regulation on green total factor productivity and the regulating effect of environmental regulation in the process of digital economy affecting green total factor productivity. The analysis of the mechanism and path is conducive to promoting the construction of digital China and beautiful China, and also provides new ideas for realizing green high-quality development.

Keywords

Digital economy; Environmental regulation; Green total factor productivity; Theoretical frameworks.

1. Introduction

The report of the twentieth CPC National Congress emphasized that "high-quality development is the primary task of building a modern socialist country in all aspects, and that efforts should be made to improve total factor productivity and to promote the economy to achieve effective qualitative improvement and reasonable quantitative growth". At present, China's economic development has shifted from high-speed development to high-quality development, and green development has become the main focus of economic growth at this stage. Resource shortages and environmental pollution are still major problems in China's economic development, the realization of green transformation is not only able to get rid of resource dependence, environmental protection, but also to release economic vitality, and promote the development of high quality and efficiency of the economy is an important step. In recent years, the digital economy has been booming, and has gradually become a very dynamic new economic form in the economic field. In 2022, the scale of China's digital economy will reach 5.02 billion yuan, accounting for 41.5% of the gross domestic product (GDP). The digital economy is a new economic pattern formed after the agricultural and industrial economies, with data resources as the key element and information networks as the main innovation carrier[1], Integration and application of information technology to promote a series of changes in the mode of production and life, become an important force to promote China's economic growth, and inject new vitality into the high-quality development of China's economy, at the same time, the combination of the digital economy and technology can promote the development of green total factor productivity. However, the development of the digital economy is currently facing

serious carbon emission problems, and environmental protection in the field of digital economy should not be delayed. In this regard, China has introduced relevant environmental regulatory policies to promote the green development of the digital industry and improve the level of green total factor productivity.

This paper integrates the digital economy, environmental regulation and green total factor productivity (TFP) into a unified framework, focusing on the impacts of the digital economy and environmental regulation on green TFP, and further investigating the moderating effect of environmental regulation in the process of the digital economy's impact on green TFP. The main conclusions are conducive to promoting the implementation of the digital China strategy, implementing the policy of building an ecological civilization and enhancing the level of green total factor productivity in China's economic development.

2. Basic Connotation

Digital economy is an emerging economic form evolved from the information economy and Internet economy through historical stages. Digital economy in the basic connotation of the broad and narrow sense, in a broad sense, the digital economy is to knowledge and information as the key elements, information network regulation to optimize the economic structure, release the economic activity, enhance economic efficiency of a form of economy; in a narrow sense, the digital economy is from the traditional economic activities of the decomposition of the digital production, distribution, exchange, consumption, and services and other digital features of the economy. Link[2]. The digital economy realizes the efficient, intelligent and sustainable development of economic activities through data-driven, networked, intelligent, innovation-driven and cross-border integration. At present, the research community has not reached a unified evaluation index for the digital economy, and scholars have constructed a relevant index system for evaluation based on their own understanding of the basic connotation of the digital economy[3].

Solow first introduced the concept of total factor productivity (TFP), which is interpreted as the portion of growth attributable to technological progress and innovation in addition to the portion of growth attributable to factor inputs. Green Total Factor Productivity (GTP) is based on the concept of Total Factor Productivity (TFP), which not only takes into account the growth effects of traditional factors of production and innovative technological factors, but also takes energy consumption and environmental factors into account. Therefore, green total factor productivity is an indicator that comprehensively evaluates economic growth, resource efficiency and environmental impact[4]. That is, it measures the efficiency of the use of factors such as energy, materials and labor and their impact on the environment in the context of economic growth, taking into account undesired outputs such as pollution emissions and energy consumption, as well as desired outputs from factors of production.

The enhancement of green total factor productivity is an important issue for the high-quality development of the economy and the green transformation of the economy in the current era of the digital economy. Traditional economic growth is often accompanied by environmental problems such as energy consumption and pollution emissions, and in order to realize the high-quality development of the economy in a green way, the environmental regulatory policy has come into being[5]. Environmental regulation is to protect the environment and realize the goal of sustainable development by restraining and regulating environmental pollution, resource waste and ecological damage in economic activities. Environmental regulation is conducive to the promotion of green technological innovation and industrial upgrading, among other aspects, and is of great significance in realizing the coordinated development of the economy and the environment, and promoting the green transformation of the economy and sustainable development.

3. Mechanism Logic

3.1. Digital Economy and Green Total Factor Productivity

The digital economy with the help of information networks to link up the whole production process, breaking the space barriers, so that the main body of multiple parties to fully share the dividends of resources, reduce the consumption of traditional factors of production, and at the same time can enhance the efficiency of resource utilization, reduce the cost of environmental resources inputs, to achieve the maximum economic output in the case of the least investment of resources, minimal cost of environmental resources. First of all, enterprise digital transformation to a certain extent to reduce the dependence on traditional factors of production, improve resource utilization efficiency. Digital technology makes information interconnection and sharing, effectively reducing the degree of resource factor mismatch, reducing resource consumption and environmental pollution, and realizing green and efficient production. The digital economy, with data as the key element, is a natural environmentally friendly way of development, and can realize output with less resource input. Under the wave of enterprise digital transformation, the digital economy will force enterprises to carry out green technological innovation, adding vitality to innovation and entrepreneurial activities. The digital economy has spawned a number of new industries, facilitating consumers' access to commodity information and reducing the waste of resources in the process of searching for commodities; the digital economy produces a number of green products with a low-carbon production and management approach, which promotes green consumption and enhances green total factor productivity. In addition, the digital economy promotes collaborative governance and supervision of green development by governments, enterprises, individuals and society. The digital economy can integrate social governance resources to form a unified governance database, and improve the level of ecological environment governance through the pooling of information in technological networks[6]. The government's use of digital technology to efficiently integrate environmental monitoring data and implement precise management measures can, on the one hand, reduce the cost of regulation and management and, on the other, promote green production. The digital media provides the public with more information, opens up new channels for public monitoring, and also creates environmental awareness for the public, deeply implements the new green development concept, promotes environmental protection activities in the whole society, and thus promotes the enhancement of green total factor productivity.

3.2. Environmental Regulation and Green Total Factor Productivity

Resource conservation and environmental protection required by environmental regulations effectively promote China's economy to free itself from resource and environmental constraints and increase green total factor productivity[7]. The implementation of environmental regulatory policies will improve green technological innovation and green total factor productivity, and the specific transmission mechanism is to follow the cost theory, environmental regulatory policies will force enterprises to carry out digital transformation and green technological innovation, improve resource utilization efficiency and reduce pollution emissions. Under the action of the market mechanism, factor resources will also flow from the disadvantaged sectors to the advantageous sectors, thus realizing the optimization of resource allocation and the enhancement of green total factor productivity, which to a certain extent also achieves the purpose of reducing resource consumption and protecting the environment[8]. According to the theory of compensation for innovation, green innovation activities undertaken by firms increase output to compensate for the costs paid as a result of environmental regulations. The increased output of the enterprise continues to support the enterprise's green innovation activities and continuously improves green total factor productivity. The existence

of environmental regulations encourages enterprises to improve their sense of social responsibility and environmental awareness, and also makes them take the initiative to adopt a series of measures to protect the environment in the production process. Environmental regulations urge enterprises to be more proactive in green production, reduce pollution emissions and resource waste, and encourage enterprises to pay more attention to environmental efficiency and improve green total factor productivity.

3.3. The Digital Economy, Environmental Regulation and Green Total Factor Productivity

In the context of the digital economy, in order to meet the requirements of environmental regulation, enterprises will develop and adopt environmentally friendly technologies and equipment, among others. This innovation-driven effect can facilitate the development of the digital economy, promote the integration and application of green innovation activities with digital technologies, deepen the degree of integration between the digital economy and the real economy, and broaden the effect of the digital economy on the enhancement of green total factor productivity of enterprises[9]. The implementation of environmental regulations by the Government can prompt enterprises to reduce waste of resources and pollution emissions and encourage them to utilize resources more efficiently. Through the introduction of digital technology and the use of information management systems to optimize resource allocation, enterprises can improve productivity and economic efficiency and enhance green total factor productivity. Environmental regulation emphasizes the sustainable development of enterprises and requires them to focus on environmental protection and social responsibility in the production process. Compliance with environmental regulations ensures that the development of enterprises is harmonized with environmental protection and promotes the sustainable development of the digital economy[10]. Similarly, environmental regulations are becoming more stringent for enterprises, prompting them to make improvements in environmental protection that can enhance their competitiveness in the marketplace. In order to survive and thrive in a competitive market environment, enterprises need to develop the digital economy to generate a number of new businesses, and to adopt unique production methods to create low-carbon green products to meet environmental requirements and attract consumers, thereby increasing green total factor productivity.

4. Path to Realization

In order to better promote the construction of digital China and ecological civilization, and more effectively promote the green and high-quality development of the economy, this paper puts forward the following realization path based on the above mechanism explanation:

4.1. Vigorous Development of the Digital Economy and Promotion of Synergies between the Digital Economy and Environmental Regulation

Actively promote the construction of digital infrastructure, encourage the digital transformation and upgrading of small and medium-sized enterprises and digital technological innovation, and increase financial investment in the digital economy to support the development and growth of digital enterprises. At the same time, it is necessary to promote the synergistic development of the digital economy and environmental regulation, to promote the integration and promotion of the digital economy and the green economy, to seek synergies between the digital economy and green development, to strengthen the top-level design, to form policy synergies, and to create a digital economy development model with green attributes.

4.2. Maintaining Appropriate Levels of Environmental Regulation, with a Focus on the Implementation of Command-and-control Environmental Regulation

Taking into account the needs of environmental protection and the realities of economic and social development, we should grasp the strength of environmental regulations, strengthen environmental supervision and law enforcement, increase monitoring, inspection and punishment by the relevant departments, and establish a sound monitoring system and information disclosure system to ensure the effective implementation of environmental regulations. The government can set up corresponding incentives and support policies to provide support for green technology research and development and promotion. At the same time, the government should strengthen cooperation with enterprises and scientific research institutions to promote the R&D and transformation of environmentally friendly technologies. This will promote enterprises to develop in a more environmentally friendly and resource-saving direction, realizing a win-win situation for both economic growth and environmental protection.

4.3. Full Realization of the Moderating Role of Environmental Regulation on the Impact of the Digital Economy on Green Total Factor Productivity

The implementation of environmental regulation policies has stimulated technological innovation in enterprises, adapted original digital technologies to production methods required by environmental regulations, and promoted the integration and development of green innovation activities and digital technologies. With the promotion of effective resource utilization as the main goal, enterprises are encouraged to optimize production processes and improve resource utilization efficiency, such as the combination of intelligent systems and the digital economy, to achieve rational allocation and efficient utilization of resources. At the same time, enterprises should establish a sustainable business model, focus on environmental protection and social responsibility, and promote sustainable development with green technological innovation.

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