Research on Transmission Mechanism of Green Development Promoted by Scientific and Technological Innovation

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Abstract: Scientific and technological innovation is indispensable to green development. This paper analyzes the connotation of scientific and technological innovation and green development, the conduction mechanism from three perspectives including production efficiency improvement, industrial structure upgrading and environmental governance and protection. This paper suggests promoting scientific and technological innovation by cultivating high-level innovative talents and increasing financial investment.

***Keywords*:** science and technology innovation, green development, environmental governance and protection

1. Introduction

The past four decades of reform and opening up have witnessed great achievements in China's economic growth, but that comes with many issues unsolved. The traditional development mode consumes large amount of resources and capital investment, which has resulted in severe pollution and resources shortage. This way of economic growth that ignores the ecological environment is not sustainable. In the report of the 19th National Congress, the construction of ecological civilization is incorporated into the overall layout of The Five-sphere Integrated Plan, in which green development has been elevated to a national strategy. China's economy has shifted from high-speed growth to a new stage of high-quality growth. Green development advocates for the balance of economic development and environment protection under the condition of low consumption and carbon emission.

Green development can't be achieved without the drive of science and technology innovation. Wang Yaping (2017) believes that science and technology innovation brings green production for industry and agriculture, optimizes and upgrades industrial structures, and produces green products for green consumption and green life, ultimately realizing green development of production, life and ecology [1]. Tian Hui (2018) argues that innovation has a facilitating effect on the green development of a smart city economy, but there are differences among different innovation drive indicators [2]. Li Guanglong (2020) finds that science and technology innovation has a significant promoting effect on urban green development, and there is a correlation between science and technology innovation and fiscal decentralization. The facilitation on urban green development efficiency gradually decreases with the increase of fiscal decentralization [3]. Abid (2022) explores the dynamic relationship between technological innovation, ISO 14001 and green growth in the context of Pakistan and found that technological innovation is significantly associated with green growth, while ISO 14001 also has a substantial correlation with green growth [4]. This paper is of theoretical and practical significance for research on the impact mechanism of technological innovation on green growth.

2. The connotation of science and technology innovation and green development

2.1 Connotation of science and technology innovation

Science and technology innovation is a combination of two concepts: "science and technology" and "innovation". Science is mainly to reveal the laws of nature or objective matter, while technology refers to the use of science and experience in production practice. The term Innovation was first introduced by Schumpeter in 1912, who believed that innovation was endogenous and arose in the production process. Schumpeter saw innovation in five forms: new products, new methods, new markets, new sources of factors, and new organizational structures. Since Schumpeter proposed the term Innovation, many scholars have expanded and extended it from different perspectives. In 1987, Freeman proposed the National Innovation System, which should include four factors, namely government policies, enterprise R&D, education and training, and industrial structures. Regional characteristics are highlighted in the process of world economic development, and the attention on regional science and technology innovation is increasing.

With the development of society, the connotation of science and technology innovation is in continuous extension, so as its understanding. From the micro perspective, it can be understood as the redistribution of resources and the adoption of new raw materials, processes and production methods; from the meso perspective, it can be understood as the redistribution of resources and re-optimization of division of labor in industries; from the macro perspective, it refers to regional science and technology innovation development. Regional science and technology innovation capability means the ability to continuously transform scientific and technological knowledge into new products, new processes and new services.

2.2 Connotation of green development

Green Development is derived from the concepts of green economy and sustainable development. Green economy was proposed by David Pearce in the 1990s, who believed that the integration of economic development with green development is a way to solve the contradiction between economic growth and environmental protection. According to UNEP (2011), green economy refers to a model of economic development that enhances human well-being and social equity while significantly reducing environmental risks and ecological scarcity. The concept of sustainable development first appeared in the 1980 IUCN World Conservation Strategy. The most widely accepted definition of sustainable development is that in the book Our Common Future by the World Commission on Environment and Development, in which sustainable development is defined as development that meets the needs of the present without compromising future generations to meet their needs.

Green development can be understood from three aspects: first, green development is the pursuit of an environmentally friendly and low-carbon development approach under the constraint of resource and energy limit, and thus achieving the coordinated development of environmental protection and economic growth (Ehresman et al., 2015; Wang, Haiqin et al., 2016); second, green development emphasizes green innovation as a new economic driver, thus coordinating comprehensive and sustainable development of economic systems, social systems, and ecosystems (Qin Shusheng et al., 2015; Wu Xiaoxia et al., 2017); third, green development is a resource-saving, environmentally sustainable and friendly, and socially inclusive economic development model.

3. The Conduction Mechanism of Science and Technology Innovation on Green Development

3.1 Scientific and technological innovation enhances production efficiency

Scientific and technological innovation enhances production efficiency through improving factor resources productivity, reducing production costs and expanding production scale, thus promoting green development.

Scientific and technological innovation is conducive to the implementation of circular economy and increases productivity of factor resources. The 14th Five-Year Plan proposes to "comprehensively implement the concept of circular economy and build a multi-level resource efficient recycling system". The circular economy emphasizes that economic activities should form a feedback loop of "resources-products-renewed resources", so that all materials and resources can be used more sustainably in the cycle. The production process of metallurgy and chemical industry emits relatively more exhaust gas, while science and technology innovation has brought new blowing gas recovery device, which can directly recover the original smoke and dust into the combustion furnace, and use it to generate electricity, eliminating pollution while saving coal, which is conducive to green development.

Science and technology innovation can bring effective cost reduction, which is only a business procurement strategy. Reducing production costs is the real need for business development and helps companies improve operational efficiency. The cost reduction achieved through scientific and technological innovation can bring long-lasting competitive edge. In terms of paints, with the upgrading of science and technology, water-soluble paints have gradually replaced solvent-based paints. Water-soluble paints use pure water as the carrier with a lower cost than traditional solvent-based paints but won't volatilize a large number of harmful organic compounds, bringing greater advantage in reducing pollution and promoting environmental protection.

Science and technology innovation helps firms to increase capital and labor productivity, which will lead to further expansion of scale and reduction of cost per unit of product. Generally, in the early stage of innovation, an enterprise needs huge amounts of capital for research and development, which is also the cost of future products. With the commissioning and production continues, the enterprise will expand the scale of production, covering the initial cost. And a unit of product of will consume relatively fewer resources, thus the production costs are subsequently reduced, increasing returns for the enterprise. China is the first country in the world to successfully develop and promote hybrid rice, which is known as the second green revolution. Hybrid rice effectively enhances land yield, and it has been planted and promoted on a large scale, which facilitates the utilization of land assets, thus saving resources and promoting green development.

3.2 Science and technology innovation promotes industrial structure upgrade

Scientific and technological innovation will optimize the traditional industrial products and technical equipment, realize the internal structure upgrade, and also promote the development of emerging industries, bringing the overall upgrade of industrial structure. With the optimization of industrial structure, the economic development mode is no longer extensive, which promotes green development.

Traditional industries can only be given a new life by relying on technological innovation to optimize techniques, production processes, products portfolio, industrial management and chains, promoting traditional industries to the middle and high end, and achieving energy saving and emission reduction. The logistics industry is one of the traditional industries, and it has been given a new life through the introduction of robotics and other innovative technologies. Robotization differs from automation in that robots can communicate and cooperate with people to better integrate into work scenarios. The maturity of robotics and its decreasing costs have led to the widespread use of robots in the logistics industry to improve its efficiency by reducing handling and loading costs. Coal has been an important energy industry. The 14th Five-Year Plan proposes to promote the clean and efficient use of coal and other fossil energy. During the 13th Five-Year Plan period, the coal industry's scientific and technological innovation capabilities have increased significantly, but there were still shortcomings in intelligent mining, low ecological damage mining, safe mining, which remain to be improved. If these problems can be solved, the coal industry can achieve high-end, digital, low-carbon industrial transformation, which is conducive to green development.

Emerging industries are the results of commercialization of major scientific and technological innovation achievements. Scientific and technological innovation can promote the development and growth of emerging industries, contributing to an increasing proportion of emerging industries in the economy and the upgrading of industrial structure. The strategic emerging industries released by the China Bureau of Statistics include the new generation information technology, high-end equipment manufacturing, new materials industry, biological industry, new energy automobile industry, new energy industry, energy conservation and environmental protection industry, digital creative industry, and related service industry, a total of nine fields. The United States, on the other hand, has indicated that it will focus its layout on artificial intelligence, new generation information technology, intelligent hardware, biological (medical) technology, space development and other directions.

3.3 Science and technology innovation helps environmental governance and protection

Science and technology innovation can contribute to green products, technology, equipment and energy, improve resource production efficiency, promote the development and growth of environmental protection technology industry, and help environmental governance and protection, thus promoting green development.

Green technology refers to the technology, process and products that follow ecological principles and ecological economic laws, save resources and energy, and eliminate or reduce ecological pollution management in general. While green technology innovation refers to the management and technology innovation with the goal of protecting the environment. The use of fuel cars consumes a large amount of petroleum resources, while causing serious environmental pollution in urban and rural areas. The transportation sector accounts for twenty-five percent of global carbon emissions, and its energy consumption accounts for nearly one-third of global energy consumption. Electric vehicles have zero exhaust gas emission and consume much less energy, which shows that green technology innovation has contributed to environmental protection and low-carbon travel.

The ecological environment is the basis for human survival and development, and it is very important to make the ecological environment healthy and sustainable. Countries globally value environmental protection and sustainable development. They have introduced relevant policies to increase investment funds of environmental science and technology innovation, so the environmental protection technology industry continues to develop and prosper. Photovoltaic power generation is a technology of converting solar energy into electricity, which is clean, safe and renewable energy. In 2022, China released the Intelligent Photovoltaic Industry Innovation and Development Action Plan (2021-2025), hoping to promote the deeper integration of photovoltaic industry and a new generation of information technology, to further improve the quality and efficiency of China's photovoltaic industry development. The photovoltaic industry will surely continue to grow.

Scientific and technological innovation can reduce resource consumption and emissions at source, and switch from traditional terminal environmental governance to clean production. The obvious energy saving and emission reduction promotes green development. With the accelerated development of information technology, paperless office has been promoted. Software could enable electronic signature. Paperless office reduces the expenditure of paper, stapler, printing and other costs, saving resources.

4. Countermeasure suggestions

Science and technology innovation can effectively promote green development. The source of scientific and technological innovation lies in people, and talents are the first factor resource. To achieve a high level of scientific and technological innovation, the country needs to cultivate high level of innovative talents. Scientific and technological innovation also needs financial support. The initial investment of scientific and technological innovation is relatively large and risky, and the demand for funds is also relatively high, so it is necessary to give full play to the demonstration role of green finance and government investment, so that more funds can be invested in scientific and technological innovation.

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