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The impact of knowledge trade on sustainable development and environment-biased technical progress

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ABSTRACT

This paper proposed a theoretical model of knowledge trade based on the new economic growth theory and investigated the impact of knowledge trade on sustainable development. The MSIH-VAR model was used to test the impact of three forms of knowledge trade (direct introduction of technology, technological spillovers of foreign direct investment (FDI), and reverse deconstruction of imported products) on sustainable development, production technology, and environmental technology. The impulse response equation indicates that developing countries can only improve their environmental technology levels through the direct introduction of technology. To prove the impact of knowledge trade on sustainable development, the interaction term of environmental technology and knowledge trade was included in the analysis to obtain a dynamic panel model. The research results indicate that knowledge trade in the form of both direct introduction of technology and reverse deconstruction of imported products can improve sustainable development locally. Below a certain level of environmental technology, knowledge trade has a positive impact on sustainable development, irrespective of its form.

1. Introduction

Economic growth and environmental protection have always been at the center of scholars' attention. In recent years, sustainable development has become a fundamental policy for the Chinese government. With the deepening of economic integration and globalization, an increasing number of scholars have focused on the impact of trade on sustainable development. Environmental problems have presented a significant obstacle to China's economic growth after its inclusion in the WTO, and people are pushing for greater coordination between environmental issues and the economy. In December 2014, the State Council published an energy development strategic plan in which it was stated that an "economized, clean, and safe" strategy should be introduced. In addition, a mechanism to control the total energy consumption was set up, creating an excellent energy consumption system and the structure to achieve a well-organized modern energy market by 2020. Technical innovation for realizing leap-type technical progress is the fundamental solution for achieving green and low-carbon development in China. Technical progress is also the key driving force of stable energy saving and emission reduction. Researchers have come to consider technical progress as an endogenous factor and acknowledge its bias, which reveals a hidden feature of the direction of technical progress. Acemoglu (2003, 2007) and Acemoglu et al. (2012a, b) have made great contributions to the development of theories on biased technical progress and defined environment-biased technical progress as progress that stimulates energy saving and emission reduction.

Copeland and Taylor (1994) suggested that, if pollution levels in developing countries decline along with economic growth, only environment-biased technical progress can be generated. The occurrence of such progress results from people's high demand for environmental quality, which tends to increase with income (Grossman and Krueger, 1991) and restrictions introduced by developed countries on the carbon content of products exported by China (Song and Wang, 2013). Cao and Wang (2017) also tested the influence of international trade on environment-biased technical progress. They argued that importing products from developed countries promotes environment-biased technical progress, while importing them from developing countries reduces it. In addition, they demonstrated that exports reduce domestic environment-biased technical progress in all cases, irrespective of the destination country. Therefore, there seems to be no agreement on the influence of trade on environment-biased technical progress.

In this paper, we argue that the fundamental limit in the previous

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analyses of the relationship between trade, technical progress, and sustainable development is that knowledge trade and biased technical progress have not yet been independently analyzed. Knowledge trade refers to the sum of scientific and rational exchange activities conducted through all kinds of intellectual resources, such as information, innovative talents, and electronic network equipment. Trade has several dimensions: from the labor force trade of "labor force resource occupation and allocation" (Ricardian Model) to the merchandise trade of "natural resource occupation and allocation" (H-O model), and finally, the knowledge trade of "intellectual resource occupation and allocation." The constant decline of traditional natural resources has increased costs year after year, while labor productivity has decreased. Profit shrinkage and per capita income reduction have caused disappointing market performance and economic recession. However, knowledge trade has produced a significant impact on traditional trade over the years. Since the 18th National Congress of the Communist Party in 2012, China has paid increasing attention to scientific innovation, which considered as the core of national development.

In this paper, we tried to disentangle knowledge trade from other trade activities. To this end, we introduced a knowledge trade equation to analyze its influence on environment-biased technical progress and sustainable development. This approach aims to fill the gap in the new growth theory and enhance the theory's explanatory power to some extent. The remainder of this paper is organized as follows. The second section reviews the existing literature. The third section introduces the theoretical model. The fourth section describes the empirical analysis, and the final section provides our concluding remarks.

2. Literature review

Through an internationalized labor division, market expansion, technical diffusion, and progress, trade can make abundant materials and multiple merchandises available to domestic residents. However, trade is often related to environmental pollution. Thus, the host country should devote substantial economic resources to environmental governance, which will significantly affect the speed of its economic growth (Chen and Hung, 2016). Rodriguez and Rodrik (2000) verified the research of Edwards (1998) and found that trade openness and economic growth are not always positively related. The robustness of their regression results depends on the selection of trade openness indexes and the empirical analysis method. For instance, Harrison and Hanson (1999) argued that the research results of Sachs and Warner (1995) lack robustness. Henry et al. (2012) tried to explain the relationship between trade and the non-linear growth of the economy from the viewpoint of trade barriers. Wang and Song (2017) explained the relationship between trade and the economy from the perspective of technical progress. However, the results are not satisfactory, and there is still no conclusive evidence on the relationship between trade and economic growth. Nowadays, environmental protection is at the center of attention. Therefore, in this paper, we focus on whether trade can stimulate economic growth while preserving environmental quality.

Technical progress is a driving force for both environmental protection and economic growth. Thus, many scholars have focused on improving technical progress. However, due to the variety of indexes used to measure technical progress, the existing research has not reach consistent conclusions. After Acemoglu had introduced the concept of environment-biased technical progress, researchers proposed several ways to measure it. Many scholars adopted the Luenberger productivity index (Chambers et al., 1996), Malmquist-Luenberger (ML) productivity index (Chung et al., 1997), and Sequential Malmquist-Luenberger (SML) index (Donghyun and Almas, 2010), among others. Lovell (2003) divided the Malmquist index into a technical change (TECH) and an efficiency change (EFFCH) component, and then, further divided TECH into: a MATECH index to measure the neutral technical progress; an OBTECH index to measure the beneficial effects of technical progress on output; and an IBTECH index, which measures the bias of technical progress. This methodology can only qualitatively evaluate the direction of biased technical progress through the "rotation" and "radial deviation" of the production frontier and allows the measurement of only two input factors. However, quantitative measurement and environment-biased technical progress with multiple inputs and outputs cannot be addressed. Fujii and Manage (2016) tried to decompose and measure environmental technology, but failed to make a breakthrough in the measurement method used, as their measurement was still based on total factor productivity.

Most research on knowledge trade focused on human resources. For example, Lall et al. (2006), Rodrik (2006), and Hausmann et al. (2007) argued that technical progress is significantly and positively related to human resources and per capita GDP. Santos-Paulino (2008), using data on the BRICs, demonstrated that technical progress and the improvement of production efficiency in these countries depend on their endowment of fundamental resources, such as human resources, income levels, and overall economic condition of the country. Weldemicael (2012) also confirmed the above conclusion. Scott (2008) pointed out that China's technical level is still low, even though its structure of exported merchandises is close to that of OECD countries, and the country should promote higher complexity in human resources and exported technologies. Foreign trade challenged China's high-tech industries, leading to a decreasing demand for high-skilled labor and relative remuneration. These changes do not favor human capital investment (Falvey et al., 2010; Long et al., 2007). However, human resources can improve the complexity of exported technologies and are an essential component of knowledge trade.

Li et al. (2017) point out that China is going through a decline in human capital dividend. Though it has a large population, most laborers are engaged in low-wage and low-skill work. However, as post-2010, the world is moving toward a high-wage, high-skill, and innovation-based economy; China needs to expand its undergraduate college education, and at the same time, cultivate special skills among its human capital, through which the problem of a shortage of skilled human capital in China can be solved. One way of addressing the shortage of human capital that has not been mentioned by Li et al. (2017) is hiring human capital from developed countries.

Kianto et al. (2017) point out that reasonable knowledge-based human resources will optimize enterprise structures and business patterns, but they do not discuss knowledge trade in depth. Perhaps most discussions on human capital are still centered on human capital within a country or enterprise, and research on transnational flow of human capital is rare. From a study of the aforementioned literature, we know that scholars have so far looked only within a nation or enterprise when trying to find solutions to the problem of human capital shortage, and have ignored transnational flow of human capital. This study also tries to address this gap.

This paper analyzed knowledge trade individually and, based on relevant theories of environment-biased technical progress and sustainable development, argues that knowledge trade can stimulate environment-biased technical progress and sustainable development. In addition, this paper tries to prove that developing countries can also benefit from knowledge trade activities, but may not be able to catch up with developed countries through foreign trade. We addressed the modeling deficiency of the new growth model in the following ways: (1) the theory boundary of the new growth model was expanded by combining environmental factors and economic factors; (2) the production department and R&D department were strictly separated and the objective of production R&D was clarified to be the increase the output of the product production department; (3) knowledge trade was introduced into the model, which, was able to fill to some extent the gap in the modeling of trade in the new growth model.