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Promoting energy and environmental efficiency within a positive feedback loop: Insights from global value chain

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ABSTRACT

Promoting energy and environmental efficiency is widely believed to be one of central issues in China's sustainable development. After entering into World Trade Organization in 2001, China has accelerated to become an extroverted economy through international openness. In the global specialization, a Global Value Chain (GVC) has been formed across economies. China has become an active player in this regard but stood in low value-added positions, which has been called "the world's factory". Manufacturing products for the whole world leads to the explosive growth of China's energy consumption and CO_2 emissions after 2003, but enterprises can also learn from developed countries due to diffusion of technology and managerial experience. By far, the precise role of China's moving-up GVC in its energy and environmental efficiency is still unknown. This paper conducts an empirical analysis on this issue by measuring the position of China's industries in GVC and their energy and environmental efficiency as well, and then setting up mixed simultaneous equations containing a Tobit model. The results show a positive feedback loop between GVC positions and energy and environmental efficiency. We further find rise in GVC positions accounts for 35% of energy and environmental efficiency improvement over the sample period.

1. Introduction

1.1. Background

Since the reform and opening up in 1978, the Chinese economy has grown rapidly and dramatically. Nevertheless, that remarkable growth might have been heavily dependent on resource use and pollutant emissions (Li and Lin, 2017a). According to BP (2016), China has overtaken the U.S. as the largest energy consumer and carbon dioxide (CO_2) emitter globally in the past decade. Furthermore, China is currently undergoing industrialization and urbanization, which require large increments of energy consumption and CO_2 emissions (Yang et al., 2017). The global call for energy conservation and emission mitigation along with the national concern for energy security compels China to properly accelerate its transformation to a more green economy by addressing its energy over-consumption and CO_2 over-emission. Therefore, China must decouple its economic growth from its excessive energy use and pollutant emissions (Lin and Liu, 2016). This situation indicates that improving energy and environmental efficiency is an essential pathway to simultaneously achieve the targets of economic growth, energy conservation, and emission mitigation.

Economic globalization over the last two decades considerably altered the patterns of international specialization and growth strategy (Kee and Tang, 2016; Sun et al., 2018). Production specialization and division worldwide are developing extensively because of the ongoing integration of the global economy and the fragmentation of production process. The proportion of intermediate goods in international trade has continuously improved, with an expanding vertical trade chain across countries or regions. Production process is divided into several stages, and different manufacturing stages occur in diverse economies depending on their comparative advantage. These specializations are linked through international trade and outsourcing. Global production has been reconstructed, with the traditional “national manufacturing” transformed into the new “global manufacturing”. Consequently, a global value chain (GVC) across economies exists for the production of a single product. Substantial variations occur in terms of resources and profit gains for countries occupying different positions in the GVC. Specifically, countries with advantages in capital and technology usually occupy high value-added positions. These countries are responsible for research and development (R&D), brand design, and high-

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tech intermediate production, all of which are high value-added, low energy and carbon intensive activities. By contrast, countries standing in low value-added positions usually undertake the processing and assembling stages, which require more energy consumption and CO_2 emissions. China has become an active participant in this regard, and is touted as “the world's factory”. This standing promotes the economic growth of China. However, such designation also indicates that China belongs to countries standing in low value-added positions. This situation raises the issue of evaluating whether this division pattern exerts harmful impacts on China's energy and environmental efficiency, which are crucial for achieving sustainable development amid globalization.

The Chinese government constantly emphasizes the extreme importance of economic development. Given resource depletion and environmental degradation, the focus of economic development has shifted into quality, rather than merely quantity. In recent years, the Chinese government began active structural adjustments, such as promoting the “Industrial 4.0″ strategy, enhancing the intelligence level of manufacturing, and reducing the share of China in low value-added production.[1] Such approach might help promote the China's transformation into a sustainable development mode by rising GVC positions.

In general, rising GVC positions can promote energy and environmental efficiency due to several channels. First, participating in GVC helps for achieving economy of scale by expanding the exports (Feder, 1983), which has been stressed by previous literature as a source of productivity growth (Biesebroeck, 2005; Li and Lin, 2017a). Second, participating in GVC also encourages importing immediate goods which are usually the main carriers of technology diffusion (Frankel and Romer, 1999; Sharma and Mishra, 2015). The third one is spillover of technological progress and managerial experiences. GVC indicates global manufacturing for a single product. As pointed out by Ivarsson and Alvstam (2010), transnational corporations would contribute to the transfer of knowledge in general and technology in particular to the partners in host countries. The first channel is scale effect, while the second and third channels are GVC induced technique effect. Both of them imply an improvement in energy and environmental efficiency.

China's move-up in the GVC leads to the relocation of dirty-good production (including offshoring of production) from China to other countries, such as Southeast Asian and African countries. A corollary is that energy consumption and pollutant emissions may rise in these countries, and thus the relocation of production only implies geographic transferring of energy consumption and pollutant emissions. As indicated by the pioneering work by Antweiler et al. (2001), it is not necessary the case. First, the scale effect and the GVC induced technology progress imply a net reduction of energy consumption and pollutant emissions from all countries. Second, even if relocation of production creates the concentrations in energy consumption and pollutant emissions in countries which undertake dirty-good production,[2] the net impacts for such countries are ambiguous at most, and the overall energy consumption and pollutant emissions in global scale could also benefit from the relocation of production due to scale effect and GVC induced technique effect. An excellent review on related issues can be seen in Copeland and Taylor (2004). Therefore, in the context of global sustainability, the world as a whole may benefit from such transferring, and then promote energy and environmental efficiency as well. Of course, in terms of energy and environmental efficiency, countries that move-up in the GVC would gain larger benefits from international specialization and global production fragmentation.

Of particular interest is that energy and environmental efficiency might also affect GVC positions in reverse, thus forming a feedback loop. The countries with higher energy and environmental efficiency can produce products with less energy inputs and less pollutant emissions, indicating higher green total-factor productivity (Chen and Golley, 2014; Li and Lin, 2017a). Such countries would be more competitive in the global specialization, especially considering green barriers in the international trade (Costantini and Mazzanti, 2012). In this case, the improvement of energy and environmental efficiency enables firms to relocate the low-value-added parts of the production process to another country, and then focus on the production of high-value-added parts. Hence, the energy and environmental efficiency might positively contribute to the rising of GVC positions. China is undergoing a substantial improvement in energy and environmental efficiency in recent years (Lin and Du, 2015; Li and Lin, 2017b), and the positive feedback loop between energy and environmental efficiency and GVC positions indicates that globalization provides a sustainable pathway for China to achieve economic growth, resource conservation as well as environmental protection simultaneously.

Yet the empirical evidence on the effects of rising GVC positions on sustainable development is scant. In this paper we estimate the interactions between GVC positions and energy and environmental efficiency in China. Raw trade data disclose the actual connection between China and its trading partners. Thus, we first measure the global production line position of China in the GVC across time; and then, we would explore how the evolution of China's GVC position interacts with energy and environmental efficiency, especially considering the aforementioned positive feedback loop.

1.2. Literature review

The GVC denotes a global network organization connecting the production procedure from the original creative design to final consumption among the participating countries (regions) to realize the commercial value of goods and services (Gereffi, 2001). Under globalization, the international specialization dominated by multinational companies evolved from an intra-industry to an intra-product system. Production processes are increasingly divided into several tasks and activities scheduled to different economies based on the optimal principle. The traditional practice to trade in goods or services also changed into trade in tasks. The GVC became the new normal of globalization and specialization (Baldwin and Lopez-Gonzalez, 2015).

In the literature, the conceptual framework for GVC specialization began with theoretical and empirical studies on the trade in intermediate goods since the 1960s (Vanek, 1963; Ethier, 1982; Helpman, 1984). UNCTAD (2013) shows that approximately 60% of global trade entails intermediate goods and services. Therefore, analyzing the international trade of such goods and services is the first step in examining GVC. However, with the extension of GVC, data on trade flows would encounter the double counting problem, which distorts the gains obtained by participating countries through trading (Hummels et al., 2001; Koopman et al., 2010, 2014; Benedetto, 2012). Hence, such data cannot measure the production position in GVC. To solve this problem, previous studies have proposed new statistical standards and methods. Among them, the trade in value-added (TiVA) standard based on the world input-output tables (WIOTs) is increasingly adopted by countries and international organizations (OECD-WTO, 2012; UNCTAD, 2013), and it has been widely used for evaluating trade-related policies.

Hummels et al. (2001) propose vertical specialization theory, indicating that vertical trade is caused by the rising fragmentation of global production. They divide the intermediate imports of a country into two parts according to the non-competitive input-output table; they are imports for domestic production of final (general trade) and exporting goods (processing trade). They then use the ratio of the exported intermediate imports to the gross exports as an indicator for measuring the level of vertical specialization and analyzing the competitiveness of a certain country in the GVC. This method (HIY for short) became the footstone for studying position in GVC specialization

[1] China's general trade exports increased from 720.6 billion dollars in 2010 to 1.2173 trillion dollars in 2015, while the ratio of processing trade to general trade is decreased from 1.03 to 0.66. Relevant discussion can be seen in Kee and Tang (2016).

[2] This is called composition effect in Antweiler et al. (2001).

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