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Toward to economic growth without emission growth: The role of urbanization and industrialization in China and India

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A B S T R A C T

The contradiction between economic growth and carbon emissions in China and India is the most prominent in the world. Both countries have faced tremendous pressures to curb carbon emissions, because they are major source of new added emission sources. Meanwhile, both countries have faced greater pressures to achieve industrialization and urbanization in order to eradicate poverty. Better understanding the decoupling status and its drivers can serve to develop effective policy to achieve economic growth without an increase in emission. This paper comparatively analyses the decoupling effect of the economic growth from the carbon emissions as well as its drivers during the period 1980–2014 in China and India. The Tapio decoupling model was used to analyze the decoupling status, and the co-integration theory and the impulse response functions were applied to investigate the effects of urbanization, industrialization, per capita GDP and carbon emission intensity to decoupling. The results show that China mainly performed a weak decoupling of economic growth from carbon emissions in 1980–2014, while the decoupling status of India was no regular. In China, carbon emission intensity is the biggest contributor of decoupling, followed by urbanization, per capita GDP, and industrialization. In India, the biggest driver of decoupling is also the carbon emission intensity, followed by urbanization, industrialization, and per capita GDP. Therefore, improving energy efficiency is the best policy to toward economic growth without emission growth in China and India.

1. Introduction

Nowadays, the climate change caused by excessive emissions of greenhouse gases (GHG) has received widespread attention from the international community and has become one of the major environmental threats to human survival (Hattermann et al., 2017; Cheal et al., 2017; Pauw et al., 2018). Evidence suggests that a majority of the extra CO_2 emissions come from China and India (Ahmad et al., 2016; Patra, 2017; Wang and Li, 2016). As the leading developing country, China and India have been making efforts to expand the economy, aiming to raise the national income level and achieving the goal of getting out of poverty. According to statistics, by the end of 2016, there are approximately 62.04 million people living in poverty in China, while the poor population in India is about 400 million people. In the face of more and more serious global warming, countries are struggling to take action to suppress the excessive growth of carbon emissions, which results in a contradiction between carbon emissions and economic growth. In accordance with the EKC theory (Danish et al., 2017; Ulucak and Bilgili, 2018), the economic development grows in step with the CO_2 emissions during the early stage of rapid economic development.

Thereupon, for the sake of resolving the conflict between the CO_2 emissions and economic growth and achieving an ideal state of strong decoupling of economic development from carbon emissions, it is essential to better understand the correlation between the two. For that reason, the objective of this paper is to research the decoupling development trend of economic growth from carbon emissions in China and India over the past 3 decades. Further, this paper estimates the driving factors of decoupling and provides sound scientific basis for China and India to coordinate their development.

The remainder of the paper is organized as follows: Section 2 reviews and summarizes the relevant literature. Section 3 briefly describes the data source and the model specification. Section 4 expounds the empirical results and discussion. Finally, the last

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section is a summary based on the foregoing.

2. Literature review

Recently, a lot of studies on decoupling between economic growth and carbon emissions came to the fore (Al-Mulali and Ozturk, 2015; Liu et al., 2017; Wang et al., 2018a; Wang et al., 2018c), due to the intensification of global warming problem. Taken together, these studies produced different outcomes. For example, Jorgenson and Clark (2012) used the panel data in multiple countries to investigate the relationship between economic development and CO_2 emissions; Liang et al. (2014)revealed potential economic drivers and decoupling development during 1992–2010 in China, concluding that the economic growth is relatively decoupled from carbon emissions, rather than absolute decoupling. Lu et al. (2015)selected Jiangsu Province of China as the research object and estimated the decoupling between economic activity level and carbon emissions from the perspective of the industrial sector. The main conclusions are that the industrial sector maintained a weak decoupling status in recent years. Using a panel data model, Xu and Lin (2017) conducted a regional analysis of carbon emissions from the manufacturing industry in China. The research shows that there are significant regional differences in the contribution of energy efficiency, industrialization, economic growth, urbanization and energy structure to carbon emissions. Chen et al. (2016) regarded per capita GDP as an independent variable and carbon emissions as a dependent variable to study the one-way Granger causality between the two. Similarly, Ozturk and Acaravci (2013)investigated decoupling between GDP and CO_2 emissions in Turkey based on the same assumption.

Additionally, there are several studies applying the decomposition analysis to explore the drivers of CO_2 emissions. The methods widely used in decomposition analysis in academia mainly refer to the structural decomposition analysis (SDA), the index decomposition analysis (IDA), and the logarithmic mean Divisia index (LMDI) approach. Shahbaz et al. (2016) considered the impact of urbanization on carbon emissions in the light of the EKC hypothesis testing the impact of CO_2 emissions in Malaysia. Zhao et al. (2017) used the generalized log-average Divisia index (GLMDI) method to examine the role of carbon and industrial structure in mitigating CO_2 emissions of the industrial sector in the U.S., and found that they are the main drivers of carbon emissions growth in the industrial sector. Li et al. (2012) divided 30 provinces of China into five different emission areas and analyzed the effects of economic growth, industrialization, urbanization, and technological levels on carbon emissions from 1990 to 2010. The results revealed that the drivers of carbon emissions in different regions are not the same. In most of the discharge areas, the impact of urbanization and economic growth on carbon emissions is even more pronounced. Zhang and Da (2015) introduced the LMDI method into the decoupling indicator model and studied the factors affecting the decoupling of China in 1996–2010. The results showed that energy intensity and final energy consumption structure are conducive to the decoupling of economic growth from carbon emissions. Zhao et al. (2017) applied the same method to decompose the driving forces of decoupling of economic growth and CO_2 emissions from the five major economic sectors in China into several factors, so as to estimate the contribution of each factor to the overall economic decoupling. They found that energy intensity and economic activity level were the most important factors affecting China's decoupling over the past 1992–2012. Sun et al. (2017) believed that energy intensity, economic growth, and power intensity are the primary determinants affecting carbon emissions, by means of researching the drivers of carbon emissions in the power industry of China through the Laspeyres decomposition model. Yu et al. (2013) employed the IDA approach to study the dynamic impacts of six major pollutants in China on decoupling. However, this study only conducted qualitative analysis without quantifying the influence degree of each factor. Zhang et al. (2009) conducted a survey on energy-related CO_2 emissions in China's four industries from 1991 to 2006 through the Laspeyres decomposition method and found that the economic development hindered CO_2 emission reduction in all industries during this period.

To sum up, decoupling analysis is an effective way to investigate the balance between carbon emissions and economic growth. This paper attempts to explore the dynamic impact of urbanization and industrialization processes on carbon emissions and decoupling development in China and India, trying to fill in the following gaps: 1) There is a lack of long-period research in the existing relevant literature. As the most popular method in the study of decoupling, the LMDI method is mostly used to study the driving factors of changes of the inter-annual decoupling state, and pays little attention to the long period. 2) Subject to the constraint of the index decomposition methods, the LMDI method and other IDA methods are unable to decompose urbanization, industrialization and other indicators, which leads to few studies on the effects of urbanization and industrialization on the decoupling state. This paper combines the decoupling model with the co-integration theory and variance decomposition method to capture the influences of industrialization, urbanization, carbon emission intensity, and per capita GDP on carbon emissions and estimate their contributions to decoupling. 3) In the above literature, a country or region tend to be served as a single research object to explore the driving force of carbon emissions. This article systematically compares and studies the decoupling of China and India, which are the two largest developing countries with huge increment in carbon emissions. In another aspect, the results of this study can provide useful information for other countries to decrease the carbon emissions without compromising the economic development.

3. Economic methodology and data

3.1. Decoupling model specification

In nearly ten years, the decoupling analysis has become a hot topic in the field of energy resources and environment, which is usually applied to investigate the relationship between economic growth and GHG emissions, or rather, the correlation between GDP and CO_2 emissions. Initially, decoupling is defined as the weakening or disappearance of the relation between two or more physical quantities, while in this paper, decoupling is used to measure whether there is a continuous dependency between economic growth and carbon emissions. There are mainly three decoupling measure methods widely used in the academic, namely the decoupling index model proposed by the OECD organization, the decoupling elasticity coefficient method proposed by Tapio, and the decoupling evaluation method in the light of the IPAT equation.

In comparison, the OECD decoupling model focuses on the process of analyzing overall continuous change by describing the linkage between environmental pressure and economic growth (Brännlund et al., 2007). However, the evaluation results of this method are greatly affected by the selection of the base year. When choosing different base years, the evaluation results are quite different. In addition, the OECD decoupling model is prone to the measurement error, because there are no clear criteria for selecting the appropriate factors to analyze decoupling effects. To overcome these disadvantages, the Tapio decoupling model puts particular emphasis on the analysis of differences in changes between years and combining the total change indicators with the relative change index, in order to make the outcomes more rigorous and help to