Environmental Impact Assessment Review 71 (2018) 60–69

Contents lists available at ScienceDirect

Environmental Impact Assessment Review

journal homepage: www.elsevier.com/locate/eiar

Decoupling relationship between economic output and carbon emission in the Chinese construction industry

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ARTICLE INFO

Keywords:
Carbon emission
Construction industry
Decoupling analysis
LMDI model
Sustainable development
China

ABSTRACT

By positioning in the discourse that economic output is always coupled with natural resource depletion, pollution, and carbon emission, decoupling analysis is widely adopted to evaluate how "quality" economic growth can lead to fewer such downsides so as to encourage sustainable development. This paper aims at examining the decoupling relationship between economic output and carbon emission by focusing on China's construction industry, which is a pillar industry for national economic growth, meanwhile contributes a huge amount of carbon emission. The method of Tapio decoupling model is used to examine the decoupling relationships at both national and provincial levels from 2005 to 2015. It continues to identify the driving force leading to a certain decoupling state by adopting the logarithmic mean Divisia index (LMDI). Results show that: (1) there existed an expansive decoupling relationship between economic growth and construction carbon emission in most provinces of China during 2005–2015; (2) Shanghai presented the best decoupling performance, while in contrast, other provinces such as Guizhou and Fujian displayed expansive negative decoupling state; and (3) "Economic output" played the most significant role in inhibiting the decoupling at both national and provincial levels, while "Indirect carbon intensity" was the main driver for promoting the national decoupling. Although the paper refers to the specific construction of China, the decoupling analysis approach can be extended to other countries as well as to other pollutants such as land pollution, waste water and haze. The understanding of driving forces for the decoupling state in China's construction industry provides international policy-makers with valuable reference for formulating effective measures to balance the dilemma between economic output and carbon emission.

1. Introduction

Probably no industry offers as many dilemmas as construction sustainability (Lu et al., 2015). On the one hand, construction products influence human health, economic activities, social behavior as well as cultural identity and civic pride (Pearce, 2003). It is a hugely important industry in scope and scale by contributing significantly to the national economy and providing job positions (Flanagan and Jewell, 2014). On the other hand, construction also has many downsides such as natural resource depletion, pollution, greenhouse gas emissions and human-induced global warming (Li et al., 2017; Lu and Tam, 2013; Lu et al., 2017). Particularly, industry-wise, construction is the second largest carbon emitter which accounts for roughly 33% of global carbon emission. As climate change driven by carbon emission has become a serious issue throughout the world, construction is facing immense pressure to mitigate its carbon emission (Feng et al., 2016; Ürge-Vorsatz and Novikova, 2008; Zhang and Wang, 2016). The Intergovernmental Panel on Climate Change (IPCC, 2007) further predicted that the global construction sector is expected to reduce 6 billion tons of carbon emission per year by 2030, being the most potential sector for carbon emission reduction. Evidently, the pursuit of "quality" economic growth through low carbon construction is of strategic essence to relieve the impact of global climate change.

Country-wise, China is the largest carbon emitter in the world which accounts for one-quarter of global carbon emission (Ma et al., 2017; Xu and Lin, 2017). Construction is the "pillar" industry of China's national economy by contributing around 7% of the gross domestic product (GDP) and providing more than 30 million job positions (NBSC, 2015).

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https://doi.org/10.1016/j.eiar.2018.04.001
Received 3 January 2018; Received in revised form 7 March 2018; Accepted 4 April 2018

However, this economic growth depended predominantly on excessive energy resource and materials consumption, leading to burgeoning growth of construction carbon emission, which accounts for 25% of China's total amount (Chang et al., 2010; Zhao et al., 2016b), its "quality" is thus fairly low. More seriously, the proportion is projected to continually grow in tandem with the rapid development of China's economy and urbanization, which accompany with an excessively large number of construction projects (Wu et al., 2016; Zhang and Wang, 2015), if nothing is done now.

Carbon emission from the construction industry should be strictly and effeciently controlled in China. To decouple economic growth from carbon emission in this industry is considered the key in the total carbon emission mitigation strategy. "Decoupling" research deals with the dilemma of economic growth and environmental degradation. The rationale of a decoupling analysis is to identify what quality economic growth can dissociate from carbon emission (or lead to less carbon emission) so as to achieve the goal of sustainable development (Deutch, 2017). Such research has been witnessed in other countries (Andreoni and Galmarini, 2012; Deutch, 2017; Grand, 2016), or in other industries such as transportation (Tapio, 2005; Wang et al., 2017b), and manufacturing industry (Diakoulaki and Mandaraka, 2007; Ren et al., 2014). Nevertheless, the decoupling relationship between economic output and carbon emission in China's construction industry is far from clear. To understand the relationship provides a valuable reference to benchmarking the "quality" of the economic growth in terms of its carbon emission with its international peers. It is also widely recognized that the development of construction sector, including its economic growth, has witnessed a major imbalance amongst different provinces of China (Yan et al., 2017). National level "energy saving and emission reduction" policies and strategies cannot be effectively implemented without sufficient understanding regional status (Xu et al., 2017). In addition, to understand the decoupling relationship amongst different provinces may provide an "internal" benchmark to mitigate carbon emission. Thus, this study attempts to analyze the decoupling state between construction economic output and its carbon emission at both national and provincial levels.

There are mainly three specific objectives of this study: (1) exploring the decoupling degree of economic output and carbon emission in China's construction industry; (2) Comparing the decoupling state between different provinces; and (3) Investigating the driving factors leading to the different decoupling states at both national and provincial levels. The results of this research are expected to provide empirical evidence for the Chinese government to understand the decoupling state in both national and provincial construction industry, as well as formulate effective measures by focusing on the key factors in priority for achieving low carbon economy. The decoupling analysis of China in this paper can be extended to other countries and other pollutants.

The reminder of this paper is organized as follows. Section 2 gives the related literature review. Section 3 presents the research methodologies and data sources. Section 4 displays the empirical analysis results. Section 5 demonstrates the discussion on results and provides some policy suggestions. Section 6 draws the conclusion of this study.

2. Literature review

The relationship between economic growth and carbon emission has been discussed in a large body of literatures. Environmental Kuznets curve (EKC) and decoupling analysis are the two general methods at present (Shen et al., 2018b; Wang et al., 2017a; Wang et al., 2017b). EKC was proposed by Kuznets to exhibit an inverted U-shape relationship between economic growth and income inequality, and subsequently adopted in the context of environmental quality since 1991 (Zoundi, 2017). Because the global warming and its consequences become pronounced to the world, the existence of an EKC relationship between economic growth and carbon emission has attracted tremendous attentions from scholars. For example, Apergis and Ozturk (2015) for 14 Asian countries, Ahmad et al. (2016a) for India, and Ahmad et al. (2016b) for Croatia confirmed the existence of the EKC hypothesis between economic growth and carbon emission. Shuai et al. (2017a) for 165 countries and Narayan and Narayan (2010) for 43 developing countries concluded that EKC is not a specific phenomenon for all regions. Al-Mulali et al. (2015) for Vietnam and Robalino-López et al. (2015) for Venezuela did not find the inverted U-shaped curve relationship between economic growth and carbon emission in their respective economies.

Decoupling is another method that can investigate the dilemma between economic growth and carbon emission. It is commonly appreciated that "decoupling" originated from physics, and was firstly defined as breaking the link between economic growth and environmental degradation by the Organization for Economic Cooperation and Development (OECD) (Chen et al., 2017a; OECD, 2001). Since then, decoupling was gradually regarded as an indicative criterion of economy-emission integration. By comparison with EKC, the decoupling approach is easier to understand and operate due to its less calculation (Wang et al., 2017b). Moreover, Wang and Yang (2015) pointed out that the decoupling analysis, in comparison with the EKC approach, can effectively identify a real-time dynamic relationship between economic development and environmental degradation. In addition, the empirical results of the economy-emission relationship from EKC are mixed and debatable. Therefore, this study adopts the decoupling approach to investigate the classic, dilemmatic relationship between economic growth and carbon emission.

Previous studies on decoupling relationship between economic growth and carbon emission can be divided into two categories. The first category of such studies applied various indicators to measure the degree of decoupling relationship. For example, Wang et al. (2017b) adopted the Tapio model to analyze the decoupling degree in transportation during 1995–2012 with the consideration of electricity. For comparing the different decoupling indicators, Grand (2016) illustrated the different cases of decoupling signaled with three decoupling indicators using the case of Argentina. To effectively reduce environmental degradation in China, Shuai et al. (2017b) studied the evolving trend of emission decoupling during 1990–2010 with the OECD decoupling index.

The other category of studies explored the driving forces of decoupling combined with decomposition method. For instance, Li et al. (2015) established a decoupling decomposition quantitative model to explore the decoupling relationship and its influence factors between economic growth and carbon emission in China. They found that to control the factors is the key point to achieve better decoupling state. De Freitas and Kaneko (2011) incorporated the OECD decoupling index and logarithmic mean Divisia index (LMDI) model to investigate the factors affecting the decoupling relationship between economic development and carbon emission in Brazil. In order to examine whether the decoupling of industrial growth and carbon emission in the EU had made progress after the Kyoto Protocol, Diakoulaki and Mandaraka (2007) combined decoupling index with the refined Laspeyres model to analyze the decoupling level and driving causes over the period 1990–1997 and 1997–2003. In terms of the contents of two research streams, the isolated decoupling analysis fails to capture the effects of environmental externalities and indicate relevant information for improvement (Diakoulaki and Mandaraka, 2007; OECD, 2002).

There is also a body of literatures concerning the decoupling for the whole country of China (Liang et al., 2013; Riti et al., 2017; Wang et al., 2017a; Zhang and Da, 2015). Some studies focused on decoupling degree of China's industrial sub-sectors, such as transportation (Wang et al., 2017b; Zhao et al., 2016c), manufacturing industry (Ren and Hu, 2012; Ren et al., 2014), and agricultural sector (Luo et al., 2017). However, to the best of our knowledge, studies related to the decoupling for the construction sector in China are absent, despite the fact that construction is an extremely important industry also emits a huge