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Decoupling environmental pressure from economic growth on city level: The Case Study of Chongqing in China

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ABSTRACT

As cities represent the microcosms of global environmental change, it is very important for the global sustainable development by decoupling environmental pressure from economic growth on city level. In this paper, the municipality of Chongqing in China is employed as a case to show whether the decoupling of environmental pressures from economic growth has occurred in cities undergoing rapid economic growth; what is the level of decoupling; and what causes the observed degree of decoupling. Results show the following. (1) During the period of 1999–2010, decoupling from economic growth has been absolute for the emissions of SO_2, soot, and waste water, while it has been relative for total energy consumption, emissions of CO_2 and solid waste. (2) Compared with the period 2000–2005, decoupling level improved for all the six environmental pressures in the period 2005–2010. (3) Compared with China and other three municipalities of China, the overall decoupling level of Chongqing is above China's average while below those of Beijing and Shanghai. (4) During the period 1999–2000, technological change was the dominate factor for decoupling Chongqing's environmental pressure from economic growth, as it contributed 131.4%, 134.6%, 99.9%, 97.7%, 104.5% and 54.9% to the decoupling of total energy consumption, emissions of CO_2, SO_2, soot, waste water and solid waste, respectively; while economic structural change had very tiny effect to the decoupling of emissions of soot and SO_2, and it even had negative effect to that of total energy consumption, and emissions of CO_2 and waste water. Based on the above observations, we explain the difference in decoupling levels for different environmental pressures and suggest approaches for policy-makers on further promoting decoupling environmental pressure from economic growth.

1. Introduction

Decoupling environmental pressure from economic growth, i.e., breaking the link between 'environmental bads' and 'economic goods' (OECD, 2002), is one of the most critical priorities for sustainable development. There is an expanding body of literature on this topic and policy-makers and researchers worldwide continue to pay significant attention to its advancement (Arrow et al., 1995; Conrad and Cassar, 2014; De Freitas and Kaneko, 2011; Holdren, 2008; Wiedmann et al., 2015). Decoupling has been widely used as a policy objective by national, regional, and international institutions. For example, in the Organisation for Economic Co-operation and Development (OECD), decoupling environmental pressures from economic growth is adopted as the main objectives of the OECD Environmental Strategy for the first decade of the 21st century (OECD, 2002); in the European Union (EU), reducing the negative environmental impacts generated by the use of natural resources in a growing economy is the objective for the EU Thematic Strategy on the Sustainable Use of Natural Resources (EC,

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2005); in the United Nations (UN), decoupling human well-being from resource consumption is at the heart of both the International Resource Panel's mandate and the Green Economy Initiative of the United Nations Environment Programme (UNEP, 2011). These policy objectives testify to the critical importance given by policymakers to research on the driving forces of decoupling.

Previous studies on decoupling environmental pressure from economic growth fall into two main streams. In the first stream, research has focused on applying various indicators (OECD, 2002; Tapio, 2005; Wang et al., 2013) to measure the decoupling level of different regions (Kovanda and Hak, 2007; Liang et al., 2013a; Lu et al., 2014; Tachibana et al., 2008; Van Caneghem et al., 2010; Xue, 2012; Yu et al., 2013; Zhang et al., 2014; Zhu et al., 2013). Most of the studies in this avenue are at the national level and despite their importance, studies at the city level are an under researched area. Cities represent the microcosm of global environmental change (Grimm, 2008) and by current estimates account for more than 60% of global energy consumption and 75% of world greenhouse gas emissions (Satterthwaite, 2008). In 2050, the UN estimates that two-thirds of the global population will be urbanized (UN, 2008) and therefore the central role of cities in global environmental change will become more prominent.

In the second stream, the main research efforts have concentrated on exploring the driving forces of decoupling (Andreoni and Galmarini, 2012; De Freitas and Kaneko, 2011; Mazzanti and Zoboli, 2008; Liang et al., 2013a, 2013b; Lu et al., 2007; Ren and Hu, 2012; Sjöström and Östblom, 2010; Tang et al., 2014; Van der Voet et al., 2005). In these studies, the focus on decoupling economic growth from a single environmental pressure indicator is explored, e.g., carbon dioxide, domestic material consumption. However, by focusing on a single environmental pressure indicator, these studies may lead to what (Yang et al., 2012; Liang et al., 2012, 2013a, 2013b) describe as problem-shifting, i.e., the unintended aggravation of one environmental pressure resulting from the alleviation of another environmental pressure. In response to this problem, recent studies have attempted to examine multiple environmental pressures. For example, Liang et al. (2013a) explored the driving force of decoupling 31 environmental pressure indicators from economic growth in China by the method of structural decomposition analysis (SDA). However, this study is at the national level, and doesn't explain the difference in the decoupling level of different environmental pressures. On the city level, Van Caneghem et al. (2010) reported the decoupling level of eight environmental pressure indicators from the Flemish industry, but the driving force of decoupling is not examined. To our best knowledge, there are currently few studies on the drivers of decoupling economic growth for multiple environmental pressures at the city level.

Based on the above two research streams, there is a gap in the literature in studying the drivers of decoupling economic growth for a set of environmental pressure indicators at the city level. To contribute in filling this literature gap, we use Chongqing (one of China's major cities) as a case study to examine the decoupling of economic growth from multiple environmental pressures. Specifically, we examine the level of the decoupling of economic growth from six environmental pressure indicators and examine their driving forces by using the index decomposition analysis (IDA) method. The city of Chongqing was evaluated in this study based on its many advantages relevant to this research. Firstly, as a mega city with the most populous Chinese municipality, Chongqing has experienced rapid and significant changes in both its economic development and environmental pressures (Yu et al., 2015). Therefore, the city of Chongqing provides an important case study in examining the decoupling of environmental pressures from economic growth in Chinese cities. Secondly, Chongqing, as one of the four national central cities, is directly under the control of the Chinese central government, and therefore, in comparison to other cities, the economic and environmental data required for this research is more available and of higher quality.

This paper is structured as follows: Section 2 provides the general information of Chongqing. Section 3 introduces the methodology adopted in this study and reviews the steps taken for compiling the data. Section 4 reports the decoupling indexes for six environmental pressure indicators in Chongqing, evaluates the decoupling level by comparing them with other municipal cities of China, and analyses the driving forces of the decoupling phenomenon. Section 5 discusses the results of this study and provides some policy suggestions. A conclusion follows in Section 6.

2. Study site

Chongqing municipality, covering a land area of 82,403 km^2, is located between the North Latitude 28°10′–32°13′ and the East Longitude 105°11′–110°11′. Administratively, Chongqing is one of China's four direct-controlled municipalities, the other three are Beijing, Shanghai and Tianjin, and the only such municipality in inland China. As a major industrial city in China's southwest region, Chongqing is situated in the upper reach of the Yangtze River and also the upstream of the Three Gorges Dam[1] (as shown in Fig. 1). Because of this geographical location, the environmental issues of Chongqing are not only critical to Chongqing per se, but also critical to both the regions surrounding the Yangtze River and the Three Gorges Dam as it influences their ecological safety and sustainable development (Yu et al., 2015).

In 1997, the city of Chongqing was designated as the fourth national municipality directly managed by the Chinese central government. Because of the administrative attention, Chongqing has experienced very rapid economic development. For example, Chongqing's GDP increased by 269% during the period of 1999–2010. In 2010, Chongqing's GDP, GDP per capita, residential population, share of secondary industry respectively reached 793 billion CNY, 27,475 CNY, 28.8 million people, and 55%. However, along with the rapid economic development, environmental pressures also significantly increased in Chongqing, e.g., energy consumption increased by 218% during the period of 1999–2010. In this context, the decoupling of environmental pressure from economic growth is a very important issue of concern for the sustainable governance of Chongqing. Therefore, Chongqing is a good case study of decoupling environmental pressures from rapid economic growth at the level of cities in China.

3. Methods and data

3.1. Decoupling indicators

Researchers have developed various decoupling indicators to track the temporal changes in the relationship between environmental pressures and economic growth (OECD, 2002; Tapio, 2005; Wang et al., 2013). Among these, the most widely used indicator by researchers and policy makers is the Decoupling Index (DI) proposed by the OECD (2002). This indicator is defined as:

$$DI = 1 - \frac{M^t/Y^t}{M^0/Y^0} = 1 - \frac{EPI^t}{EPI^0} \quad (1)$$

where the superscript 0 and t are the initial year and the end year for a certain period of time; M and Y are respectively the environmental pressure indicator and the gross domestic product (GDP) measured

[1] The Three Gorges Dam, a hydroelectric dam that spans the Yangtze River of China, in terms of installed generation capacity, is the world's largest power station. (http://en.wikipedia.org/wiki/Three_Gorges_Dam).