Journal of Cleaner Production xxx (2016) 1–8

Contents lists available at ScienceDirect

Journal of Cleaner Production

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

Carbon emission and its decoupling research of transportation in Jiangsu Province

Yuhong Wang*, Tangyong Xie, Shulin Yang

School of Business, Jiangnan University, Wuxi, Jiangsu Province, 214122, China

ARTICLE INFO

Article history:
Received 29 October 2015
Received in revised form
23 August 2016
Accepted 9 September 2016
Available online xxx

Keywords:
Transportation
Carbon emission
Tapio decoupling
Electricity

ABSTRACT

Transportation in Jiangsu province has been developed rapidly. However, the development was accompanied with a large amount of energy consumption and carbon emissions. Combined with the coefficient in 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines for national greenhouse gas inventories and China's calorific value, this article calculated the carbon emission coefficient of usual energy covered by Jiangsu Statistical Yearbook (JSY) in detail. Based on this, carbon emission of transportation in Jiangsu Province from 1995 to 2012 was easily estimated. And from the result which appears clearly that the construction of energy consumption was changed in 2011. According to China Electricity Power Yearbook (CEPY) and China Energy Statistical Yearbook (CESY), carbon emission caused by electricity power indirectly could be estimated. With the help of Tapio model, this paper conducted a research on decoupling relationship between economic growth and carbon emission of transportation in Jiangsu Province with consideration of electricity. The results show that the amount of carbon emission by electric power is significant, which makes no difference on the overall decoupling states with an obvious periodical characteristic of Weak Decoupling (Expansive Coupling)-Expansive Negative Decoupling-Weak Decoupling. Transportation has made great achievements on reducing pollution and carbon emission in Jiangsu Province since the Eleventh Five-Year Plan, and would be better on low-carbon development in potential. However, there is still a large step to realize low-carbon transportation in reality.

1. Introduction

Transportation has greatly grown and developed in recent decades with the influence of e-business in China. However, huge waste and pollution always inevitably happened at the same time because of the lack of technology and base equipment and other factors, which led transportation development labeled with high energy-consumption and high pollution. As a vital part of the third industry, transportation indeed plays an important role in promoting economic growth and especially increasing energy consumption as well as environment pollution. A research conducted by Tonooka et al. (2006) highlights that oil consumption and carbon dioxide emission in transportation accounts for about 50% and 25% of global total respectively (Tonooka et al., 2006). However, what is the transportation and will be going in reality? It seems not so easy but necessary to answer the question if we need to keep continuing sustainable development in the future. Many empirical studies on discussing the relationships and linkages among economic growth, energy consumption and environment pollution have been conducted in different regions (Menyah and Wolde-Rufale, 2010; Andreoni and Galmarini, 2012; Zhang and Wang, 2013; Azlina et al., 2014). Diverse consequences in various methods mean differently. Whether the economy grows with less energy consumption and pollution or not which usually decides policy chosen to be implemented. Discussing and recognizing the linkages are quite both helpful to indicate the past and present development situations and guide the further directions for the government.

With the ever-deepening reform and open-up, Jiangsu Province had a rapid economy increase in last decades, and the prosperity has been playing a great vital role in China's economic boom all the time. As one of the pioneers in China, Jiangsu Province keeps fast growing all the time in various fields. In constant price of 2000, the regional gross domestic product rose from 855.369 billion in 2000–3618.435 billion in 2012 at an average annual growth rate of 12.77%, which was much bigger than the national average then.

* Corresponding author.
E-mail address: wyh2003@gmail.com (Y. Wang).

http://dx.doi.org/10.1016/j.jclepro.2016.09.052
0959-6526/

However, there still seems to be a lot of unhealthy factors in its total development, and the prosperity may be exactly at the price of a giant number of energy consumption. According to the statistic data, the average annual growth rate of energy consumption reached to 10.60% in the period from 2000 to 2012. The little gap between these two rates shows a significant fact that the economic growth perhaps still be totally extensive for Jiangsu Province, which reminds the government not only to focus on pursuing economical efficiency, but also to consider enhancing the energy conservation and environment quality. The case of transportation industry in Jiangsu Province further proves this. Actually, driven by the domestic fast development of internet and electronic commerce, transportation industry is experiencing a totally quite rapid change and development, especially in Jiangsu. According to JSY, the energy consumption in transportation industry grew at an average annual rate of 13.52% in the period from 2000 to 2013, which was obviously higher over 2.92% than the total growth rate. Therefore, a deep research on recognizing the detail relationships among economical growth, energy consumption and environment pollution in the transportation industry will be quite meaningful and instructive.

This paper is generally constructed with two steps. Firstly, estimate the carbon emission based on various raw data from different official statistic yearbooks. Totally speaking, the carbon emission estimation in this paper includes two sources from fuel consumption and electricity aspect, the later of which is just one of the innovation views. On the one hand, carbon emission estimation from fuels could be calculated with an equation for the product of fuel consumption amounts and the relevant emission coefficient. Considering accurate coefficients are the key foundation of the whole estimation undeniably, this paper calculated the carbon emission coefficients of nine frequently used types of energy covered by the statistical yearbook of Jiangsu Province in advance, with the help of the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines for national greenhouse gas inventories and China's average calorific energy reference value. And then, data about the energy consumption amount are prepared to make further calculations through China Energy Statistical Yearbook (CESY) and Jiangsu Statistical Yearbook (JSY). On the other hand, carbon emission estimation from electricity aspect could be approximately calculated with the extra help of China Electricity Power Yearbook (CEPY), which will be shown in detail in part 3.2 below. Secondly, examine the decoupling between the economic growth and carbon emission during 1995–2012, which is the newest documented period. Data on economic growth can also be easily got from JSY. It is worth noting that tapio decoupling model is chosen as the evaluation method via multiple comparisons because of its easy understanding and operating.

This study also pays attention to another variable, which has hardly been considered by most researchers. Electricity is concluded in energy consumption according to the statistical yearbook. Many studies regard electricity as a clean energy without carbon producing. However, most of the electricity is actually generated by the thermal power plants in China. That is to say, electricity makes carbon emission in an indirect way rather than a direct. What about the relationships between the economic growth and environment pollution will be if the carbon emission produced by electricity is really evaluated? This paper will give the answer exactly.

The results of this research are expected to provide the references and instructions for the government of Jiangsu to decide how to realize long-term sustainable development in transportation industry. The rest of the paper is structured as follows. Section 2 reviews some relevant studies and literature. Section 3 introduces the methodology used about carbon emission calculation and Tapio model. Section 4 presents the data description and empirical analysis results. The conclusions drawn are summarized in Section 5 at last.

2. A brief literature review

A vast body of researches has been conducted to discuss the relationships between growth and emission. In 1970, a study introduced by Kraft on the relationships between energy consumption and output seems be the first one to start all the following relevant researches. From then on, a series of methods such as correlation analysis, simple regression, unit root testing, and variance decomposition et al. were put into use for examining the linkages among economic growth, energy consumption and pollutants emission.

Through consulting many published studies, EKC (environment Kuznet curve) and decoupling are two usual methods at present. EKC, coming from Kuznet curve, is a method that can usually be used for examining economic growth and energy/emission intensity with curve fitting. Various shapes like U-shape, inverted U-shape, and N-shape refer to different relationships. Pak and Lee (2011) examined an EKC hypothesis by analyzing annual panel data of 16 metropolitan regions in Korea over a 16-year time period. The results show different pollutants including CO, NO2 and SO2 keep diverse linkages like dominant U-shape, region-specific U-shape and potential N-shape with GRDP separately (Pak and Lee, 2011). Azlina et al. (2014) examined the dynamic linkages among transport energy consumption, income and carbon dioxide emission in Malaysia during 1975 to 2011using the same method of EKC hypothesis, including unit root testing, co-integration and Granger causality (Azlina et al., 2014). Liu (2011) used EKC and concluded that there was a lack of healthy environment to keep society survive and development as a result of human-induced environmental degradation (Liu, 2011). Decoupling is another method, which calculates with the growth rate of economy and energy consumption or emission. In fact, decoupling is not initiated for environment. The notion of decoupling wasn't applied into environmental studies firstly until 2000s. When it comes to 2002, OECD started to present decoupling as one of the indicators (OECD (Organization for Economic Co-operation and Development), 2002). And thus, decoupling was gradually regarded as an important conceptualization of economy-emission integration. The outstanding progress for decoupling was made by Vehmas et al. (2003) and Tapio (2005). Based on the framework explaining different aspects of decoupling constructed by Vehmas et al., Tapio proposed eight logical possibilities to distinguish decoupling state. After that, many papers covering decoupling-analysis can be found in various publications. For instance, Luken and Piras (2011) conducted researches on decoupling of the energy consumption and industrial output in the Aisan region (Luken and Piras, 2011). Wang et al. (2013) examined the decoupling indicators on the carbon dioxides emission and economic growth linkage with the whole case of Jiangsu (consist of primary, secondary and tertiary) (Wang et al., 2013). Generally, eight kinds of measuring methods for decoupling exist. But no uniform about the decoupling indicators can tell us which is the best method (Zhong et al., 2010). By comparison with EKC, decoupling, with more specific conception and less calculation, can be understood and operated in an easy way. More and more studies have adopted this model to analyze the relationships among economy, energy use and emission.

Decoupling was applied to analyze the relationship of economic growth and transport volume in transportation fields very early (De Bruyn 2002; Hinterberger and Schmidt-Bleek, 1999; Schmidt-Bleek, 2000; Tapio, 2002; Vehmas et al., 2003). Moreover, the discourses of decoupling economic growth from transport volume

Please cite this article in press as: Wang, Y., et al., Carbon emission and its decoupling research of transportation in Jiangsu Province, Journal of Cleaner Production (2016), http://dx.doi.org/10.1016/j.jclepro.2016.09.052