Atmospheric Environment 145 (2016) 280–292

Contents lists available at ScienceDirect

Atmospheric Environment

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

How to achieve the 2020 and 2030 emissions targets of China: Evidence from high, mid and low energy-consumption industrial sub-sectors

Juan Wang [a,*], Tao Zhao [a], Yanan Wang [b]

[a] College of Management and Economics, Tianjin University, Tianjin, 300072, People's Republic of China
[b] College of Economics and Management, Northwest Agriculture and Forestry University, Yangling, 712100, People's Republic of China

HIGHLIGHTS

- This study identified whether the emissions reduction targets of 2020 and 2030 can be achieved.
- Index decomposition analysis and JJ co-integration method were utilized.
- Economic growth and energy intensity were crucial driving forces for three industrial subgroups.
- It is very likely for China's industrial sector to achieve the reduction targets in 2020 and 2030.
- The energy efficiency improvement for high energy-consumption sectors is urgently required.

ARTICLE INFO

Article history:
Received 25 May 2016
Received in revised form
1 September 2016
Accepted 19 September 2016
Available online 20 September 2016

Keywords:
Carbon emissions
Decomposition analysis
Different energy-consumption sectors
Co-integration relationships
Scenario analysis

ABSTRACT

Facing the challenge of meeting emissions reduction targets of China, this paper employed the logarithmic mean Divisia index (LMDI) method to study the changes of energy-related carbon emissions in high energy-consumption sectors (HES), mid energy-consumption sectors (MES) and low energy-consumption sectors (LES) from 1996 to 2012. The decomposition results revealed that the economic growth was the most significant factor to increase carbon emissions of three subgroups while the decrease in energy intensity was the dominant factor to reduce carbon emissions of MES and LES. Considering the important roles economic growth and energy intensity played in carbon emissions, three scenarios were set based on the different growth rates of these two factors to identify whether the emissions reduction targets of 40–45% in 2020 and 60–65% in 2030 can be achieved using the co-integration technique. It was indicated that the emissions targets both in 2020 and 2030 can be achieved by LES in the base scenario. In stark contrast to LES, the carbon intensity of HES reduced only 10.03% in 2020 and 14% in 2030 compared to the 2005 level. Therefore, more attentions should be focused on the economic activity and energy intensity of HES. Finally, according to the results obtained, policy implications were provided to further mitigate the carbon intensity of China's industrial sector.

1. Introduction

Ongoing and rapid growth in important part of the world economy, China who is experiencing the rapid growth of population and economy, is commonly to result in large amounts of energy use, especially fossil fuels. Notably, carbon emissions in China were highly associated with the excessive consumption of fossil fuels. As an indisputable fact, climate change mainly driven by carbon emissions has affected the survival and development of human society. As the world biggest energy consumer and largest carbon emitter, China is responsible for 23% of global energy consumption and 23.4% of carbon emissions (BP Statistical Review, 2015; IPCC, 2014). Therefore, mitigating climate change has become a strategic imperative of China, and the Chinese government has issued a great deal measures to conserve energy and mitigate carbon emissions. In 2009, the Chinese government committed that the carbon intensity (carbon emissions per unit of GDP) would be reduced by 40–45% in 2020, compared with 2005

* Corresponding author.
E-mail address: wangjuan_tju@163.com (J. Wang).

http://dx.doi.org/10.1016/j.atmosenv.2016.09.038
1352-2310/

(Kang et al., 2014). During the Twelfth Five-Year Plan (12th FYP) period (2011–2015), the government proposed a quantitative targets for National Economic and Social Development, which stated that energy intensity (energy consumption per unit of GDP) and carbon intensity would be respectively reduced by 16% and 17% in 2015, compared to 2010. Moreover, in 2015, the Chinese government committed that its peak for carbon emissions would be reached no later than 2030 and the reduction of 60–65% in carbon intensity below the 2005 level would be implemented by 2030.[1]

At present, the China's industrial sector plays an important role in the process of rapid development of industrialization and urbanization. Meanwhile, its high dependence on energy-intensive industries has resulted in the interdependence of industrial growth, energy consumption and carbon emissions. According to National Bureau of Statistics of China, the energy consumption in the industrial sector increased significantly, which grew from 682.44 Mtce (million tons coal equivalent) to 1723.22 Mtce in 2012 and accounted for about 69.8% of the total energy consumption in China (NBSC, 2013a). However, the industrial value added (IVA) increased from 2806.94 BY (billion yuan) in 1996 to 14050.47 BY in 2012 (at constant price in 1995), and the share of IVA in total GDP was just 45.32% in 2012 (NBSC, 2013b). With the end use of the fossil fuels increasing, the carbon emissions of industrial sector were driven up by 3490.97 Mt (million tons) during the period of 1996–2012 and constituted approximately 70% of China's total energy-related CO_2 emissions (Liu et al., 2015). Xu et al. (2014a, 2014b) and Zhang and Da (2015) pointed out that it is difficult to reduce carbon emissions of China's industrial sector with its relatively concentrated energy consumption. Therefore, it is urgent for China to find an effective way to control carbon emissions of industrial sector.

Given that previous researchers only focused on the identification of the driving factors from the perspectives of the whole industry or certain sub-sectors, this study divided 36 industrial subsectors into high energy-consumption sectors (HES), mid energy-consumption sectors (MES) and low energy-consumption sectors (LES) in the boundary of energy intensity. Then, the LMDI method was applied to respectively study the impacts of underlying factors on the carbon emissions of these three subgroups. Besides, research about whether the emissions reduction targets of 40–45% in 2020 and 60–65% in 2030 in industrial sector can be achieved was limited. This paper analyzed this by setting different scenarios according to the co-integration relationships between carbon emissions and the impact factors. Based on the scenario analysis, which subgroup is the key item for improvement in the future was identified. Furthermore, this paper aimed to solve three major problems. First, identifying the underlying factors impacting carbon emissions of HES, MES and LES. Second, exploring the emissions reduction issues of HES, MES and LES in 2020 and 2030. Third, finding effective and practical policy implications for industrial sector to achieve the mitigation targets in 2020 and 2030.

The rest of this paper is organized as follows. Section 2 presents the literature review. Section 3 introduces the research methodologies and data sources. Section 4 provides the results and discussions. Section 5 concludes the study and offers policy recommendations.

2. Literature review

Considering the important role that industrial sector played in China, a great many researchers took considerable interest in the environmental issues of China's industrial sector. Energy efficiency improvements have been considered as an important way to counteract the expansion of carbon emissions. Thus, many previous studies have researched the energy efficiency of industrial sector at sector level (e. g., Li and Shi, 2014; Chang et al., 2013) and provincial level (e. g., Shi et al., 2010; Wang et al., 2012a; Zhang et al., 2008; Zhao et al., 2014; Wang and Wei, 2014). In addition, Wei et al. (2007), Lin and Long (2015), Shu et al. (2011) and Wang and Zhao (2016) respectively evaluated the energy efficiency of industrial sub-sectors at provincial level, such as iron and steel sector, chemical industry, power generation sector and non-ferrous metals sector.

Additionally, index decomposition analysis has been widely used in exploring the driving forces that underlie the increase in energy consumption and energy-related carbon emissions of China's industrial sector. A lot of valuable results were obtained. Liu et al. (2007) analyzed the changes of industrial CO_2 emissions from 36 industrial sectors in China over the period of 1998–2005 based on LMDI method. Wang et al. (2012b) conducted a deep and comprehensive analysis on the change of CO_2 emissions for 6 energy-intensive sectors from 2000 to 2007 based on the LMDI method. Ren et al. (2012) focused on finding the factors influencing changes in energy-related CO_2 emissions of China's industrial sector in nine economic regions using an LMDI method. Xu et al. (2014b) employed an LMDI method to explore the changes of greenhouse gas emissions from the sectoral perspective during the period of 1996–2012, and the industrial sector was included. Yan and Fang (2015) addressed the historical trajectory and features of CO_2 emissions in the Chinese manufacturing industry and investigated the influencing factors of CO_2 emissions changes from 1993 to 2011 using an LMDI method. The above-mentioned studies proved that industrial activity is the major factor contributing to the increase in industrial CO_2 emissions, whereas energy intensity is the major contributor to the decrease of CO_2 emissions. Liu et al. (2015) applied an extended LMDI method to disentangle the carbon intensity into three influencing factors and further to explore the contributions of individual industrial sub-sectors to each factor. Wang et al. (2016) probed into the decoupling status between carbon emissions and industrial growth in Taiwan, as well as its impact factors using LMDI method. And then the contributions of industrial sub-sectors to each influencing factor were analyzed. These two studies indicated that the energy-intensive industries were the most representative sub-sectors in affecting the carbon intensity through each influencing factor. Regarding to the energy use studies of China's industrial sector, Zha et al. (2009) studied the structure and intensity effects that affected energy intensity of industrial sub-sectors in China based on both arithmetic mean Divisia index (ADMI) and LMDI. Ke et al. (2012) analyzed China's industrial energy consumption trends, focusing on the impacts of the Top-1000 Enterprises Energy-Saving Program and the Ten Key Energy-Saving Projects. Hasanbeigi et al. (2013) studied the energy use and economic structure of China's manufacturing sector. The results showed that the production effect was the dominant cause of the rapid growth in industrial energy consumption, while the efficiency effect was the major factor slowing the growth of industrial energy consumption. Besides, the major industrial subsectors of China in extremely energy-intensive industries have been investigated using the LMDI method, such as cement industry (Wang et al., 2013), chemical process industry (Lin and Long, 2014b) and textile industry (Lin and Moubarak, 2013).

The above mentioned studies have contributed greatly to the understanding of carbon emissions and mitigation for China's industrial sector. However, LMDI method just determines the impact of individual factor on carbon emissions. The co-integration technique serves as an effective tool to test a long-run relationship

[1] These commitments were reported in the Intended Nationally Determined Contributions of China on Jun. 30, 2015.