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Analysis of CO_2 emissions embodied in China's bilateral trade: a non-competitive import input–output approach

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ABSTRACT

CO_2 emissions embodied in international trade are critical to the national carbon mitigation strategy. Studies estimating embodied CO_2 emissions in China often overestimate actual values. This work calculates China's CO_2 emissions embodied in bilateral trade with the USA, European Union, Japan and other countries using a modified, non-competitive import input–output method and latest data. The results show that net CO_2 emissions embodied in China's trade in 2007 were only 400 million tons, much lower than previous estimations. Accordingly, China's CO_2 emission on the consumption side in 2007 dropped to 5.628 billion tons, with the transfer part accounting for 6.6% of total CO_2 emissions calculated for the production side. It is concluded that because CO_2 emissions embodied in trade are not as great as previously estimated, China should place more emphases on energy saving and emission reduction on its own side instead of emission transfer to substantially mitigate CO_2 emissions.

1. Introduction

According to a report of the Energy Information Administration, China overtook the USA as the greatest CO_2 emitter in the world in 2009, and contributes 23% of total global emissions. From the international trade perspective, China has also become the world's largest importer and exporter, with a 47% dependence on foreign trade in 2012. Fig. 1 depicts the trend of CO_2 emissions and trade in the country in recent years. It is seen that those emissions have increased from 3083 million tons in 2001–7217 million tons in 2010, with an average annual growth rate of 9%. Meanwhile, Chinese import and export trade rose from 509.6 billion USD in 2001–2974 billion USD in 2010, with a high average growth rate of 20%. It is also seen that China's CO_2 emissions and international trade had similar changes and strong correlations. In 2003, and 2004, both CO_2 emissions and trade reached maximum growth rates of 17.3% and 36.4%, respectively. Owing to the financial crisis in 2008, the country's trade experienced its first negative growth (−13.9%) in 2009. Accordingly, CO_2 emissions in that year had their lowest growth rate, at 4.5%.

The USA, European Union (EU) and Japan are the three major trading partners of China. As shown in Fig. 2a, bilateral trade with these three constituted 13%, 16% and 10% of total Chinese trade in 2010, respectively. This trade was accompanied by large amounts of CO_2 emission. In 2010, the shares of China, USA, EU and Japan of total global CO_2 emissions were 24%, 18%, 12% and 4%, respectively, collectively exceeding half of that total. Such a large trade volume and disproportionate trade structure have had a significant effect on China's energy consumption and environment. The imbalance of trade volume and structure reveals the disparity of CO_2 emissions worldwide and corresponding confusion of responsibility for carbon emission mitigation. Therefore, it is feasible to investigate bilateral carbon transfer between China and its major trading partners (such as the three mentioned above) as representative of its entire international trade.

The calculation of CO_2 emissions is often for the production side. This overestimates CO_2 emissions of energy- and carbon-intensive product-exporting countries, and underestimates emissions of the major importers of these products. It is better to examine actual emissions, clarify the responsibility for emission reduction, and satisfy the principle of equitable burden sharing of each country by estimating CO_2 from the consumption side, with consideration of

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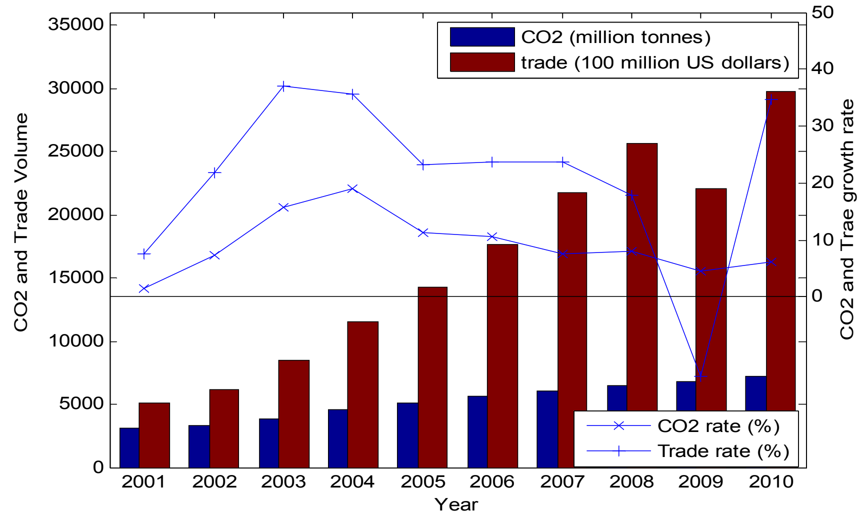

Fig. 1. Trend of China's CO_2 emissions and trade (2001–2010).
Data Source: IEA, 2012; China Customs Statistics Yearbook 2011.

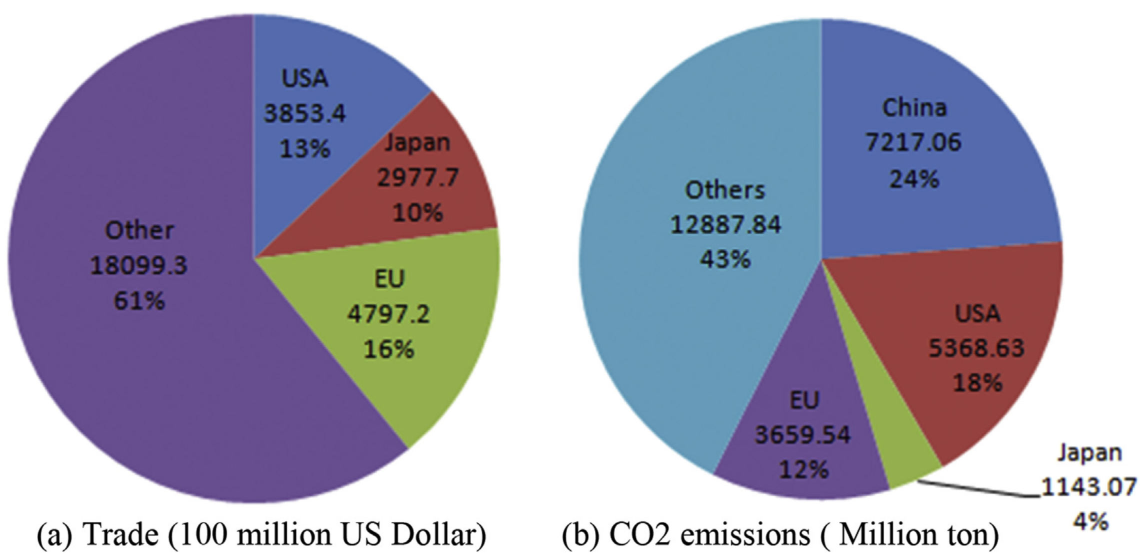

Fig. 2. China's structure of trade and CO_2 emissions in 2010.
Data Source: IEA, 2012; China Customs Statistics Yearbook 2011.

emissions embodied in trade and induced by intermediate products (Fan et al., 2010). Thus, we chose to examine CO_2 emission embodied in China's trade, especially in its bilateral trade with the USA, EU and Japan, and estimate carbon emission from the consumption side. The aim was to analyze the status quo of China's CO_2 emission transfer and provide corresponding policy suggestions.

The structure of the rest of the paper is as follows. Section 2 presents a brief literature review. Section 3 introduces the methodology for estimation of CO_2 emissions embodied in trade. Data sources are presented in Section 4. Section 5 compares CO_2 embodied in trade between China and major trading partners, including the USA, EU, Japan and the rest of the world. Finally, a range of conclusions and policy implications are given in Section 6.

2. Literature review

There have been many studies reporting embodied CO_2 emissions in the trade of China (e.g., Pan et al., 2008; Weber et al., 2008; Xu et al., 2011; Su et al., 2013; Su and Ang, 2013, 2014; Jiang et al., 2015; Zhang and Chen, 2010; Zhang et al., 2014, 2015). However, owing to varying methods and data sources used to calculate carbon emission transfer, there are tremendous differences in the estimation and analysis of embodied CO_2 emissions. For example, for the measurement of China's CO_2 embodied in trade in 2007, Yang et al. (2011) obtained a result of 808 million tons, whereas Wang et al. (2011) and Jiang et al. (2015) estimated 3087 and 1400 million tons, respectively. The calculations and databases used in the literature mainly differ in the following three aspects.

First, given the availability of data, most studies have been based on competitive input–output (IO) tables; e.g., Pan et al. (2008) used these tables to calculate embodied CO_2 in China in 2002. Using such tables, CO_2 embodied in intermediate goods in imports are not considered, so CO_2 emission transfer in China cannot be precisely examined. Modifications have been made on the basis of competitive IO tables. Assuming that all imported goods are noncompetitive, Su and Ang (2013) approximately constructed these tables. Some studies also assumed that imports were distributed according to the proportion of intermediate inputs to final demand