

1. Introduction

China's economy has been developing at a continuously rate of the average annual growth rate of 9.36% since the economic reforms and open-door policies in 1978, which has become the fastest growing economy in the world. China's GDP in 1978 was 367.87 billion yuan, which accounted for 1.8% of the world economy¹, while in 2019, China's GDP has exceeded 99 trillion yuan, which is expected to account for more than 16% of the world economy². However, since the foundation of China's national economy was weak and the economic development lagged far behind western developed countries at the time of 1978, China has started with the extensive economic growth mode based on the low level of technologies, resulting excessive energy consumption, causing the rapid increase of carbon dioxide emissions and environmental pollution from then on. As China has made considerable progress in the economic development and technologies, the awareness of energy saving and emission reduction has been gradually enhanced as well. At present, China is at a critical period of national economic development, accompanying with the reduction of the consumption of fossil energy and reducing carbon emissions.

As a big and responsible country, China has made a commitment to reduce carbon dioxide emissions per unit of GDP by 40% to 45% by 2020, based on the level of that in 2005, and has successfully fulfilled the commitment in advance. Then China has announced to reach the peak of CO₂ emissions at around 2030 and strive to achieve it even ahead of that time. Another commitment for 2030 is that the CO₂ emissions per unit of GDP in China is to be reduced by 60% to 65% than that in 2005³. Therefore, it is significant to study the causes and the measures for the decoupling of China's economic growth and carbon emissions to find out the more efficient measures for the further carbon reduction.

2. Literature review

The current study on the relationship between economic growth and carbon emissions focuses on the following aspects: firstly, using economic analysis tools to study the law between carbon emissions and economic growth Zhang (2013) has used environmental Kuznets curve (EKC) to analyze the relationship between per capita income and per capita CO₂ in the study of carbon emissions and economic growth in Beijing. Via EKC hypothesis and the decoupling theory, Zhang et al. (2017) have found that the coordination of carbon emissions and economic growth between EU and other countries is very good, but in the developing countries, such as China and India, it needs to be strengthened. Qi (2018) has analyzed the fluctuation trend of the "expansion connection –weak decoupling– strong decoupling" between China's economic growth and carbon emissions by using the decoupling model.

Secondly, by summarizing empirical data, analyzing empirically the relationship between economic growth and carbon emissions Wang (2010) has analyzed the relationship between energy consumption and economic growth in China, basing on the historical data from 1990 to 2007, and has pointed out that at certain stages, the economic growth and energy consumption can be in absolute decoupling or in relative decoupling. Peng et al. (2011) have analyzed the relationship between carbon dioxide emissions and economic growth from a national or regional perspective, which shows a weak decoupling phenomenon in China then. Schandl (2016) has assessed the decoupling potential of economic growth and environmental pressure in 13 countries and regions around the world, and has found that OECD countries still have great potential to reduce carbon emissions and have little impact on economic growth.

As for the building of China's emission trading scheme (ETS), it is based on the experience of EU ETS with the typical mode of Cap and Trade. Wang & Chen (2018) have combed through the relevant policy development and the process of China's carbon market building. They have analyzed the market performance and the performance of each pilot carbon market. Tian & Xu (2019) have summarized the

1 *The 23th of series reports on the achievements of economic and social development in the 70th anniversary of the founding of the People's Republic of China.* National Bureau of Statistics of China: <http://www.stats.gov.cn/>
2 *China's economy in 2019.* The State Council Information Office of the People's Republic of China: <http://www.scio.gov.cn/>
3 *China's Energy Policy 2012.* The State Council Information Office of the People's Republic of China: <http://www.scio.gov.cn/>

results of China's carbon trading pilot and has put forward relevant policy recommendations considering the existing problems. Li et al. (2014) have compared the operation mechanism and current situation of emission trading market at home and abroad, and has analyzed the transaction volume and transaction volume of the seven major carbon emission trading pilot areas in China to found out the root cause of the slow development of carbon emission trading market. Based on the development of global carbon market, Wang & Zhao (2019) have analyzed the research situation of carbon accounting, carbon quota and carbon pricing and have put forward corresponding countermeasures and suggestions for China's national carbon market construction according to the research results and gaps.

The above-mentioned literatures mainly analyze the relationship between economic growth and carbon emissions through empirical analysis, but few studies the reasons for the decoupling of economic growth and carbon emissions from the internal relationship among the economic growth, energy consumption and carbon emissions. Therefore, it is significant to take the coupling relationship between energy consumption and economic growth as the starting point so as to have further explanation for the policies and measures which make China's economic growth and carbon emission be decoupled through the reduction of carbon intensity.

3. The decoupling process of China's economic growth and carbon emission

China has become a middle-income country since 2012 and has become the world's second largest economy after the United States. As China's economic development continues, the quality and the efficiency of the economic development are taken into consideration with keen interest. For a couple of decades, China has been trying to find a green and low-carbon development mode consistent with the national conditions to decouple the economic growth from the carbon emissions. As the carbon emissions mainly depends on energy consumption structure and energy efficiency, on the premise of unchanged energy consumption structure, the larger energy consumption means the more carbon emission, and the higher the energy efficiency, the lower the carbon intensity. Therefore, China takes energy consumption as the breakthrough point and gradually realizing the decoupling of the carbon emissions from the economic growth by optimizing energy structure and improving energy efficiency.

3.1. The decoupling turning of China's economic growth and carbon emission

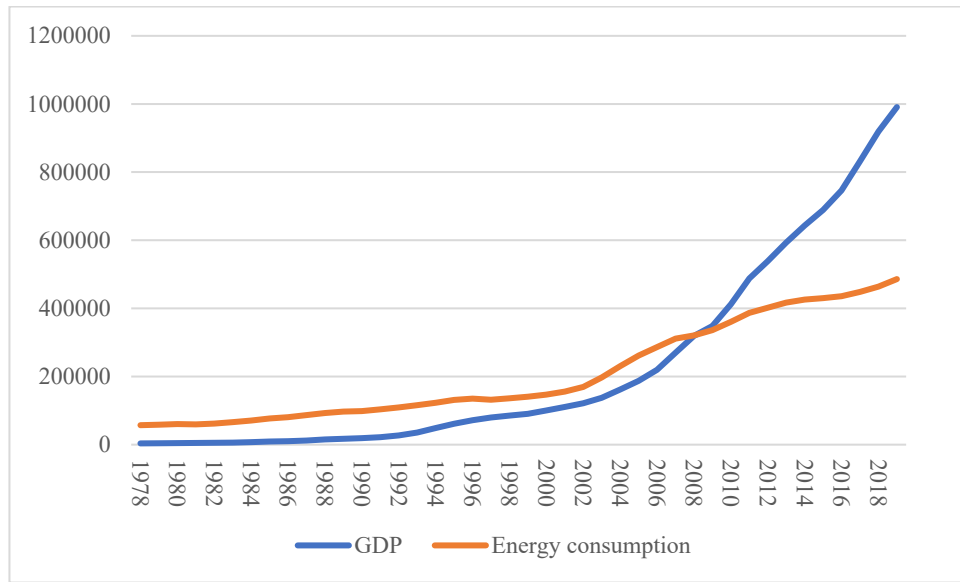
3.1.1. China's economic growth coupling the increasing growth rate of energy consumption

China's GDP has shown a rapid growth trend from 1978 (the beginning of the reforms) to 2019. In the period of the early stage of the reforms and opening-up, the economic growth has the priority and the extensive and high-speed growth is characterized by "high energy consumption and high pollution" which lead to various environmental problems. The growth of GDP means the increasing consumption of energy. The dual effects of industrialization and urbanization cause the energy consumption and carbon emission increasing rapidly, which make China become the world's top energy consumer and carbon dioxide emitter, accounting for nearly 30% of global emissions although China's per capita carbon emission is still at a low level⁴.

It can be seen from Fig. 1 that over the past 40 years, China's energy consumption has increased with the increase of economic aggregate, especially before 2008. Although China's economic development has made remarkable achievements, the rapid growth trend of energy consumption should be eased.

4 Shan, Y.; Guan, D. et al. *China CO2 emission accounts 1997–2015*. Sci Data 5,170201 (2018); <https://doi.org/10.1038/sdata.2017.201>

Figure 1. The trend of GDP growth and energy consumption growth in China 1978-2019

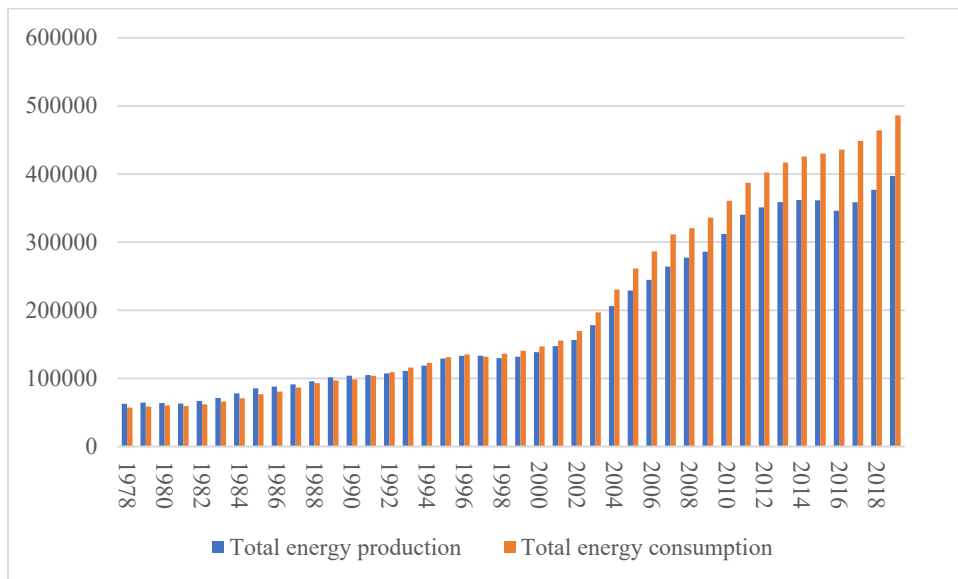


Data source: National Bureau of Statistics of China

Fig. 2 shows that since 1978, with the development of China’s industry and the advancement of urbanization, the total energy consumption has increased year by year and exceeded the total energy production in early 1990s. As China’s economic growth has increased continuously together with that of the energy consumption, it brings about the increase of carbon emission since 1978.

Since 2000, due to the rising proportion of manufacture in the national economy, China’s growth rate of energy consumption is much higher than that of energy production. Until the “12th Five Year Plan” period of 2011-2015, China has emphasized the transformation of energy development mode and the adjustment of energy structure as well, resulting in the slowdown of the growth rate of total energy consumption and total energy production, although the energy production and consumption have picked up a bit since 2017.

Figure 2. China’s energy production and consumption from 1978 to 2019



Data source: National Bureau of Statistics of China