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The relationships between population factors and China's carbon emissions: Does population aging matter?

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A B S T R A C T

Reducing carbon emissions and managing the aging crisis represent two major challenges in China that involve various requirements for continued economic growth. This paper investigated the relationships between population factors and carbon emissions and further explored the impact of population aging on carbon emissions at the national and regional levels based on the STIRPAT model and provincial panel data from China. Our results show that at the national level, population aging and population quality are positively correlated with China's carbon emissions. The impact of the population living standard on carbon emissions exhibits an urban-rural difference. At the regional level, the impact of population aging on carbon emissions exhibits regional differences.

Contents

1. Introduction

According to the Global Carbon Project, the global carbon emissions associated with human activities reached a record high of 36 billion tons in 2013. Meanwhile, China's carbon emissions were the highest globally, accounting for 29%, and China's per capita carbon emissions exceeded those of EU countries for the first time. Long-term, extensive economic growth can lead to excessive energy consumption and environmental deterioration. As one of the signatories to the Kyoto Protocol, China plans to reduce its GHG emissions per unit of GDP in the year 2020 by 40–45% based on 2005 levels [20]. The urgent reduction requirement may slow future economic growth in China.

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Currently, a key issue associated with China's population problems is the changing population age structure. As the most populous country in the world, China is rapidly becoming an aging society. Differing from developed countries, China's population aging is characterized by "aging before getting rich". In 1995, the share of people over 65 was 6.2% in China, increasing to 9.7% in 2013. According to the United Nations, the global average annual growth rate of the aging population will be 2.5% from 1990 to 2020, while this growth rate will be 3.3% in China. For an aging society, China's social insurance system and medical health service system remain far from perfect, particularly in rural areas. Rapid economic growth has played an important role in perfecting the above systems and improving population quality and living standards.

The negative impacts of human activities on the environment have been proven, while the relationships between population aging and carbon emissions remain controversial. Currently, reducing carbon emissions and handling new population problems, especially the aging crisis, are introducing various requirements for China's economic growth. In the stage of the "new normal" economy, China should not only improve their quality of economic development to control carbon emissions but also maintain stable economic growth to improve the endowment insurance system and address new population problems.

Therefore, it is necessary to build an analytical framework to investigate the relationships between population factors and China's carbon emissions. The relationships between population factors and carbon emissions have been previously discussed [8,39]. However, most studies have focused on population size, population growth and urbanization rate. The impacts of population aging on carbon emissions should be given more attention. Furthermore, China encompasses a vast territory with large socio-economic differences among the eastern, central and western regions. However, most studies have neglected regional differences [53,43]. This study investigated the relationships between population factors and China's carbon emissions and further explored the impacts of population aging at the national and regional levels based on the STIRPAT model using panel data from 29 provinces in China from 1997 to 2012. Our study aims to determine how carbon emission levels are connected to population factors and whether the relationship between population aging and carbon emissions differs across regions.

2. Literature review

The existing literature concerning the relationships between population factors and carbon emissions has mainly focused on three aspects. First, more attention was given to population growth. Through employing the test of causality developed by Granger, [23] proposed a short-term dynamic relationship between carbon dioxide emissions and population growth for the first time. Moreover, based on data from 93 countries from 1975 to 1996, [39] found that global population growth is more than proportionally associated with an increase in carbon emissions and that the impact of population growth on carbon emissions is much more pronounced in developing countries than in developed countries. Second, other studies address population size, as there are diseconomies of scale associated with the largest nations that are not consistent with the IPAT model's assumption of direct proportionality (loglinear effects) commonly used in most previous studies [13]. Third, other demographic factors began to be considered in addition to population size and population growth. Both higher urbanization rates and lower average household sizes have been proven to increase carbon emissions [8].

The first method used is index decomposition analysis (IDA). Carbon emissions are usually decomposed into the products of emission intensity based on income (C/Y), income per capita (Y/POP) and population size (POP) [36]. The logarithmic mean weight Divisia index (LMDI) method is most extensively applied [1,37]. The second most common method is structure decomposition analysis (SDA). Using an input-output model, structure decomposition analysis provides a unified framework to clarify the underlying causes of increased GHG emissions [47]. The third method is the IPAT model and its extended forms. They have been extensively employed to study the impacts of human activities on the environment. Specifically, the STIRPAT model allowed for precise specification of the sensitivities of environmental impacts to driving forces. This method not only analyses the basic science of environmental change but also identifies the factors that may be most responsive to policy [10,39,48,49]). Because it is difficult to introduce other demographic factors into the LMDI model except for population size and input–output table data are needed for SDA, this paper uses the STIRPAT model to analyze the relationship between population factors and China's carbon emissions.

Since the end of the 19th century, population age structure has gradually been recognized as one of the most important demographic factors connected to carbon emissions. Generally, two views exist. The first view is that societies with high shares of working-age individuals are characterized by higher carbon emissions [39,49]. Conversely, the other view suggests that societies with high shares of individuals under 15 years of age emit more carbon dioxide [16]. Moreover, [8] insist that carbon emissions are not significantly related to age composition. These results, which were derived using mixed data from developed and developing countries, have been criticized because they presume homogeneous relationships between emissions and their determinants in spite of different socio-economic conditions [36]. In fact, the relationships between population age structure and carbon emissions vary for different levels of development. From 1975 to 2005, the proportion of the population between 15 and 64 years had a negative impact on the total carbon dioxide emissions of countries with high income levels, whereas the impact was positive at other income levels [15]. [30] also found a negative correlation between the population share aged 35–64 and carbon emissions in developed countries. However, in the long run, it is noteworthy that population aging reduced U.S. carbon dioxide emissions by almost 40% in a low population scenario, and the effects of aging on emissions can be as large as, or larger than, the effects of technological change in some cases [11]. Focusing on OECD countries, [29] found that based on household electricity consumption, the effect of age structure on carbon emissions exhibited a U-shaped curve. Additionally, [35,36] noted that carbon emissions increased as the share of individuals born after 1960 increased.

With growing pressure to reduce emissions in recent years, research has focused on emissions in China. For example, [53] examined the impacts of population size, population structure and consumption level on China's carbon emissions. [42] focused on Guangdong Province and studied the influences of population, economic level, technology level, urbanization level, industrialization level, service level, energy consumption structure and foreign trade degree on energy-related carbon emissions. [43] used Beijing as an example and analyzed the driving forces of household transportation emissions from the perspective of individual travel characteristics. [34] investigated the complex mechanisms of the impacts of demographic changes, economic growth and technological advancements on energy consumption and pollutant emissions. [50] examined the influences of regional variations associated with urbanization, consumption ratio and consumption structure on residential indirect carbon emissions.

In summary, a consensus has not been reached regarding the