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Will income inequality affect environmental quality? Analysis based on China's provincial panel data

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ABSTRACT

During the last two decades of China's rapid economic growth, the gap in citizens' income has widened and environmental quality has deteriorated. Using Gini coefficients as the measure of income inequality, this study investigated the impacts of income inequality on carbon emissions per capita in China. To control for potential endogeneity and allow for dynamics, the Generalized Method of Moments (GMM) technique is utilized. Moreover, the influential factors that can affect carbon emissions per capita in China have been examined. The empirical results indicate that carbon emissions per capita increase as the income gap expands for nationwide and in the eastern and non-eastern regions of China. Among all factors that may affect carbon emissions per capita, a "U" shaped relationship exists between per capita income and per capita carbon emissions, and increasing the value-added share of secondary industry in the GDP would significantly increase carbon emissions per capita.

1. Introduction

Since the period of economic reform the late 1970s, China's economy has achieved rapid development. In the meantime, the sharp increase in China's energy consumption and carbon dioxide emissions has become a significant problem that has attracted domestic and foreign attention. According to *World Development Indicators 2006*, 16 of the world's 20 most polluted cities are located in China. In recent years, serious haze and fog pollution has plagued large areas of northern and eastern China, which reflects the fact that air pollution has become one of the most crucial environmental issues in China. China's environmental deterioration and vulnerability has seriously threatened the physical and psychological health of Chinese citizens and has exerted a negative impact on China's international image (Zhang and Hao, 2016). According to statistics from the Oak Ridge National Laboratory Carbon Dioxide Information Analysis Center (CDIAC), China has become the world's largest CO_2 emitter since 2008, with carbon emissions in 2012 accounting for approximately 25% of the global greenhouse gas emissions. Consequently, China has been under tremendous pressure from the international community to control carbon emissions and to improve environmental quality. In recent years, China's government has made a great effort to sustain energy conservation and reduce emissions, making several specific and ambitious commitments. For example, China's State Council declared in 2009 that China was set to cut carbon intensity (the carbon emissions as a percentage of GDP) by 40–45% by 2020 based on the 2006 level. In November 2014, in a joint statement on climate change by China and the United States, Chinese president Xi Jinping promised to achieve China's peak CO_2 emissions by 2030 and raise the share of non-fossil fuels in primary energy consumption to approximately 20%.[1] Impressive and systematic changes may occur in China following this series of energy saving measures and emission reductions being carried out as well as the optimization and adjustment of China's economic and social structure.

Due to China's rapid economic development, its economic and social structure is undergoing drastic changes, including the expansion of the regional income gap and the unbalance of the distribution pattern. Galor and Moav (2004) theorized that the widening income gap was not conducive to sustainable economic development. Therefore, building a well-off society and rejuvenating China requires narrowing the income gap and

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[1] For reference, see http://uk.reuters.com/article/2014/11/12/china-usa-climatechange-idUKL3N0T17FC20141112.

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alleviating the unfair distribution of income. China is currently facing major challenges in reducing energy consumption, energy conservation and emission reduction to guarantee more reasonable and fair economic development.

Protecting the environment and narrowing the income gap are significant issues on which China will focus for some time to come. Do the two issues share a degree of correlation? The relationship between income gap and environmental pollution raises two questions: (1) Whether the widening income gap would lead to detrimental impacts on environmental quality; if yes, how would it affect the environmental quality and what consequences would cause. (2) Whether the income gap will influence economic development and thus aggravate environmental pollution as the economy grows or weaken environmental governance through economic adjustments. Domestic and foreign scholars have studied the relationship between income gap, economic development, and environmental pollution, but they have not yet reached a conclusion.

Therefore, this study's main contributions include: (1) using the GMM method rather than the unconventional fixed effects method for measurement, which can control endogeneity and involve dynamic effects; (2) using provincial panel data to analyze how income inequality would affect pollution emissions in China; (3) verifying this relationship in different regions with regional discrepancies considered.

To overcome various deficiencies in the previous analyses of their relationship, we carefully choose appropriate methods for empirical analysis and prove the stability of results through the study of different regression specifications. For example, to examine the influence of economic development and regional economic disparity on carbon emissions, we overcome the potential deficiencies of multinational data by using China domestic data and systematically measuring the carbon emissions of Chinese provinces. We infer the calculation formula for the Gini coefficient by calculating the provincial-level Gini coefficients from 1995 to 2010 using Tian's (2012) methodology and assuming that Lorenz curves refer to the ratio of the area between the line of equality and the Lorenz curve over the area of perfect equality of incomes. We use the formula to measure and calculate the Gini coefficients of incomes of rural and urban residents in provincial regions from 2011 to 2012. Then, we use the grouping weighting method to calculate the Gini coefficient of residents' total incomes in provinces (cities, districts) from 2011 to 2012. This method yields complete panel data with compatible, comparable calculations, using provincial regions from 1995 to 2012 as basic indexes, which allows us to empirically examine the influence of regional income gaps on carbon emissions. To fully introduce dynamic factors into our quantitative analysis of the relationship, we use the GMM method to verify their relationship except for the fixed effects estimates of standard static panel data. Meanwhile, considering the differences of carbon emissions in northern, central and western regions, we adopt both national and regional data to analyze the influences of carbon emissions and identify variables such as GDP per capita, regional Gini coefficients, industrial structure, energy intensity and the urbanization level as explanatory variables for China's carbon emissions. We then focus further on the influence of regional income differences on carbon emissions to offer policy suggestions for environmental protection and economic development in different regions. Selecting proper regression methods and specifications validates the credibility of our empirical results and guarantees the rationality of the corresponding policy recommendations.

The remainder of this study is organized as follows: Section 2 briefly reviews the relevant literature. Section 3 introduces the theoretical models explaining the possible relationships between income inequality and environmental quality, and Section 4 describes the data source and methods of empirical analysis. Section 5 presents the empirical estimation results and the corresponding analysis. Section 6 concludes the study and describes several policy implications.

2. Literature review

The relationship between economic development and environmental pollution was mainly based on the Environment Kuznets Curve (EKC) hypothesis. This hypothesis posits the existence of an "inverted-U" shaped relationship between economic development and environmental pollution, that is to say, in an early stage of economic development, the environmental quality was deteriorating steadily with the increase of per capita income. However, when the income level reached a certain turning point, the increase of income would positively influence environmental quality. The previous analyses mainly focused on economic growth and the increase of per capita income, but paid insufficient attention to the pattern of economic development. To further explore the relationship between economic development and environmental pollution, income distribution, as another aspect of economic development, should also be included in the analysis. In terms of income distribution, the relationship between income gaps and economic growth had long attracted scholars' interest. Theoretically, although income gaps might contribute to economic growth at an early stage, it would curb economic growth that reached a certain level.[2]

Several scholars have recently empirically tested EKC hypothesis. Their research can be divided into two categories based on their conclusions: (1) studies that verify the influence of income inequality on environmental pollution by examining the existence of the EKC, including Torras and Boyce (1998), Grossman and Krueger (1991), Shafik and Bandyopadhyay (1992), Selden and Song (1994), Panayotou (1993), Coondoo and Dinda (2002), John and Pecchenino (1994), Shao et al. (2011), and Golley and Meng (2012). They conducted empirical studies on the relationship between different environmental pollution indicators and economic growth as well as income gaps, respectively. Their research proved the existence of EKC and found that the constantly widening income gap affected environmental quality. For example, Torras and Boyce (1998) focused on environmental policies and adopted indicators of water quality provided by 287 observation stations in 58 countries and observable air quality indicators of 18–52 cities in 19–42 countries. By detecting seven different types of pollution variables, they empirically proved that income inequality would lead to environmental degradation. By employing models using sulfur dioxide, smoke and dust as indicators of environmental quality, they discovered that widening income gaps and the degradation of environmental quality coexist in low income countries, which paves the way for studies about the relationship between income inequality and environmental pollution. In similar studies, Grossman and Krueger (1994), Shafik and Bandyopadhyay (1992) and Selden and Song (1994) also found that income inequality would lead to deviation from environmental policies. Rich people, who often had more political power, only considered economic costs and benefits, whereas the terrible environmental cost was mostly borne by the poor, who accounted for most of the population; such environmental policies would aggravate pollution. Because everyone

[2] Except for examining the existence of EKC, some other aspects of the relationship between environmental quality/energy consumption and the economic development have also been investigated. For instance, some researchers examined the causality between environmental quality/energy consumption and the economic development (e.g., Wang et al., 2011; Zhang, 2011), some studies examine the so-called "decoupling effects" or "rebound effects" of energy consumption and related CO_2 emissions (e.g., Zhang and Da, 2015; Zhang et al., 2015).