



Would income inequality affect electricity consumption? Evidence from China



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ABSTRACT

Recently the expansion of urban-rural income inequality and the rapid growth of fossil-energy consumption have become two significant challenges China should address to achieve its ambitious goals. For the first time, this study uses the Chinese provincial panel data during the period of 1996–2013 to perform a quantitative analysis on the relationship between the urban-rural income gap and the per capita electricity consumption. Fully considering the potential endogeneity problem, this paper uses the orthogonal-difference Generalized Method of Moments (GMM) as the benchmark estimation method. To ensure the robustness of the estimations, the Theil index and per capita urban-rural income are utilized to measure the urban-rural income gap. The estimation results indicate that the influences of urban-rural income inequality on electricity depend on the income level. At the current stage of economic development, the income disparity has significantly negative impacts on provincial per capita electricity consumption. Moreover, there is also strong evidence for the existence of the inverted U-shaped relationship between per capita electricity consumption and GDP per capita. Furthermore, other economic and social factors, including the enhancement of urbanization and industrialization levels, the adjustment of the population structure, and the development of import-export trade may also promote electricity consumption.

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1. Introduction

Despite the remarkable achievements of economic development in the past three decades since the reform and opening up in the late 1970s, criticisms and suspicions have been recently looming over the sustainability of China's neck-breaking growth.¹ Currently, the increasing inequality in development between urban and rural areas and deteriorating environmental quality have become the main barriers to China's sustainable development.² Due to the dualistic economic structure and the specific tax and fiscal policies that favored the development of urban areas, the huge gap in development between urban and rural areas has long

been a problem in China (e.g., [89,94]). As shown in Fig. 1, since 2002, the ratio of China's urban-rural residential income has been consistently over 3.0. Particularly, in 2009, this ratio achieved its highest level of 3.33. In recent years, the urban-rural income gap has slightly narrowed, although the level remained high at 3.03 in 2013. Among China's three main regions (east, center and west), the urban-rural income disparity is lowest in the prosperous eastern region while largest in the relatively less developed western region.

Partly because of the accelerated industrialization, urbanization and rapid economic growth, in recent years, China's consumption of fossil energy surged (e.g., [47,102]). The impact of urbanization and migration may significantly affect energy consumption and

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¹ According to *China Statistical Yearbook 2015*, from 1979 to 2014, the average annual growth rate of China's GDP was 9.7%. For more information, please refer to <http://www.stats.gov.cn/tjsj/ndsj/2015/indexch.htm>.

² There has been growing anecdotal evidence that the urban-rural development gap and environmental problems may impede China's sustainable growth. For instance, refer to <http://www.bbc.com/news/business-13945072> and <https://www.weforum.org/agenda/2015/11/will-china-become-a-global-climate-leader/>.

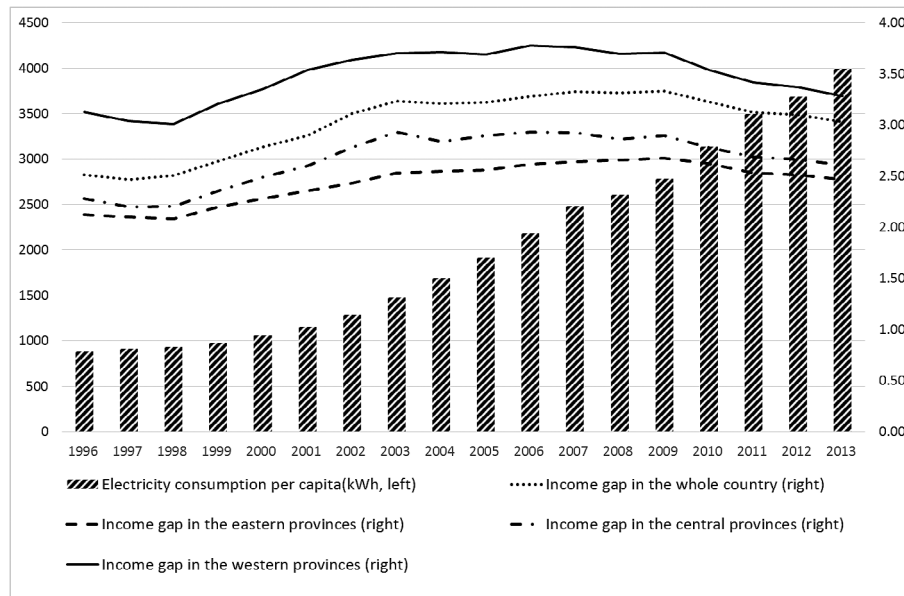


Fig. 1. Per capita electricity consumption and the income gap between urban and rural areas in eastern, central and western provinces as well as in the whole country, 1996–2013. Notes: The eastern provinces include Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan; the central provinces include Heilongjiang, Jilin, Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan. The western provinces include Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, Xinjiang.

Data sources: China Statistical Yearbooks and Chinese Energy Statistical Yearbooks of various years

carbon emissions, and therefore bring pressure to the energy system [57,97]. Consequently, China's CO₂ emissions ballooned, which garnered the increasing focus of the international community as global warming has become a growing threat to the world. In recent years, due to the improvement of production efficiency, China's carbon dioxide intensity (i.e., CO₂ emissions per unit of GDP) has been dramatically decreased. However, the total amount of CO₂ emissions continues to soar. In 2009, to promote energy conservation and emission reduction, the State Council of China, for the first time, formulated carbon emission reduction targets; by 2020, China's carbon intensity (CO₂ emissions per unit of GDP) is set to be decreased by 40%–45% of the 2005 level. Since then, China has announced a series of ambitious goals to curb CO₂ emissions. Before the 2015 UN Climate Change Conference in Paris, China vowed to peak total CO₂ emissions by 2030, and the carbon intensity is expected to be decreased by 60%–65% in 2030 compared with the level of 2005. Therefore, the ensuing 10–15 years are a critical period for China to accomplish its goals in constraining CO₂ emissions and enhancing green development.

The promotion of the usage of electricity, the relatively cleaner energy source, particularly the increase in renewable energy power generation, is an important measure to promote energy conservation and reduction of CO₂ emissions (e.g., [43,62]). In China, the amount and the importance of electricity consumption have grown very rapidly in recent years, and the ratio of traditional fossil energy in the energy mix is declining. According to *Chinese Energy Statistical Yearbook 2014*, China's electricity consumption per capita had increased by over four-and-a-half times from 894 kW-hours (kWh) in 1996–3993 kWh in 2013 (as shown in Fig. 1). During this period, the average annual growth rate of China's electricity consumption per capita was 9.3%, which was slightly higher than the annual growth rate of GDP per capita (9.1%). In a recent study, Hao et al. [33] found that China's consumption of coal, the main source of CO₂ emissions and haze pollution, is expected to peak around 2020. The reduced proportion of fossil energy was partly absorbed by renewable energy. According to Renewable 2015 Global Status Report, China's renewable energy power generation represented

23% of the global level in 2014.³ In the same year, the investment in renewable energy power generation initially exceeded the net investment of fossil energy power plants, among which wind power generation was more than 100 GW-hours (GWh), and hydropower represented 27% of the global level. The growth of electricity consumption, particularly power generated from renewable energy, contributed to the cleaning of China's energy structure and the reduction of CO₂ emissions, which could further help to improve China's environmental quality [19,35]. There has been much research on the factors that affect the electricity consumption. For instance, Shiu et al. [69] found that there was a co-integration relationship between actual GDP and electricity consumption in China. Jacobson et al. [42] indicated that the quality of energy services, as well as the level of industrialization and economic development of a country, has a significant impact on electricity consumption. Sanquist et al. [68] concluded that household income, local electricity prices, access to natural gas and consumption characteristics in an electricity market are important factors that affect energy consumption.

In the context of China, there is remarkable disparity in urban-rural income inequality and electricity consumption across different regions. As shown in Fig. 2, the disparity in the distribution of electricity consumption across Chinese provinces was persistent during the sample period between 1994 and 2013. Specifically, in both 1994 and 2013, certain central and western provinces, including Henan, Hubei, Hunan, Sichuan, Chongqing and Yunnan, had a relatively higher urban-rural income gap, and the electricity consumption in these provinces was relatively low.⁴ Additionally, as represented in panels b) and d) of Fig. 2, the Theil

³ For more information, please refer to <http://www.climatechangenews.com/2015/06/19/renewable-energy-in-numbers-ren21-report/> and <http://www.ren21.net/status-of-renewables/global-status-report/>.

⁴ Currently, there are 23 provinces, four Centrally Administered Municipalities, and five autonomous regions in China. Because these entities are administratively equal, the term "province" is utilized throughout the paper. Tibet and Taiwan are excluded due to data unavailability.

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