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Research paper

Different effects of main influence factors on household energy consumption in three typical rural villages of China

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ABSTRACT

Three typical rural villages are chosen as study areas to study the different effects of main influence factors on rural household energy consumption using the ordinary least squares (OLS) model and the quantile regression (QR) model. Three typical rural villages include an affluent rural village in the richest province, a well-off rural village in the most energy-rich province and an out-of-poverty rural village in the most population province. The OLS results show family size and household income are significant at the 10 % level in all study areas, while air conditioner and refrigerator are only significant at the 5 % level of the affluent rural village. Family size has a positive effect on energy consumption, while household income has different effect in different areas. The QR results fluctuate around QLS results with large amplitude, indicating a different pattern of the effect of main independent variables on energy consumption using different models. The slopes are significantly different for all study areas at 10% significant level, which shows the distribution heterogeneity in studying the relationships between energy consumption and influence factors. This study is useful to develop more appropriate energy policy according to the main influence factors in different rural villages.

1. Introduction

With the rapid urbanization in China, the rural population was declining in recent years, whereas rural household energy consumption was rising sharply. Although the rural population declined from 745.4 million in 2005 to 603.5 million in 2015 (NBS, 2017), energy consumption of rural residents increased from 115.5 million tons coal equivalent (tce) in 2005 to 211.8 million tce in 2015 (NBS, 2016), with an annual growth of 6.6%. The average annual household energy consumption of rural residents increased from 155 kg coal equivalent (kgce) in 2005 to 351 kgce in 2015, approximately 226.5%. If China can maintain the average annual urbanization rate of 1% and reach an urbanization rate of approximately 70% by the end of 2030, there will still be more than 400 million rural population, which means enormous rural household energy consumption due to rising average annual household energy consumption of rural residents (Yu and Guo, 2016).

To reduce the enormous rural household energy consumption by the large rural population, it is necessary to further study the effect of main influence factors on rural household energy consumption. Some researchers analyzed the effect of main influence factors on household energy consumption at the macro-level, with the data came from the government statistics such as China Statistical Yearbook. The stochastic impacts by regression on population, affluence and technology (STIRPAT) model is the most widely applied at the macro-level to research the relationship between household energy consumption and its influence factors (Ding et al., 2016). GDP per capita, average temperature, and population are the popular influence factors used in this model (Ding et al., 2016; Miao, 2017; Li, 2015). Logarithmic mean Divisia index (LMDI) technique is also frequently applied to the field of energy consumption (Nie and Kemp, 2014; Chung et al., 2011; Zhang and Guo, 2013), which can analyze the influence factors on energy consumption at the macro-level. Population, floor space, energy mix, appliance, and climate effect may be chosen as influence factors in the LMDI decomposition analysis. Residential energy model global (REMG) model (Daioglou et al., 2012), bottom-up model for residential energy use (van Ruijven et al., 2011), piecewise linear model (Liu et al., 2016), panel smooth transition regression (PSTR) model (Lee and Chiu, 2011), consumer lifestyle approach (CLA) (Wei et al., 2007), stochastic impacts by regression on population, affluence, and technology (STIRPAT) model (York, 2007), quantile regression (QR) model (Kaza, 2007), local area resource analysis (LARA) model (Druckman and Jackson, 2007) are also applied to research the influence factors on household energy consumption. However, due to the lack of detailed statistics on rural household energy consumption, researching the main influence factors on household energy consumption at the macro-level focuses on a province-level or city-level, and the conclusions are applied to

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Table 1
The summary of factors influencing the rural residential energy consumption in recent studies.

	Authors	Sample	Data period	Data source	Rural/urban	Influence factors	Methods	How do the factors act on the household energy consumption/ electricity consumption?
Macro-level	Ding et al. (2016)	30 provinces in China	1997–2013	China Energy Statistical Yearbook (1998–2014), China Statistical Yearbook (1998–2014), National Meteorological Information Center	Rural and urban	GDP per capita, urbanization level, annual average temperature	STIRPAT model	Significant positive impact (GDP per capita), significant negative impact (annual average temperature), uncertainty (urbanization level)
	Liu et al. (2016)	540 observations in 30 Chinese provinces	1995–2012	China Energy Statistical Yearbook (1996–2013), China Statistical Yearbook (1996–2013)	Rural and urban	Income	Piecewise linear model	Significant impact on residential electricity consumption (income)
	Li and Lin (2015)	A balanced panel data set of 73 countries	1971–2010	World Bank, UN	Rural and urban	Urbanization, industrialization	STIRPAT model	Significant impact (urbanization, industrialization)
	Nie and Kemp (2014)	China	2002–2010	China statistical yearbook 2011, China energy statistical yearbook (2003–2011)	Rural and urban	Population, floor space, energy mix, energy demand from appliances effect	LMDI technique	The most important factor (energy demand from appliances effect), the second most important factor (floor space), the third most important factor (population), negligible factor (energy mix)
	Zhang and Guo (2013)	China	1991 to 2010	China Statistical Yearbook, China Energy Statistical Yearbook	Rural	Population, energy intensity, per capita net income, energy mix	LMDI technique	The critical factor (per capita net income), dominant role (energy intensity), followed effect (population), very minor role (energy mix)
	Daioglou et al. (2012)	India, China, South East Asia, South Africa and Brazil	2007	World Development Indicators of the World Bank, World Bank, World Health Organization	Rural and urban	Population, household expenditure, population density, household size, temperature	REMG model	Primary drivers of energy use (population, household expenditure, population density, household size, temperature)
	van Ruijven et al. (2011)	India	1971–2003	OECD Environmental Outlook scenario, National Sample Survey Organization (NSSO) of the Ministry of Statistics	Rural and urban	Population, household size, income and temperature	Bottom-up model	Primary drivers of energy use (population, household size, income and temperature)
	Lee and Chiu (2011)	24 OECD countries	1978–2004	The World Development Indicators	Rural and urban	Real income, electricity price, and temperature	PSTR model	Significant impact (real income), negative or U-shaped relationship (temperature), no influence (electricity price)

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the average situation rather than the actual rural village. Because (NBS, 2017), many non-farmer population are often classified as rural resident is defined "the resident living outside of urban area" rural population in Chinese official statistics, which leads to great