CHINA'S URBAN RESIDENTIAL ENERGY DEMAND AND REBOUND EFFECT: A STOCHASTIC ENERGY DEMAND FRONTIER APPROACH

Zheming Yan, Shaanxi Normal University, +86-18629268760, zhemingyan@snnu.edu.cn

Shuai Shao, Shanghai University of Finance and Economics, +86-18621838918, shao.shuai@sufe.edu.cn

Kerui Du, Shandong University, +86-18559676996, kerrydu1986@gmail.com

Overview

Given the solid commitment for reducing the use of exhaustible energy, China's ambitious goal of climate change mitigation is facing with many challenges, among which energy rebound effect (RE) represents the not-proportionate relationship between energy efficiency gains and energy consumption reduction (Dimitropoulos, 2007). That is, the actual energy saving may be smaller than the potential energy saving of energy efficiency gains (Sorrell, 2007). Thus, a feasible climate-change-mitigation strategy should take account of the rebound effect, which relies on scientific and consistent RE estimation. Following the industrial sector, the residential sector is the second energy consumer in China. To our best knowledge, the existing evidences on China's residential RE are still not consistent (Shao, 2014; Zhang and Lin Lawell, 2017; Zhang et al., 2017).

Moreover, the RE is important not only because of its policy implications, but also because it brings about interesting and challenging topics for energy demand theory, economic production theory and other related fields. In general, many studies estimated rebound effect by calculating the price elasticity of energy demand, assuming a symmetric relationship between price change and energy efficiency change. But such an assumption has been intensively challenged, which induces the methodological innovations in RE estimation recently. In particular, Orea et al. (2015) employed an energy demand frontier model approach that can avoid the above symmetry assumption. But when investigating residential sector's energy demand and energy rebound effect, few studies took account of the impact of climate change. Thus, a consistent estimation of China's RE of the residential sector requires more methodological innovations.

Methods

In this paper, we employ the direct measurement of energy rebound effect, which relies on estimation of energy efficiency level of the residential sector. Specifically, we use the energy demand frontier model that is firstly proposed by Filippini and Hunt (2012) and then developed by Orea et al. (2015). Regarding the econometric specification of the energy demand frontier model, we take account of factors that influence the residents' energy demand and factors that determine the residents' level of rebound effect, e.g., we construct a variable of temperature deviation that captures the impact of climate change on energy demand. To estimate the stochastic (energy demand) frontier model, we use a data panel of 30 Chinese provinces over the period of 2001-2014, and employ the maximum likelihood estimator as suggested by Orea et al. (2015).

Results

Comparing the model with energy rebound effect to the model without energy rebound effect, we find the estimated results of coefficients are quite different, indicating that the implicit energy efficiency of the same sector are different between the models. So the neglect of energy rebound effect might cause bias when exploring the energy efficiency and energy demand.

Regarding the results of energy demand frontier model with non-zero rebound effect, we find the energy price, resident's income, temperature deviation, population and population density are significant impact factors of energy demand of the residential sector in China, and the energy price and resident's income are significant impact factors of the rebound effect.

The estimated energy rebound effect of the residential sector shows an obvious variation among provinces. While the mean value of the adjusted energy rebound is 0.54, the year-and-province specific energy rebound effect ranges from 0.0003 to 0.9999 for the research samples.

Conclusions

This paper provides with some new evidences regarding the energy rebound effect in China's residential sector, while most exsiting studies explored the energy rebound on the micro-economic level or on the industrial sector level. The results of this paper suggest the necessity of energy rebound effect when investigating energy demand and energy efficiency. Regarding the specific energy rebound effect in China's residential sector, the mean level of 0.54 and a non-negligible regional difference remind China's climate policy makers the significance of energy rebound effect.

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