

AN ANALYSIS OF HOUSEHOLD ENERGY CONSUMPTION IN TAIWAN: EVIDENCE FROM QUANTILE REGRESSION

Wen-Hsiu Huang, Department of Public Finance, Ling Tung University,
No.1, Ling Tung Rd, Taichung 40852, Taiwan
e-mail: michelle@teamail.ltu.edu.tw

Ming-Che Chao, Institute of Civil Engineering, National Chi Nan University,
No.1, University Rd, Puli, Nantou County 54561, Taiwan

Phone: +886-04-9291-2151, Fax: +886-04-9291-0907, e-mail: dreame79.tw@yahoo.com.tw

Overview

With the industrialization and urbanization, the rapid growth in energy consumption occurs in most of Asian countries. In Taiwan, energy consumption has grown 30% from 2000 to 2011, which is higher than the average international increase of 26% (IEA, 2011). Moreover, almost 98% of the energy supply is imported in Taiwan. Coal and crude oil account for 78% of the total energy supply. Thus, energy efficiency and energy saving are particularly important for sustainable development in Taiwan. In the residential sector, it is also revealed that energy consumption increases over time. From 2000 to 2011, Taiwan's residential energy consumption increases by 15% compared with the worldwide increase of 13%. The household, as a basic unit of the market, plays a critical role in energy demand. However, it is challenging to promote household energy saving. Since households are run by individuals and are not forced to take particular actions, it is difficult to control household energy consumption through regulation (Hori, 2013). Therefore, it is important to identify the determinants of household energy consumption in order to make policies for promotion of sustainable energy consumption. In this paper, we employ the quantile regression (QR) models to analyse the determinants of household energy consumption for different levels of energy use and investigate how the behaviours of household energy consumption have changed over the past four decades.

Methods

Due to the great diversity of behavior, household consumption may exhibit a pattern of heterogeneity. Deaton (1997) showed that the elasticity of household expenditure varies across the quantiles. With the high variability in the energy consumption dataset, the classical ordinary least squares (OLS) regression would draw doubtful conclusions (Randolph, 2008). In particular, when the response is skewed, the OLS regression may result in misleading regression coefficients (Reeves and Lowe, 2009). To account for the heterogeneity and skewed distribution in the data, we employ the quantile regression model to investigate the determinants of household energy consumption. Quantile regression, developed by Koenker and Bassett (1978), estimates the effects of predictor variables on specific quantiles of the dependent variable. As a tool of comparative analysis, QR provides a complete view about the effects of possible factors on household energy consumption. We use the household data from the 1981, 1991, 2001, and 2011 waves of Taiwan's Family Income and Expenditure Survey (FIES). In order to improve our understanding of the distribution and trends in household energy consumption in Taiwan, we explore how demographic, socioeconomic, and household dwelling characteristics may contribute to household energy consumption over time. We use per capita household energy expenditure as the dependent variable. The independent variables include household head characteristics, household characteristics, economic variable, and household dwelling characteristics.

Results

Our results show that the parameter estimates of QR differ along the distribution of household energy consumption. First, household income had significantly positive effects on energy consumption and the magnitude of income effects increased monotonically across quantiles. High energy use households were more sensitive to the increase of income than low energy use households. In particular, the effects of income variable decreased over time. This implies that energy use gradually decoupled from economic growth. Second, the characteristics of household head had significant effects on household energy consumption. Female-headed households consumed more energy than male-headed households at the high quantile. Educational attainment of household head had negative effects on household energy consumption. The magnitude of education effect is greater in the upper and lower quantiles of the energy use than in the middle. Third, as for the impacts of household characteristics, we find that the elderly ratio in a household had a positive effect on energy use in the 90th quantile, except in 2001. This implies that the elderly were more likely to spend their time at home and led to higher energy use. In addition, household size had negative effects on energy consumption due to the economy of scale. The contribution was highest at the top quantile. The effects increased over time because household size gradually declined. Whether the household is agricultural was

not a significant factor for energy consumption in 1981, 1991, and 2001. However, agricultural households consumed more energy than non-agricultural households in 2011. The possible reason is that modern agriculture which relies on new techniques and tools may be more energy-intensive than before. Fourth, household dwelling characteristics matter for energy consumption. The type of housing structure, such as housing area and number of floors, had influence on energy consumption. Other housing attributes, such as ownership status, whether or not the house is used for business, and number of energy-consuming appliances, also affected energy consumption. Fifth, as for the location factor, urban households had higher energy use than rural households. The differences of marginal effects between the upper and lower quantiles of energy use had augmented over time. This implies that the impacts of urbanization on energy use are stronger than before.

Conclusions

This study shows that the effects of demographic, socioeconomic, and household dwelling characteristics on household energy consumption may differ across the quantiles and change over the past decades. Our results suggest that strategies for energy conservation should focus on specific groups that household heads are female and low education attainment. In addition, households with higher income, smaller household size, and a higher ratio of the elderly would tend to consume more energy. As household size continues to decline and the aging population is expected to rise, more attention is required for the effects of demographic structure on energy demand. Thus, promotion of energy efficiency, especially for households that tend to consume more energy, may lead to significant benefits in energy conservation. Fortunately, the income effects on energy consumption had declined over time, suggesting a phenomenon that energy use gradually decoupled from economic growth. To hasten the decoupling procedure, it would be critical to increase incentives for households to use the energy efficient appliances.

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