

# ***THE DETERMINANTS OF INDIVIDUALS' EFFORTS FOR REDUCING ENERGY USE IN TRANSPORTATION AND RESIDENCE***

Wen-Hsiu Huang, Department of Public Finance, Ling Tung University, Taiwan, E-mail: michelle@teamail.ltu.edu.tw  
Ming-Che Chao, Institute of Civil Engineering, National Chi Nan University, Taiwan,  
Phone: +886-04-9291-2151, E-mail: dreame79.tw@yahoo.com.tw

## **Overview**

In recent decades, the impacts of global warming and climate change have become the main threats to environment and human life. The deterioration of environment is largely attributed to human activities. People are highly dependent on fossil fuels, including of coal, natural gas, and oil. The concentrations of greenhouse gases continue to increase. The International Energy Agency reported that fossil fuels consumption accounted for 66% of total energy consumption, and nearly 53% of fossil fuels were consumed in transport and residential sectors (IEA, 2014). Therefore, making strategies to reduce energy use in transport and residential sector is particularly important for sustainable development. 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 et al., 2013). The voluntary efforts of individuals for pro-environmental protection should be the highest priority for the aim of sustainable development. In this paper, we employ the generalized ordered logit model to analyze the determinants of individuals' efforts for reducing energy use in transportation and residence. Then, we know how to improve individuals' efforts for energy saving. The world-wide data are used to analyze the global model. In addition, we focus on some Asian countries, including Taiwan, Japan, Korea, and Philippines. We investigate whether there are different pro-environmental behaviors between these Asian countries.

## **Methodology**

Data for the analysis are obtained from the environmental modules of the International Social Survey Programme (ISSP) in 2010. This cross-sectional survey contains 34173 observations in 32 countries and includes questions about environmental behaviors, attitude, knowledge, and concern (ISSP Research Group, 2012). In the questionnaire, two questions can be used to capture individuals' efforts for energy saving in transportation and residence. One is "how often do you cut back on driving a car for environmental reasons?", and the other is "how often do you reduce the energy or fuel you use at home for environmental reasons?" Responses were coded as 4 = Always, 3 = Often, 2 = Sometimes, and 1 = Never. Since the ISSP database codes the degree of individuals' efforts according to a four-point scale from the lowest to the highest level, the ordered logit model would be suitable for estimation. However, the ordered logit model assumes that there exists equal relationship between each pair of categories of dependent variable, which is named as the proportional odds assumption. Accounting for the possible violation of the proportional odds assumption, we need to relax the assumption and allow that only a subset of variables violates the proportional odds assumption. Hence, we employ the generalized ordered logit model (Long, 1997). Based on the consideration of parameter variation, we can avoid incorrect, incomplete, or misleading results (Greene and Hensher, 2010; Kaplan and Prato, 2012). In the model, we use the degree of individuals' efforts for energy saving in transportation and residence as the dependent variable. The independent variables include objective and subjective factors. The objective factors contain the characteristics of respondents, such as age, income, education, gender, marital status, and residential location. The subjective factors consist of environmental knowledge, willing-to-pay, environmental efficacy, risk consciousness, and environmental concern.

## **Results**

The results confirm that the impact of explanatory variables on the ordered discrete outcome would not be same across all alternatives. The generalized ordered logit model would be an appropriate framework to explore what are the determinants of individuals' efforts for energy saving in transportation and residence. We estimate the global model and four models of Asian countries, including Taiwan, Japan, Korea, and Philippines. We obtain the following results. First, the income variable has significantly negative effects on pro-environmental behaviors in the global model. The negative effects of the income variable also can be verified in Japan and Korea. These results indicate that people would tend to pursue a better material life standard and consume more energy when their economic ability increases, especially in the highly developed countries. Second, in the global model, the education

level has no effects on individuals' efforts for energy saving in transportation and residence. The positive effects of education only can be found in Philippine among these Asian countries. Thus, how to embed environmental education in the formal education courses and improve pro-environmental behaviors through education would be important for the aim of sustainable development. Third, other characteristics of respondents, such as age, gender, marital status, and residential location also have significant effects on pro-environmental behaviors in the global model. The elder, female, and unmarried people tend to make more efforts for energy saving than the younger, male, and married people. Urban residents have more intention to save energy than rural residents. Fourth, as for the effects of subjective factors, environmental knowledge, environmental attitude, risk consciousness, and environmental concern have significantly positive effects on pro-environmental behaviors in transportation and residence for the global model. We further observe the effects of these subjective factors in the four Asian countries. Environmental knowledge has significantly positive effects on pro-environmental behaviors for all of the four Asian countries. But, the positive effects of risk consciousness and environmental attitude only can be verified in Korea among these Asian countries. Therefore, even people are conscious with risks of climate changes, they would be hard to modify their energy consumption patterns. There exists a gap between environmental attitude and behavior. These results reflect the phenomenon of "behavioral lock-in", which means that the consumption habits are potentially counterintentional (Marechal, 2009; Marechal, 2010; Sun et al., 2014).

## Conclusions

This study employs the generalized ordered logit model to analyze the determinants of individuals' efforts for energy saving. In particular, we focus on pro-environmental behaviors in the aspects of transport and residence. The results show that the demographic and socioeconomic characteristics, such as gender, age, marital status, income, and residential location would have significant effects on pro-environmental behaviors. It is worth noting that the education level is not a significant factor, although the increase of environmental knowledge can improve pro-environmental behaviors. This result implies that people with higher education would not have more intention to save energy. Our results suggest that strategies for energy conservation should focus on environmental education in school. The formal education should emphasize the importance of environmental protection and enlighten the environmental impacts of human activities. In addition, better environmental attitude and higher risk consciousness would not result in more friendly environmental behaviors for specific Asian countries. The lock-in effect of consumption habits would be an obstacle for the aim of energy saving. Therefore, the government should make effective policies to encourage people's willingness to practice and take more strict actions to change individuals' behaviors. Our results also showed that it is more challengeable to change people's behavior patterns in transportation than in residence. The policy makers should pay more attention to induce people's travel behavior toward energy conservation.

## References

- Greene, W. H. and D. A. Hensher (2010) *Modeling Ordered Choices: A Primer*. Cambridge University Press, UK.
- Hori, S., K. Kondo, D. Nogata, H. Ben (2013) "The determinants of household energy-saving behavior: Survey and comparison in five major Asian cities," *Energy Policy* 52, 354-362.
- International Energy Agency (2014) Energy balances statistics. <http://www.iea.org/statistics/topics/energybalances/>.
- ISSP Research Group (2012) International Social Survey Programme: Environment III - ISSP 2010. GESIS Data Archive, Cologne. ZA5500 Data file Version 2.0.0, doi:10.4232/1.11418.
- Kaplan, S. and C. G. Prato (2012) "Risk factors associated with bus accident severity in the United States: A generalized ordered logit model," *Journal of Safety Research* 43, 171-180.
- Long, J. S. (1997) *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks, CA: Sage Publications.
- Marechal, K. (2009) "An evolutionary perspective on the economics of energy consumption: The crucial role of habits," *Journal of Economic Issues* 43(1), 69-88.
- Marechal, K. (2010) "Not irrational but habitual: the importance of "behavioural lock-in" in energy consumption," *Ecological Economics* 69(5), 1104-1114.
- Sun, C., X. Ouyang, H. Cai, Z. Luo and A. Li (2014) "Household path way selection of energy consumption during urbanization process in China," *Energy Conversion and Management* 84, 295-304.