

2 0 2 0 年度

青山学院大学審査学位論文の要約

指導教員 松本 茂 教授

世帯の省エネ製品の選択と家計部門の省エネ対策に関する研究

—日本を対象とした調査—

A Study on Household Selection of Energy-Efficient Products and
Energy Conservation in the Household Sector:
The Case of Japan

経済学研究科

経済学専攻

WANG JIAXING (王 佳星)

A Study on Household Selection of Energy-Efficient Products and Energy Conservation in the Household Sector: The Case of Japan

Summary

Of the many environmental problems plaguing the earth today, global warming is the problem that attracts the most attention. Greenhouse gas (GHG), especially the carbon dioxide (CO₂) produced by human activity, have made a major impact on the earth's climate. Therefore, the reduction of GHG emissions, especially CO₂ emissions generated by economic activity, is key to global warming mitigation.

In this study, I focus on energy conservation in the household sector. Although GHG emissions from the household sector account for a large proportion of total emissions, the progress of the household sector's energy conservation is much slower than that of the industrial sector. One reason for this slow progress is that regulatory enforcement is more difficult with the household sector.

To lower the energy burden of the household sector, the government has been in an effort to penetrate energy-efficient products among households. In this doctoral dissertation, I investigate the effect of household energy efficiency investment on energy-consuming durables. Specifically, I conduct three analyses: (1) identification of households that feature energy-efficient/inefficient appliances; (2) identification of the socioeconomic characteristics of households that determine home appliance replacement cycles; and (3) the effectiveness of rebate programs for promoting energy-efficient products. I clarify the relationship between household socioeconomic characteristics and the selection of energy-efficient products and discuss effective measures for promoting energy-efficient

products to achieve household energy conservation.

In Chapter 2, I focus on household purchase decisions regarding energy-consuming durables. Previous studies have reported that households tend to not choose an energy-efficient appliance even if appropriate energy-saving information is provided. To identify the determinants of energy efficiency investment, I conducted a household survey in the Tokyo metropolitan area. Specifically, I collect product model information for the refrigerator that a household owns and calculate the yearly loss incurred from choosing a less efficient model. I then identify socioeconomic characteristics of households that are associated with these yearly losses. I find that wealthy households with many family members tend to purchase inefficient models. I also find that a house-renter with a high income is more likely to purchase an energy-inefficient model. A program targeted at such households could be effective for increasing energy savings in the residential sector. A revised version of this chapter has been published as: Wang, J., Sugino, M., and Matsumoto, S. 2019. Determinant of household energy efficiency investment: Analysis of refrigerator purchasing behavior. *International Journal of Economic Policy Studies* Vol.13, pp.389-402. <https://doi.org/10.1007/s42495-019-00014-0>.

A considerable number of households continue to use their old appliances even if they are informed that they can reduce their electricity bill by replacing them with new, energy-efficient versions. To resolve this underinvestment condition, governments have encouraged appliance replacement. In Chapter 3, I focus on product replacement and examine how household socioeconomic characteristics are associated with the REF replacement cycle. If the pattern of appliance use varies between households, then I expect that appliance replacement cycle also varies between households. Although many

studies identified early adopters of new energy-efficient products, no study has examined households that have been using old energy-inefficient products and how their characteristics are associated with product replacement. In this study, I initially modify a survival function and develop an economic model to evaluate the impact of household characteristics on appliance replacement. I subsequently apply the model in microlevel data analysis from the Survey on Carbon Dioxide Emission from Households obtained from the Ministry of the Environment of Japan. I use information about age distribution of refrigerators (REFs) and examine how family size, household income, and age of household's head affect the replacement cycle of REFs. The empirical results reveal that (1) large-sized, (2) high-income, and (3) young households replace REFs more rapidly. These findings suggest that policies that encourage small-sized, elderly, and low-income households to replace old appliances are needed. A revised version of this chapter has been published as: Wang, J., Matsumoto, S. 2021. An economic model of home appliance replacement: application to refrigerator replacement among Japanese households. *Environmental Economics and Policy Studies*. Online first. <https://doi.org/10.1007/s10018-020-00295-2>.

In Chapter 4, I investigate how such rebate programs affect household product selection. I focus on Hybrid Electric Vehicles (HEVs) and identify the households that switched from conventional gasoline vehicles to HEVs during the Eco-car program. Although many countries have implemented subsidy programs for energy-efficient products in order to reduce energy consumption and the greenhouse gas emissions associated with using those products, the effect of such programs has not yet been fully investigated in terms of their influence on households' product selection. The Japanese government introduced a subsidy program called the "Eco-car program" in 2009 and 2012. In this

study, I apply multinomial logit (MNL) models to micro-level data on vehicle selection from the National Survey of Family Income and Expenditure in order to identify the types of households that switched from conventional gasoline vehicles to hybrid electric vehicles (HEVs) using this subsidy program. I further apply a nested logit (NL) model to examine whether the subsidy program modified households' vehicle selection process. Our analyses demonstrate that more higher income households that used compact gasoline vehicles (CGVs) prior to the Eco-car program made a drastic switch to HEVs using the subsidy than those that used regular gasoline vehicles (RGVs). While older consumers chose HEVs over CGVs before the Eco-car program, younger consumers began choosing HEVs over CGVs after the program. Furthermore, the results from the NL model suggest that households' decision-making processes on vehicle selection have changed as consumers began choosing their vehicles more flexibly after the subsidy program. These findings suggest that subsidy programs did not only contribute to the promotion of energy-saving products, but also to the generalization of consumers' product selection. I received the revision request from Research in Transportation Economics and have submitted the revised version of this chapter to the journal.

Given the results obtained through these three empirical studies, I argue that policies targeting households that do not choose energy-efficient durables are necessary along with programs that enable households to recognize energy-saving benefits.